SCOPE AND SEQUENCE CHART FOR MSCE BIOLOGY

A. PLANT STRUCTURE AND FUNCTIONS

1. PHOTOSYNTHESIS

- Detailed leaf structure as seen under light microscope.
- Detailed mesophyll cell as seen under electron microscope.
- Adaptations of the leaf for photosynthesis.
- Investigating pigments of the leaf.
- Chemical equation of photosynthesis.
- Light and dark stage of photosynthesis.
- Fate of glucose after photosynthesis
- Importance of photosynthesis.

2. TRANSPORT IN PLANTS.

- Xylem and phloem tubes.
- Diffusion, active transport and osmosis.
- Transpiration.
- Translocation.

3. PLANT TROPISM.

- Phototropism.
- Hydrotropism
- Geotropism.

B. ANIMAL STRUCTURE AND FUNCTIONS

1. HUMAN DIGESTIVE SYSTEM

- Food substances.
- Enzymes.
- Physical and chemical digestion
- Absorption.
- Assimilation.
- Adaptations of small intestine to its functions
- Problems associated with digestive system

2. HUMAN CIRCULATORY SYSTEM.

- Functions of circulatory system
- Structure and functions of blood cells
- Structure and functions of heart artery, vein and capillary.
- Blood clotting
- Problems associated with circulatory system
- Lymphatic system.

3. EXCRETION

- Detailed structure and function of the kidney.
- Osmoregulation.
- Excretory substances.
- Kidney machine.

4. RESPIRATORY SYSTEM

- Gas exchange in lungs capillary and tissues.
- Carbonmonoxide poisoning
- Effects of smoking.
- Respiration in fish and insects
- Adaptations of respiratory structures of fish, insects and humans to their functions.

5. LOCOMOTION.

- Types of skeletons.
- Structure and function of bones
- Types of joints.
- How muscles work.
- Locomotion in fish and birds

6. REPRODUCTION

- Chromosomes.
- Mitosis and meiosis.
- Menstrual cycle.
- Fertilization and pregnancy
- Structure and functions of placenta.
- Birth process.
- Breast feeding.
- Contraception.
- Problems associated with reproduction

7. COORDINATION

- Neurons
- Central nervous system.
- Reflex actions and arcs.
- Conditioned reflexes
- Effects of drugs and alcohol on central nervous system
- Problems associated with nervous system
- Endocrine glands and hormones.

C. GENETICS AND EVOLUTION.

1. GENETICS.

- Variations amongst organisms of the same species.
- Source of variation.
- Mendelian inheritance pattern.
- Terms used in genetics
- Sex determination.
- Sex linked characteristics.
- Mutations
- Plant and animal breeding

2. EVOLUTION.

- Natural selection
- Darwin's theory of evolution.
- Evidence of evolution.
- Speciation.

D. HUMAN DISEASES.

- Diseases caused by protozoa. bacteria, viruses and fungi
- Mode of transmition of diseases caused by organisms mentioned above.
- Control and prevention of diseases caused by organisms mentioned above.
- Immunity.
- Blood groups.
- Blood transfusion
- Organ transplant
- Cancer.

E. ENVIRONMENT.

1. HUMAN POPULATION.

- Describing human population growth
- Factors affecting human population growth
- Problems associated with rapid population growth.

2. ECOSYSTEMS.

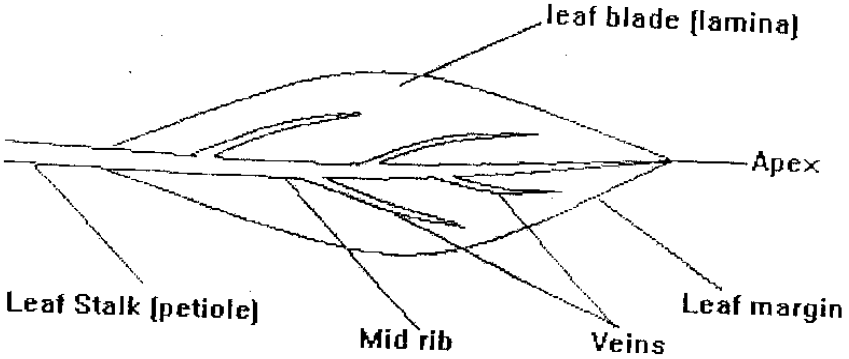
- Physical factors in fresh water and savanna woodland ecosystems.
- Plant communities in fresh water and savanna woodland ecosystems.
- Primary productivity.
- Environmental stress.
- Impact of human activities on the ecosystems.
- Management of resources in ecosystems.

TOPIC ONE: PHOTOSYTHESIS

All green plants are able to make their own food. This occurs because they have chloroplasts in their cells.

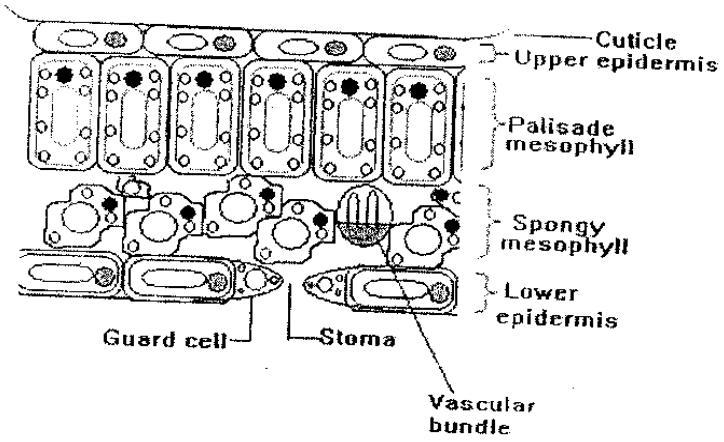
The process by which plants make their own food is called **Photosynthesis**. This process occurs in green parts of the plant such as leaves.

EXTERNAL PARTS OF A LEAF.



THE CROSS SECTION OF A LEAF SEEN UNDER LIGHT MICROSCOPE

When a leaf is cut transversally and observed under light microscope, its inner parts look like the figure below.



DISCRIPTION OF DIFFERENT PARTS OF A LEAF SHOWN ON THE CROSS SECTION ABOVE.

A. CUTICLE.

It is a thin water proof layer that covers upper and lower surface of a leaf.

Functions of cuticle.

1. It prevents excess loss of water from leaf.
2. It prevents unnecessary entry of water into a leaf.
3. It protects inner parts of a leaf from external physical damage.
4. Hairy cuticle protects a leaf from predators.

B. EPIDERMAL LAYERS (UPPER AND LOWER EPIDERMIS).

- These are layers of cells that lie after cuticle.
- Cells that form epidermal layers have no chloroplasts as such they can not make their own food.

Functions of epidermal layers.

1. They maintain shape of the leaf.
2. They reduce evaporation of water from the leaf.
3. They protect mesophyll cells from invasion of the pathogens
4. They protect inner cells from external physical damage.

C. PALISADE MESOPHYLL.

- It is a layer of cells just below upper epidermis.
- Palisade mesophyll has cylindrical cells called **palisade cells**.
- Palisade cells are tightly packed together and have lots of chloroplasts.

Function of palisade mesophyll.

- It provides an area where photosynthesis occurs.

Adaptations of palisade mesophyll for photosynthesis.

1. Its cells have lots of chloroplasts where photosynthesis occurs.
2. Its cells are tightly packed together which increases surface area for photosynthesis.

D. SPONGY MESOPHYLL.

- It is a layer of cells just below palisade mesophyll.
- Spongy mesophyll has irregular shaped cells called **spongy cells**
- Spongy cells are loosely packed and have few chloroplasts.
- Spongy cells have several air spaces in between, which provide an area for gas exchange.

Functions of spongy mesophyll.

1. It provides an area for gas exchange.
2. It provides an area for photosynthesis.

E. STOMATA

- These are tiny pores (holes/openings) found on the leaf surface.
- Experiments have shown that lower surface of the leaf has more stomata than the upper surface.
- A stoma is surrounded by two bean shaped cells called **guard cells**.
- Guard cells control the opening and closing of stoma
- Guard cells have also chloroplasts as such they can also carry out photosynthesis.

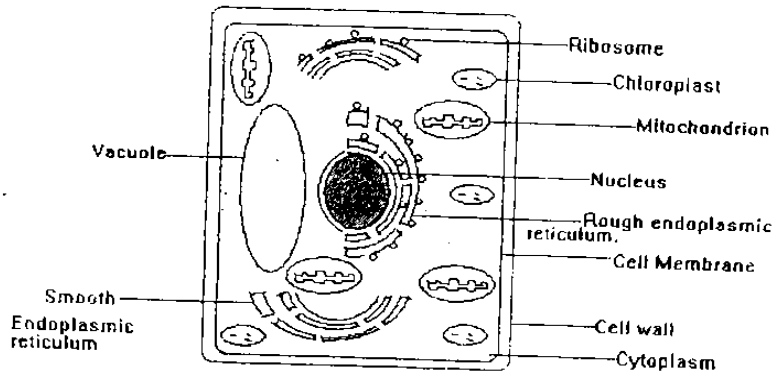
Functions of stomata

1. For gas exchange.
   During the day CO_2 enters the leaf and O_2 escape from leaf through stomata
   At night O_2 enters the leaf and CO_2 escape from leaf through stomata.
2. For transpiration.
   Transpiration is the loss of water vapour from leaves.

ADAPTATIONS OF A LEAF FOR PHOTOSYNTHESIS.

1. It has stomata for gas exchange.
2. It has chlorophyll that traps sunlight energy.
3. It has veins that supply water required for photosynthesis.
4. It is broad and flat that increases surface area exposed to sunlight.
5. It is supported by stem and petiole that expose a leaf to maximum sunlight.
6. Its epidermal cells have no chloroplasts that allow sunlight energy to reach mesophyll layers.
7. It has several air spaces in its spongy mesophyll for gas exchange.
8. It has thin lamina for easy penetration of light and gases into a leaf.

PALISADE MESOPHYLL CELL AS SEEN UNDER ELECTRON MICROSCOPE.



DESCRIPTION OF DIFFERENT PARTS (ORGANELLES) OF PALISADE MESOPHYLL CELL AS SEEN UNDER ELECTRON MICROSCOPE.

A. CELL WALL

- It is the outer most layer of the plant cell.
- Cell wall is made up of cellulose and some carbohydrates.
- Cell wall is **fully permeable** as such all materials are allowed to pass through it.

Functions of cell wall.

1. It maintains the shape of the cell.
2. It supports the cell by preventing it from stretching.
3. It protects inner parts of the cell from external physical damage.

B. CELL MEMBRANE.

- It is the inner layer that surrounds cytoplasm.
- Cell membrane is made up of proteins and lipids.
- Cell membrane is **semi permeable** as such some materials are allowed to pass through whilst others don't pass through.

Functions of cell membrane.

1. It selects materials that should enter or leave a cell.
2. It bounds cytoplasm.

C. CYTOPLASM.

- It is the fluid found inside the cell.

Function of cytoplasm.

- It is the site for chemical reactions that occur in the cell.

D VACUOLE.

- It is the membrane bound sac found in a plant cell.
- Vacuole contains a fluid called **cell sap.**
- Cell sap is made up of sugar and salt solution

Functions of vacuole.

1. It regulates amount of salts in the cell.
2. It supports the cell when it is filled with more water.

E. CHLOROPLAST.

- It is a disc like structure found in the cytoplasm.
- Chloroplast has green pigment called chlorophyll that traps sunlight energy, which is used for photosynthesis.

Functions of chloroplast.

1. It is a site for photosynthesis.
2. It stores starch for future use.

F. MITOCHNDRION

- It is tiny structure that looks like sausage found in cytoplasm.
- The inner membrane of mitochondrion is highly folded that increases surface area for chemical reactions.

Function of mitochondrion

- It is the site for respiration.

Respiration is the chemical process in which energy is released from food.

G. RIBOSOMES

These are tiny structures that look like granules (small round particles) found in the cytoplasm.
Most ribosomes are found on endoplasmic reticulum.

Function of ribosomes.
They are sites for protein synthesis. (Areas where proteins are manufactured in the cell)

H. ENDOPLASMIC RETICULUM.(ER)

These are tiny tubules that run through out cytoplasm.
Endoplasmic reticulum are divided into two groups. These are:

i. Rough Endoplasmic reticulum- these have ribosomes on their surface.
ii. Smooth Endoplasmic reticulum- these have no ribosimes on their surface.

Functions of Endoplasmic reticulum.

1. They provide passage of materials within the cell.
2. They store cell substances.
3. Rough ER manufactures proteins.
4. Smooth ER manufactures lipids.

I NUCLEUS.

- It is the spherical structure found at the centre of the cell.
- Nucleus is surrounded by two membranes called nuclear membrane.
- Nuclear membrane is also **semi permeable**
- Inside the nucleus they are thread like structures called **chromosomes.**
- Chromosomes carry genetic information about an organism.

Function of nucleus
It controls all activities of the cell such as cell division, cell growth and protein synthesis.

DETAILED DESCRIPTION OF PHOTOSYNTHESIS.

Photosynthesis is the chemical process in which plants make their own food using water and carbondioxide in presence of sunlight and chlorophyll. This process can be summarized by both word equation and chemical equation as shown below.

Word equation of photosynthesis.

$$\text{Water} + \text{Carbondioxide} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose} + \text{Oxygen.}$$

Chemical equation of photosynthesis.

$$6H_2O + 6\,CO_2 \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

STAGES OF PHOTOSYNTHESIS.

There are two main stages of photosynthesis. These are:

i. Light stage (Photochemical stage)
ii. Dark stage (Carbon stage)

Light stage.

- This is the first stage of photosynthesis, which requires light for it to take place.
- During light stage, chlorophyll traps sunlight energy and convert it to chemical energy.
- This chemical energy is used for splitting **water molecules** into **hydrogen atoms** and **oxygen atoms**.
- The process in which water molecule is split into hydrogen atoms and oxygen atom is called **photolysis**.
- During photolysis, energy is released, which is stored in **ATPs** (Adenosinetriphosphates)
- Oxygen atoms released during photolysis, recombine to form **Oxygen gas,** which escapes from leaves through stomata. This shows that oxygen released from leaves come from water not carbondioxide.
- Hydrogen atoms and ATPs are taken into the dark stage.

Summary of the light stage.

$$2H_2O \longrightarrow O_2 + 4H + ATPs$$

Dark stage.

- This is the last stage of photosynthesis, which does not need light but it occurs during the day.
- During dark stage, **Carbondioxide** from atmosphere combine with **hydrogen atoms** from light stage using energy stored in **ATPs** to form **glucose**.
- Glucose is the main product of photosynthesis, which is required by plants for different functions.

Summary of the dark stage.

$$CO_2 + 4H + ATPs \longrightarrow C_6H_{12}O_6$$

Differences between light stage and dark stage.

Light stage	**Dark stage.**
Requires light	Does not need light
Water is the main raw material	Carbondioxide is the main raw material
Oxygen is the main product	Glucose is the main product
Hydrogen atoms and ATPs are produced.	Hydrogen atoms and ATPs are used

FUNCTIONS OF GLUCOSE TO A PLANT.

1. Glucose is used for respiration in which energy released is used for active transport and growth.
2. Glucose is changed to cellulose, which is used for making cell wall.
3. Glucose is changed to proteins by combining it with nitrogen and sulphur.
4. It is changed to lipids and vitamins that are useful for plant growth.
5. Excess glucose is changed to starch and stored in storage organs such as seeds

MINERAL ELEMENTS REQUIRED DURING PHOTOSYNTHESIS.

1. Magnesium and Iron

There are required for formation of chlorophyll that traps sunlight energy needed during photosynthesis.

2. Nitrogen and sulphur.

These are required for formation of proteins that form enzymes that speed up the process of photosynthesis.

3. Potassium and phosphorus.

These are mineral elements required for formation of molecules that stores energy required for the chemical reactions that occur during photosynthesis e.g. ATPs and ADPs Potassium is also required for the opening and closing of stomata, which are used for gas exchange.

4. Carbon, Hydrogen and Oxygen.

These are required for formation of organic compounds e.g. glucose.

PIGMENTS FOUND IN A LEAF.

Pigments are substances that give colour to an object e.g. leaf
Leaf has three major pigments. These are:

i. Chlorophyll- Green pigment.
ii. Carotene- Orange pigment.
iii. Xanthophyll- Yellow pigment

Investigating pigments of a leaf.

To show that leaves contain three pigments, the following experiment is done.

Procedure.

1. Collect fresh green leaves and pound them in a mortar.
2. Add methylated spirit/ alcohol and continue pounding.
3. Extract the greenish liquid and filter it.
4. Put few drops of greenish liquid on the filter paper just above its edge.
5. Hung the filter paper in a closed test-tube filled with methylated spirit such that the filter paper should just touch methylated spirit.
6. Wait for a while to allow methylated spirit to rise up through the filter paper.
7. Remove the filter paper and dry it when the methylated spirit reaches the top of the filter paper

Expected results.
Three major colours appear on the dried filter paper. These are green, yellow and orange, which represent chlorophyll xanthopyll and carotene respectively.

Importance of photosynthesis.
Photosynthesis is very important to both plants and animals. Its importance includes the following:

1. It produces food used for respiration and growth e.g. glucose and proteins respectively.
2. It produces Oxygen used for aerobic respiration in both plants and animals
3. It purifies air by absorbing Carbondioxide from atmosphere and releasing Oxygen into atmosphere.
4. It reduces global warming by absorbing carbon dioxide from atmosphere which is green house gas (gas responsible for global warming)
5. It produces plant materials e.g. wood, silk and rubber which are used for both domestic and industrial purpose.
6. It produces medicines that are used for curing different kinds of diseases

TWO EVIDENCE OF PHOTOSYNTHESIS.

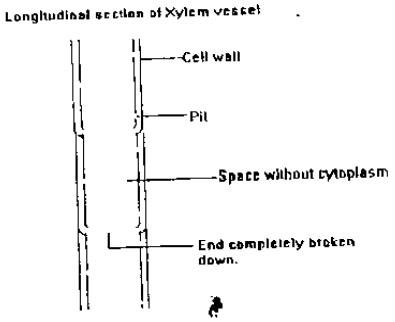
1. Presence of Starch in a leaf.
2. Release of Oxygen from leaves.

TOPIC TWO: TRANSPORT IN PLANTS.

Plants need water from the soil for photosynthesis. After photosynthesis, the manufactured food needs to be distributed to all parts of the plant for different functions These two activities are achieved by the transport system of the plant.
There are two tissues that are responsible for transportation of substances within the plant. These are:

i. Xylem vessels
ii. Phloem tubes

Xylem vessel.
It is a plant tissue that carries water and mineral salts from the roots to the leaves.



Description of xylem vessel.

1. Xylem vessel is made up of long hollow cells that are joined end to end
2. The ends of cells that form xylem vessel are completely broken down.

3. Cells that form xylem vessel have no cytoplasm and nucleus as such they are dead cells. Cytoplasm is lost during the development of these cells.
4. Cell wall of cells that form xylem vessel has cellulose and lignin. Lignin gives strength to xylem vessel that enables it to support woody plants.
5. Xylem vessel has pits along its wall that allow side ways movement of water when one vessel is blocked.

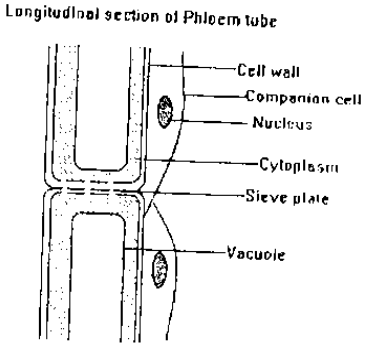
Functions of xylem vessel

1. It transports water and mineral salts from roots to leaves.
2. It supports plant stem.

Phloem tube.

It is the plant tissue that transports manufactured food from leaves to all parts of the plant.

Part of the plant where food is manufactured is called the source where as part of the plant where food is used or stored is called sink



Description of the phloem tube.

1. Phloem tube is made up of living cells called sieve elements.
2. Sieve elements have cytoplasm but not the nucleus.
3. The cell wall of sieve elements has cellulose but not lignin.
4. The ends of sieve elements are not completely broken down; instead, they form sieve plates.
5. Each sieve element has companion cell. Each companion cell has nucleus.

Functions of phloem tube.

It transports manufactured food from leaves to all parts of the plant.

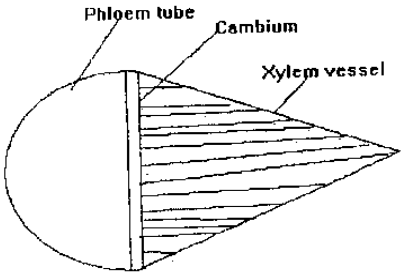
VASCULAR BUNDLES.

Vascular bundle is a group xylem vessel and phloem tube.

In a vascular bundle, xylem vessel is separated from phloem tube by a cambium.

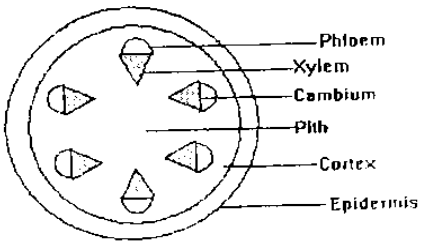
Cambium produces new cells that form xylem vessel and phloem tube thereby thickening the stem.

Structure of the vascular bundle.

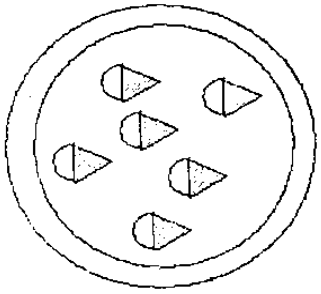


Arrangement of vascular bundles in dicotyledonous and monocotyledonous stems.

Dicotyledonous plants.
These are plants that produce seeds with two cotyledons eg beans
Vascular bundles in stems of dicots are arranged in ring pattern around the pith as shown in figure below.



Monocotyledonous plants.
These are plants that produce seeds with one cotyledon eg maize.
Vascular bundles in monocot stems are scattered without any pattern as shown in figure below.



PROCESSES THAT MOVE SUBSTANCES IN PLANTS.

A. DIFFUSION.

- It is the movement of particles from a region of high concentration to a region of low concentration.
- The difference in concentration of particles between two regions is called **concentration gradient or diffusion gradient.**
- Diffusion does not require energy but it occurs faster when the diffusion gradient is great.

Factors that affect rate of diffusion.

1. **Temperature.**

Rate of diffusion increases when temperature increases because at high temperature particles move very fast.

2. **Size of particles.**

Small particles diffuse faster than large particles because they move faster.

3. **Concentration of particles.**

Rate of diffusion increases with an increase in concentration of particles on one region because diffusion gradient becomes bigger or more steep.

4. **Area over which diffusion occurs.**

Rate of diffusion increases on large surface area because particles have enough space for movement.

5. **Nature of the barrier.**

Rate of diffusion increases on thin barrier between two regions because particles cover a short distance to move from one region to the other region.

Importance of diffusion.

1. It helps in gas exchange in leaves and lungs.
2. It helps in absorption of food substances in small intestine.

B. ACTIVE TRANSPORT

- It is the movement of particles from a region of low concentration to a region of high concentration.
- Active transport can also be defined as the movement of particles against concentration gradient.
- This process requires energy.

Importance of active transport.

1. It helps plant roots to absorb mineral salts from soil.
2. It helps plants to transport manufactured food in phloem tubes.
3. It helps in absorption of food substances in small intestine.
4. It helps in re-absorption of food nutrients in the kidneys.

C. OSMOSIS.

- It is the movement of water from a region of high water concentration to a region of low water concentration across semi permeable membrane.
- Water is said to have high concentration if there are no solutes dissolved in it. The concentration of water is reduced when solutes dissolve it.
- Osmosis like diffusion does not require energy.

Importance of osmosis.

1. It helps plant roots to absorb water from soil.
2. It helps to move water from one cell to the other in a plant.

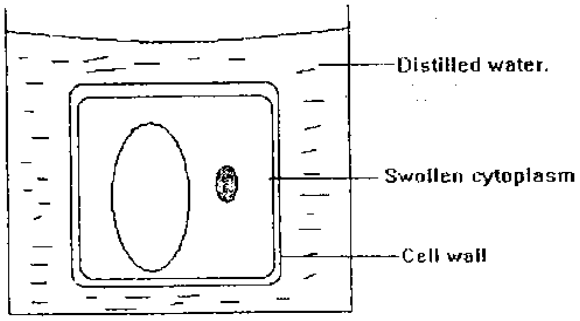
3. It helps in absorption of water in large intestine.

INVESTIGATIONS ON OSMOSIS.

1. Placing a plant cell in distilled water.

- Water enters into cytoplasm and vacuole across cell membrane by osmosis
- This occurs because distilled water has higher water concentration than cytoplasm and cell sap in vacuole.
- When more water enters into a cell, cytoplasm and vacuole swell up and exert outward pressure on cell wall. This outward pressure is called turgor pressure
- The condition in which a cell has turgor pressure is called turgidity.
- Turgidity helps to support plants without wood e.g. Biden

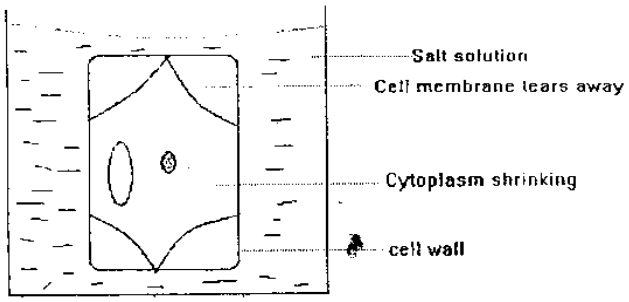
Figure below shows a plant cell in distilled water.



2. Placing a plant cell in concentrated solution eg salt solution.

- Water moves from cytoplasm and vacuole across cell membrane into salt solution by osmosis. This occurs because cytoplasm and cell sap in vacuole have higher water concentration than salt solution.
- When more water moves out of the cell, cytoplasm and vacuole shrink and stop exerting pressure on the cell wall. This condition is called **flaccidity**
- Excessive loss of water from a cell tears away cell membrane from the cell wall. This condition is called **plasmolysis.**
- Plasmolysis occurs when a plant cell is placed in highly concentrated solution eg acids.
- Plasmolysis kills a cell since it damages cell membrane.

Figure below shows a plant cell in salt solution



MOVEMENT OF WATER FROM SOIL TO LEAVES.

Water moves from soil into root hair cells by osmosis. This increases turgidity of root hair cells; as a result water is forced out to the next cell towards inside the root. In the root, water is passed from one cell to the other by osmosis until it reaches xylem vessel. In xylem vessel, water is pushed up by root pressure and pulled from above by transpiration until it reaches leaves.

The movement of water within the plant is called **Transpiration stream.**

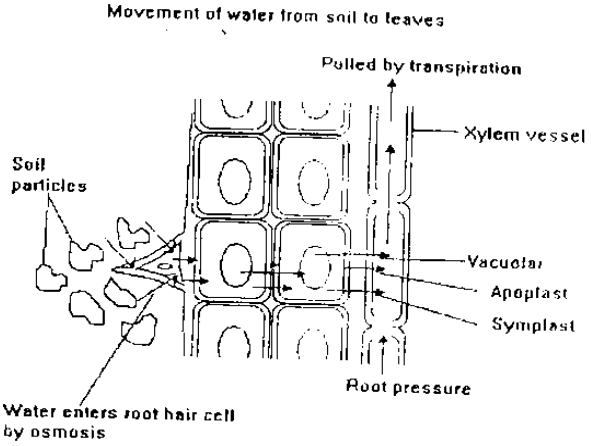
Three pathways of water in a root.

There are three routes of water in a root. These are:

i. Apoplast- Movement of water from one cell to the other across cell wall of adjacent cells

ii. Symplast- Movement of water from one cell to the other across cytoplasm of adjacent cells.

iii. Vacuolar- Movement of water from one cell to the other across vacuole of adjacent cells.



Movement of substances in phloem tube.

Phloem tubes transport manufactured substances from leaves to all parts of the plant. Experiments have shown that transportation of substances in phloem tubes requires energy. This indicates that substances in phloem tubes are transported by **active transport.**

EVIDENCE THAT PHLOEM TUBES TRANSPORT MANUFACTURED FOOD.

1. Use of Aphids.

An aphid is a small insect that suck juice from plants using its stylet.

In this experiment, aphid is anaesthetized (killed) as it is sucking juice and its stylet is cut off.

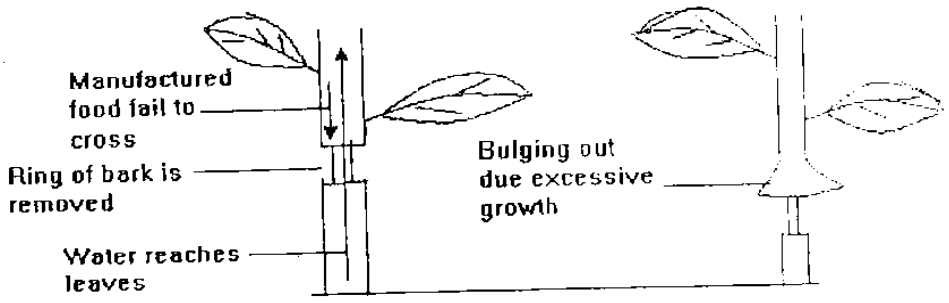
The juice that oozes from the stylet is collected and analyzed in the laboratory to find out its components.

During analysis, it is found that the juice contains organic substances e.g. carbohydrates and proteins. This shows that phloem tubes transport manufactured food.

2. Ringing experiment.

In this experiment, a ring of bark is removed from a plant stem and the plant is observed for several days. After some days region of the plant above the ring bulges out. showing excessive growth of the plant. This occurs because when a bark is removed, phloem tubes are removed too whilst xylem vessels remain intact since phloem tubes lie beneath the bark.

This makes water to continue moving from roots to the leaves but manufactured food fails to cross an area where phloem tubes are removed as a result the food accumulates on the region just above the ring- hence excessive growth of the plant on this particular region. Failure of manufactured food to cross where phloem tubes are removed shows that phloem tubes transport manufactured food



TRANSPIRATION.

It is the loss of water vapour from leaves through stomata.

How does transpiration occur?

Leaf cells are surrounded by thin layer of moisture that dissolves gases for easy diffusion When the temperature rises, this moisture evaporates and escapes from leaves through stomata.

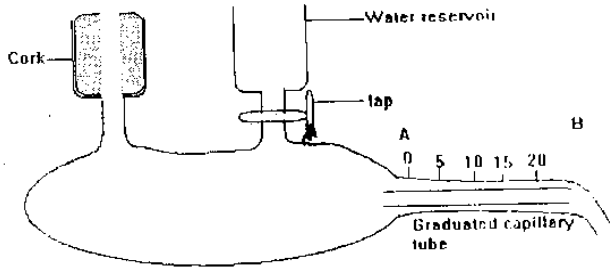
When water evaporates from leaves, more water moves from xylem vessel into leaf cells to replace lost water. This helps in movement of water in xylem vessel from roots to leaves.

Rate of transpiration.

It is the amount of water vapour lost from leaves per unit time.

Rate of transpiration is measured by an instrument called **potometer**.

POTOMETER



How to measure rate of transpiration using potometer.

1. Fill the potometer with water by immersing it a basin filled with water.
2. Cut the shoot of the plant under water and keep the end of the shoot under water to avoid air bubbles in xylem vessel.
3. Insert the shoot through the hole in a cork of the potometer.
4. Smear Vaseline in an area between shoot and cork to make it air tight.
5. Open the tap of water reservoir to fill graduated capillary tube with water
6. Close the tap when the capillary tube is full.
7. Put the apparatus at an area of interest and observe the movement of water meniscus.
8. Record the volume of water in the potometer after an hour and calculate the rate of transpiration.

$$\textit{Rate of transpiration} = \frac{\textit{Initial volume of water} - \textit{final volume of water}}{\textit{Time taken.}}$$

NOTE: As the shoot transpires, water moves from the potometer into a plant in order to replace lost water. This makes the meniscus to move from point B to point A. The difference in volume of water between point B and point A indicates amount of water absorbed and transpired by the shoot.

FACTORS THAT AFFECT RATE OF TRANSPIRATION.

1. Temperature.

Rate of transpiration increases when temperature increases because at high temperature more water evaporates from leaves.

2. Light intensity

Rate of transpiration increases with an increase in light intensity because leaves open stomata in order to get carbondioxide for photosynthesis and in the process water vapour escapes from leaves.

3. Water supply.

An increase in water supply increases rate of transpiration because leaves open stomata.

4. Humidity.

Rate of transpiration increases when humidity is low because air around stomata is dry and absorbs more water vapour.

5. Wind speed.

Rate of transpiration increases with an increase in wind speed because wind drives away water vapour around stomata thereby decreasing humidity of air around stomata.

IMPORTANCE OF TRANSPIRATION.

1. **It cools a plant when it is hot.**

Water that evaporates from leaves carry heat energy from leaves thereby reducing the temperature of the leaf.

2. **It helps to transport water and mineral salts from soil.**

When water evaporates from leaves, more water is drawn from xylem vessel to replace lost water. This creates tension in water column due to cohesion and adhesion of water molecules. As a result the water column moves upwards towards the leaves. Water carries dissolved mineral salts absorbed from soil.

Dangers of transpiration.

Plants may dry up due to excessive loss of water.

Ways of reducing rate of transpiration by plants.

1. Plants close stomata when it is very hot.
2. Some plants roll up their leaves to reduce surface area of the leaf e.g. maize
3. Some plants lose their leaves during dry season.
4. Some plants develop small leaves that can lose little water.
5. Leaves of some plants are modified into spines e.g. cactus and Euphobia

TOPIC THREE: TROPISM.

Plants respond to changes in environment by either growing towards it or away from it. Unlike animals, response in plants is very slowly.
The plant growth response in relation to direction of stimuli is called **Tropism**.

Stimuli that affect plant growth.

i. Light.
ii. Gravity.
iii. Water.

Hormone responsible for tropism.

Tropism is brought about by plant growth hormone called **Auxin.**
Auxin is produced in **meristems.** Meristems are regions of the plant where there is active cell division e.g. shoot tips and root tips.
The major function of auxin is to induce cell elongation (increasing length of the cell)
Plant without shoot tip does not grow because there is no auxin that can stimulate cell elongation in the shoot.

Factors that affect distribution of auxin in the plant.

1. **Light.**

More auxin accumulates on the shaded side of the plant thereby making cells in shaded part to elongate more rapidly than cells in illuminated side.

2. **Gravity**

More auxin accumulates on the side of the plant that faces downwards (gravity)

KINDS OF TROPISM.

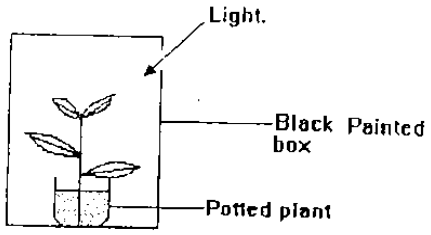
1. PHOTOTROPISM.

It is the plant growth response in relation to direction of light.
In plants, shoots bend towards light whereas roots bend away from light. This shows that shoots have **positive phototropism** whereas roots have **negative phototropism**.

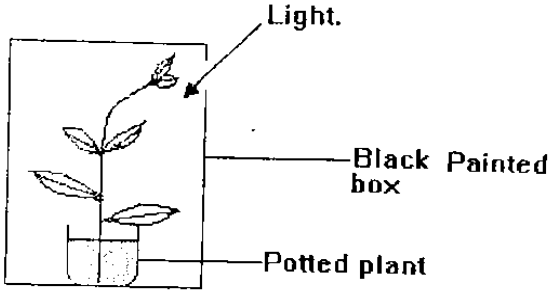
INVESTIGATIONS ON PHOTOTROPISM.

A. Illuminating a plant from one side.

Put a potted plant in black box with a hole at the top of one side and observe it after a week.



Expected results.



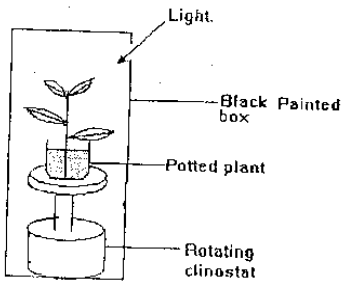
The shoot bends towards the direction of light.

Explanation of results.

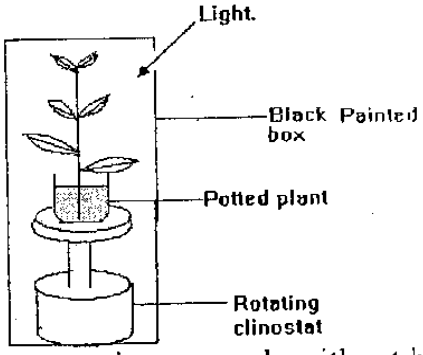
When a plant is illuminated from one side, auxin diffuses from illuminated side to the dark side of the plant. This makes cells in the dark side to elongate more rapidly than cells in illuminated side. As a result, the shoot bends towards illuminated side (light).
NOTE: Black painted box is used in this experiment in order to have one source of light.

B. Illuminating a plant from all sides.

Put a potted plant on rotating clinostat and place it in a black box with a hole at the top of one side. Observe the plant after a week.



Expected results.



The shoot continues growing upwards without bending.

Explanation of results.

Rotating clinostat exposes all sides of a plant to light. This makes auxin to be distributed equally in a plant and cells of the plant elongate uniformly. As a result, the plant grows vertically.

IMPORTANCE OF PHOTOTROPISM.

a. Positive phototropism helps shoots to expose their leaves to sunlight for photosynthesis.
b. Positive phototropism exposes flowers to pollinators for pollination.

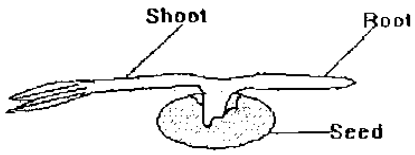
2. GEOTROPISM.

It is the plant growth response in relation to direction of gravity.
In plants, roots bend towards gravity whilst shoots bend away from gravity. This shows that roots have **positive geotropism** whereas shoots have **negative geotropism**

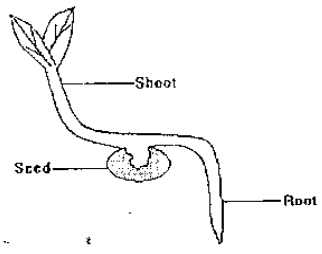
INVESTIGATIONS ON GEOTROPISM.

A. Exposing one side of a seedling to gravity.

Put a seedling horizontally on moist soil in a dark room and observe it after a week

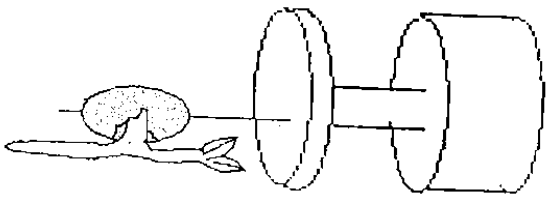


Expected results.

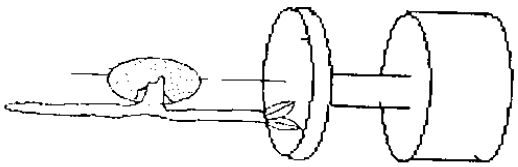


Explanation of results.
When a plant is placed horizontally in a dark room, Auxin diffuses from the upper part of the plant to the lower side of the plant.
This makes cells in the lower side of the shoot to elongate more rapidly than cells in its upper part. As a result, the shoot bends upwards.
On the root, cells in lower part elongate more slowly than cells in the upper part because an increase in auxin reduces cell elongation in roots. As a result, the root bends downwards.

B. Exposing all sides of the seedling to gravity.
Put a seedling horizontally on moist cotton wool in a dark room and place it on rotating clinostat. Observe the seedling after a week.



Expected results.



The shoot and the root continue growing horizontally.

Explanation of results.
Rotating clinostat exposes all sides of the seedling to gravity. This makes auxin to be distributed equally in all sides of the seedling. As a result, the seedling continues growing horizontally.
Experiments aimed at finding effects of gravity on plant growth are done in dark place to avoid effects of light that also an effect on plant growth.

Importance of geotropism.
1. Negative geotropism helps the shoot to grow upwards thereby exposing leaves and flowers to sunlight and pollinators respectively.
2. Positive geotropism helps roots to bend downwards to anchor the plant and to absorb water from the soil.

3. HYDROTROPISM
Plant growth response in relation to direction of water. In plants roots have positive hydrotropism as they grow towards water

TOPIC FOUR. HUMAN DIGESTIVE SYSTEM

It is the body system that is responsible for food digestion and absorption.
After digestion the body gets food substances that are used for different functions in the body.

Kinds of food substances.

1. Carbohydrates.
2. Lipids
3. Proteins.
4. Vitamins
5. Mineral salts
6. Water.

CARBOHYDRATES.

These are food substances that mainly provide energy in the body.
Carbohydrates are organic compounds because they have carbon atoms in their molecules.
Apart from Carbon atoms, carbohydrates also contain; Hydrogen atoms and Oxygen atoms.
The empirical (simplest) formula of carbohydrates is CH_2O, in which the ratio of Hydrogen atoms to oxygen atom is 2:1.
Carbohydrates exist in ring form not straight chain as expected.

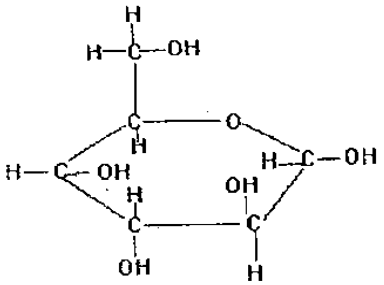
Classes of carbohydrates.

1. Monosaccharides.
2. Disaccharides.
3. Polysaccharides.

MONOSACCHARIDES.

These are simplest carbohydrates that are made up of one sugar molecule in their compounds e.g. Fructose, glucose and galactose.
The general molecular formula of monosaccharides is $C_6H_{12}O_6$.

Structure of glucose.



Properties of Monosaccharides.

1. They are fairy sweet (faint sweet taste)
2. They are soluble in water.
3. They are reducing sugars as they react with Oxygen.

Test for reducing sugars (Monosaccharides) in a food sample.

1. Dissolve the food sample in distilled water.
2. Add benedict solution to the food sample and heat the mixture gently.
3. Observe the colour changes.

If the food sample has reducing sugars, Benedict solution changes from blue to brick red.

DISACCHARIDES.

These are complex carbohydrates that are made up of two sugar molecules eg Sucrose, maltose and lactose.

Disaccharides are formed when two monosacharides combine during the chemical reaction.

The process in which large molecule is formed when small molecules react is called **Condensation.**

During condensation, water molecule is released.

Examples of condensation process.

1. Glucose + fructose ⟶ **Sucrose** + water.

2. Glucose + glucose ⟶ **Maltose** + water.

3. Glucose + galactose ⟶ **Lactose** + water.

4. $C_6H_{12}O_6$ + $C_6H_{12}O_6$ ⟶ $\mathbf{C_{12}H_{22}O_{11}}$ + H_2O

* The general molecular formula for disaccharides is $\mathbf{C_{12}H_{22}O_{11}}$

Disaccharides can be broken down into two monosacharides.

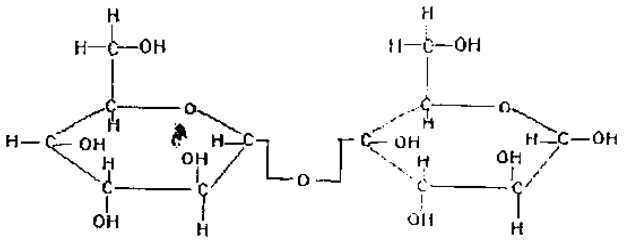
The process in which large molecule is broken down into small molecule or its components is called **Hydrolysis or Digestion.**

During hydrolysis, water is used e.g.

Sucrose + water ⟶ glucose + fructose.

* Condensation and hydrolysis also need enzymes.

Structure of Maltose.



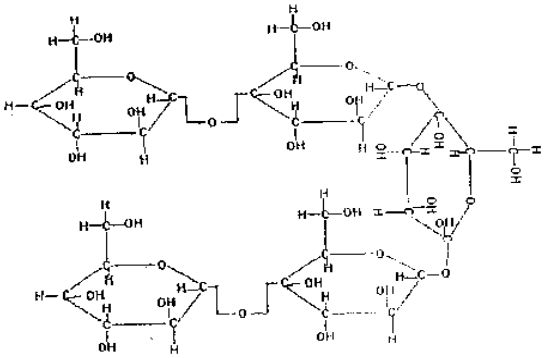
Properties of Disaccharides.

1. They are very sweet e.g. Sucrose.
2. They are soluble in water.
3. They are non reducing sugars as they don't react with Oxygen.

LYSACCHARIDES.

ese are very complex carbohydrates that are made up of several sugar molecules joined ;ether by **glycosidic bond** e.g. Starch, glycogen and cellulose.
lysaccharides are formed when several monosaccharides combine together during ndensation process.
lysaccharides can be broken down into monosaccharides during hydrolysis.

ructure of polysaccharide.



Properties of polysaccharides.

1. They are not sweet.
2. They are insoluble in water.
3. They are non reducing sugars.

Test for starch in a food sample.

Add iodine solution to a food sample and observe colour changes.
If the colour of iodine solution changes from brown to blue black, the food sample has starch.

Functions of carbohydrates.

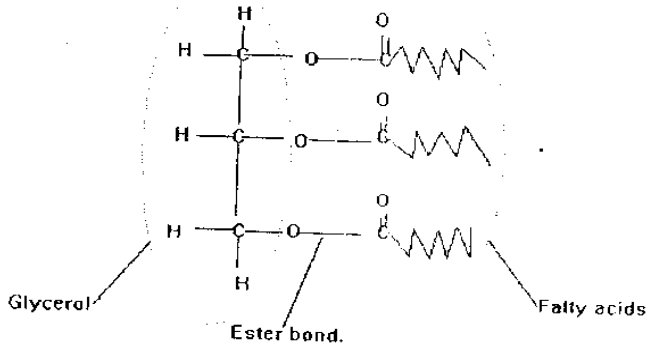
1. They provide energy to the body as they are used for respiration.
2. They form components of cell membrane.
3. Excess carbohydrates are converted to animal fats and stored under the skin

LIPIDS.

These are fats and oils.
- Fats are solid at room temperature (20^0C) eg margarine and butter.
Oils are liquid at room temperature eg cooking oil.
Lipids are organic compounds as they contain carbon atoms in their molecules.
Lipid molecule also contains Hydrogen atoms and Oxygen atoms, in which the ratio of Hydrogen atoms to Oxygen atoms is more than two to one.

Lipid molecule is made up of **three fatty acids** and **one glycerol molecule** as such they are called **triglycerides.**
In a lipid molecule, Glycerol is joined to fatty acids by **ester bonds.**

Structure of lipid molecule.



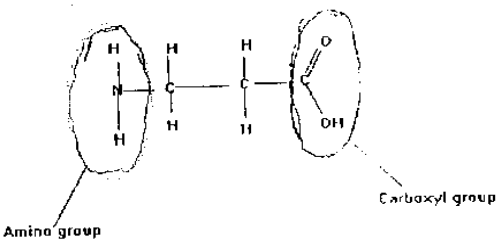
Properties of lipids.
1. They are insoluble in water.
2. They are soluble in ethanol/ alcohol.

Functions of lipids.
1. They provide energy in the body. Lipids provide more energy than carbohydrates.
2. They form protective layers of internal organs eg heart, kidney and the liver
3. They insulate the body when laid under the skin.
3. They are solvent of the following vitamins: Vit A, D, E and K.
4. They form components of cell membrane.

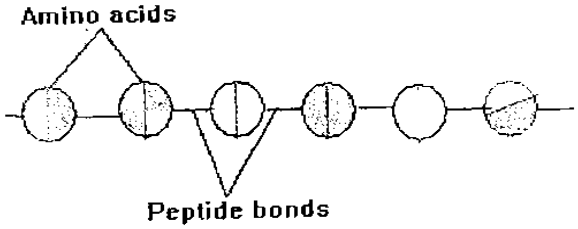
Test for lipids in a food sample.
Rub the food sample against the filter paper and observe.
The area where the food sample was rubbed becomes translucent when the food sample has lipids.

PROTEINS.
These are food substances that are required for body building.
Proteins are organic compounds as they contain carbon atoms.
Protein molecule also contains Hydrogen atoms, Oxygen atoms, Nitrogen atoms and Sulphur atoms.
The simplest molecule of proteins is **amino acid.**
Protein molecule is made up of several amino acids that are joined together by **peptide bond.**
There are twenty different kinds of amino acids that form vast number of proteins.
Some amino acids are said to essential amino acids whilst others are said to be non essential amino acids.
Essential amino acids can not be manufactured by our body as a result they are only obtained from the food we eat.

Structure of amino acid.



Model of a protein molecule.



Properties of Proteins.

1. Some proteins are soluble in water eg Haemoglobin.
2. Some proteins are insoluble in water eg Keratin.
3. Proteins are denatured (Change in structure) at high temperature.

Test for proteins in a food sample.

1. Dissolve the food sample in distilled water.
2. Add Biuret reagent (Sodium hydroxide and copper sulphate) to the food sample.
3. Shake the mixture gently and observe colour changes.

Biuret reagent changes from blue to violet/ purple when the food sample has proteins.

Functions of proteins.

1. They are used for growth.
2. They are used for formation of body structure eg finger nails, cell membrane.
3. They are used for making enzymes and hormone.
4. They are used for making blood proteins eg haemoglobin, antigens, fibrinogen and antibodies.
5. They can be converted to carbohydrates and used for respiration.

ENZYMES.

Chemical reactions that occur in the body cells would have taken long period of time to be completed if they were no enzymes.

Enzymes are biological catalysts. This means that they are chemical substances produced in the body in order to speed up chemical reactions e.g. respiration and chemical digestion.

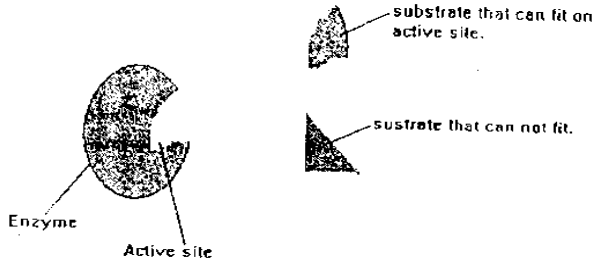
Naming digestive enzymes.

Digestive enzymes are named by adding a suffix –**ase** to the substrate. Substrate is a food substance that is being acted upon by an enzyme e.g.

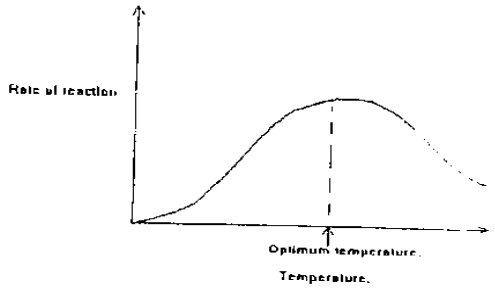
i. Maltase acts on maltose.
ii. Amylase acts on amylose (starch)
iii. Sucrase acts on sucrose.

Properties of enzymes.

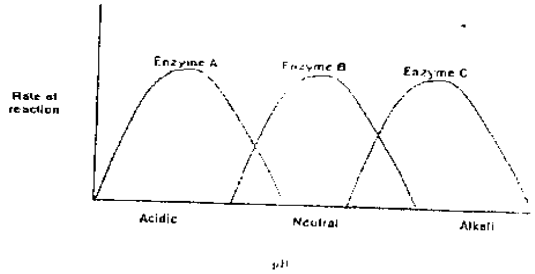
1. Enzymes are proteins since they are made up of amino acids.
2. Enzymes are specific. This means that one enzyme catalyses only one chemical reaction e.g. Amylase catalyses the breaking down of starch but not proteins. This occurs because enzymes have an active site which fits only the substrate it catalyses.



3. Enzymes work best at particular temperature called **optimum temperature**. At this temperature enzymes are **very active** as such the chemical reaction occurs very fast. At temperature below optimum temperature, enzymes are **inactive** as such chemical reaction occurs slowly. Chemical reaction stops at high temperature because enzymes are **denatured.**



4. Enzymes work best at particular pH called **optimum pH.** Some enzymes work best in acidic environment eg Pepsin, some work best in neutral environment eg Intestinal enzymes and others work best in alkali environment eg Salivary amylase. At optimum pH, the rate of chemical reaction becomes very high because enzymes are active. When pH changes, enzymes are denatured and chemical reaction stops.



5. Enzymes are catalysts. This means that enzymes only speed up the rate of chemical reaction without being used up or finished.

Factors that affect rate of reaction catalyzed by enzymes.

1. Temperature.
Rate of reaction increases with an an increase in temperature. At high temperature rate of reaction slows down and stops because enzymes are denatured.

2. pH.
Rate of reaction becomes very high at optimum pH but slows down when pH changes because enzymes are denatured.

3. Concentration of substrate.
Rate of reaction increases with an increase in concentration of substrate. When the concentration of substrate is very high, rate of reaction becomes constant.

4. Presence of inhibitors.
Rate of reaction slows down if they are inhibitors that block enzymes.

FOOD DIGESTION.

Food that is taken into our mouth needs to be digested so that the body can absorb food substances and use them.
Food digestion is the breaking down of large particles of food into small particles

Two kinds of food digestion.
i. Physical digestion.
ii. Chemical digestion.

PHYSICAL DIGESTION.
It is the breaking down of large pieces of food into small pieces by applying external physical force. This process does not change chemical form of the food.
Physical digestion occurs in the mouth, where large pieces of food are broken by teeth when chewing.
It also occurs in the stomach, where food is churned by the rhythmic contraction of stomach wall.

Importance of physical digestion.
1. It reduces size of food particles for easy swallowing.
2. It reduces size of food particles so that enzymes can easily act on the food. Enzymes easily act on small pieces of food because small pieces of food have large surface area to volume ratio.

CHEMICAL DIGESTION.

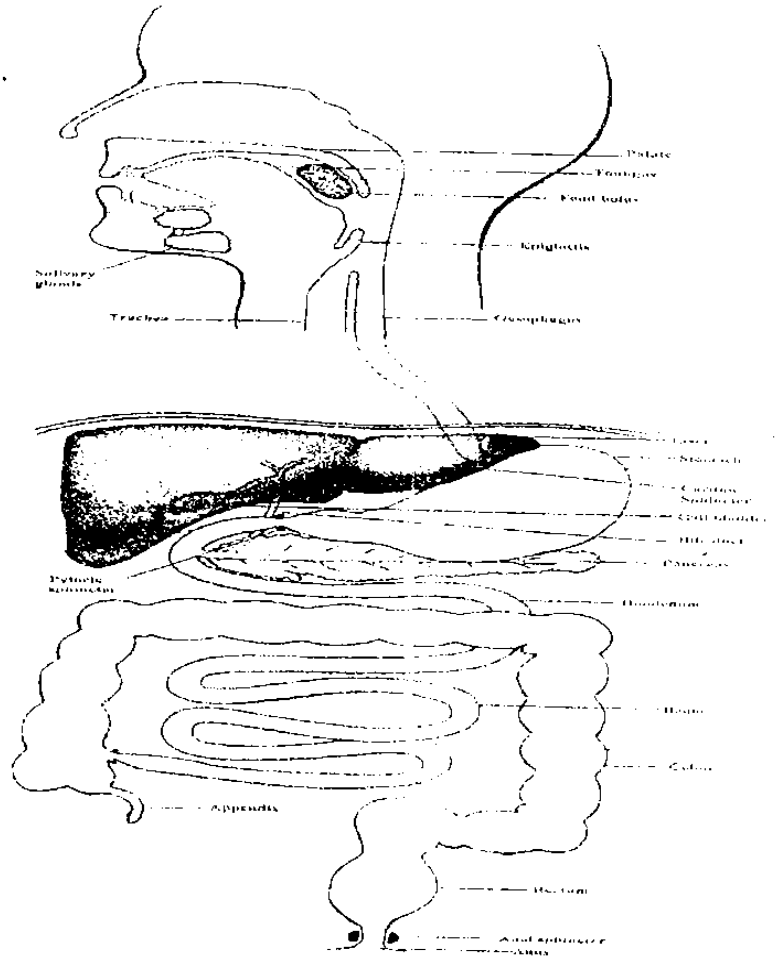
It is the breaking down of large molecules of food into small molecules by the action of enzymes. This process changes the chemical form of the food.

Importance of chemical digestion

It reduces the size of food molecules for easy absorption.

HUMAN ALIMENTARY CANAL (GUT)

It is the long hollow muscular tube that begins from the mouth to the anus.
Alimentary canal has several glands along its wall that secrete juice, which contains digestive enzymes.



Parts of human alimentary canal.

1. Mouth.

It is part of alimentary canal that receives food from outside the body.
In the mouth, the food is chewed and mixed with saliva. Chewing reduces size of the food particles for easy swallowing.

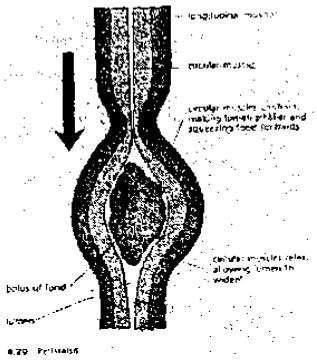
Functions of saliva.

1. Saliva has water that softens the food.
2. It has mucus that lubricates the food for easy swallowing. Mucus also binds food particles into a bolus for easy swallowing.
3. Saliva contains an enzyme called **salivary amylase/ ptyalin** that digests cooked **starch** to **maltose.**

In the mouth, there is a tongue that rolls up chewed food into a food bolus for easy swallowing.

2. Oesophagus.

It is the passage of food from the mouth into the stomach.
In oesophagus and the whole alimentary canal, food moves by **peristalsis.**



Peristalsis is the wave like movement of the wall of alimentary canal due to contraction and relaxation of circular muscles and longitudinal muscles that form the wall of alimentary canal.
From oesophagus the food enters into the stomach passing through narrow passage controlled by **cardiac sphincter muscles.**
Cardiac sphincter muscles relax when the food is approaching the stomach so that the passage should open to allow food to enter into the stomach.

3. Stomach

It is an enlarged region of the alimentary canal.
The inner lining of the stomach is highly folded and has several glands called gastric glands.
In the stomach, the food is churned and mixed with gastric juice. Churning occurs due to wave like contraction of the stomach wall.
Churning breaks large pieces of food into small pieces for easy chemical digestion

Importance of gastric juice.

1. It contains an enzyme called **pepsin** that digests **proteins** into **polypeptides.**
2. In young mammals, gastric juice contains **rennin** that solidifies protein in milk so that it should easily be digested by pepsin.
3. Gastric juice also contains hydrochloric acid that performs the following functions:

a. Killing germs taken together with food in the alimentary canal.

b. Providing acidic environment required for the action of pepsin.
c. Activating/ changing pepsinogen into pepsin.
d. Dissolving/ softening bones taken together with food so that they should not damage the gut.

- Hydrochloric acid does not damage the wall of stomach because it is coated with thick layer of mucus. Mucus also protects the wall of alimentary canal from autodigetion/ self digestion. Auto digestion is also prevented by releasing enzymes inactive state and at the time when there is food at that particular part of alimentary canal.

* Churning changes the food from solid state into semi solid state called **chyme.** Chyme then flows into small intestine at interval when pyloric sphincter muscles relax.

4. Small intestine.
It is part of alimentary canal where most chemical digestion and food absorption occurs.

Two main regions of small intestine.
i. Duodenum.
ii. Ileum.

Duodenum (30 cm long)
It is the first part of small intestine just close to stomach.
In duodenum, the chyme is mixed with **bile** and **pancreatic juice.**

BILE.
It is the greenish-yellow liquid manufactured by the **liver** and stored in the gall **bladder**.
Liver manufacture bile from the substances released when old and damaged red blood cells are being broken down.

Functions of bile.
1. It emulsifies lipids. Emulsification is the breaking down of lipids into small droplets physically.
2. It neutralizes acid in the chyme so that enzymes found in small intestine must act on it.
3. It activates lipase that digests lipids.

Importance of neutralizing acid found in chyme.
a. To allow enzyme found in small intestine to act on chyme.
b. To prevent acid in the chyme from damaging the wall of small intestine since it is coated with a thin layer of mucus.

PANCREATIC JUICE.

It is produced by the pancreas.

Functions of pancreatic juice.

1. It contains digestive enzymes such as:
   a. **Trypsin** that digests **polypeptides** and **proteins** to **peptides**.
   b. **Pancreatic amylase** that digests **starch** to **maltose**.
   c. **Lipase** that digests **lipids** to **fatty acids** and **glycerol**.
2. It contains sodium bicarbonate that neutralizes acid in chime.

Ileum (8m long)

It is the longest part of small intestine as such small intestine is also called **ileum**

In ileum, chyme is mixed with intestinal juice.

Intestinal juice is produced by the wall of small intestine.

Intestinal juice contains the following digestive enzymes:

i. **Maltase** that digests **maltose** to **glucose**.
ii. **Sucrase** that digests **sucrose** to **glucose** and **fructose**.
iii. **Lactase** that digests **lactose** to **glucose** and **galactose**.
iv. **Lipase** that digests **lipids** to **fatty acids** and **glycerol**.
v. **Peptidase** that digests **peptides** to **amino acids.**

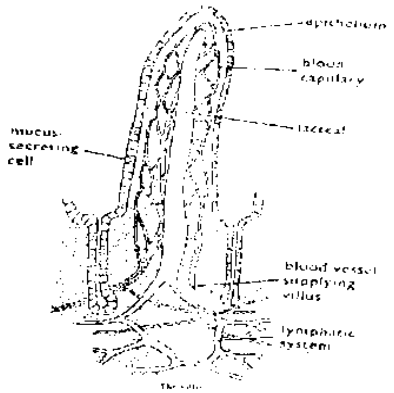
Glucose, galactose, fructose, amino acids, fatty acids and glycerol are called **end products of digestion**. These end products of digestion are then absorbed into the blood stream across the wall of small intestine by either **diffusion or active transport**

In the blood stream, end products of digestion are taken to the liver through **Hepatic portal vein.**

Adaptations of small intestine for food absorption

1. It is long and folded that increases surface area for food absorption.
2. Its inner lining has several finger like projections called villi that increase surface area for food absorption.

Structure of the villus.



3. Villus has thin epithelium (one cell thick) for easy diffusion of food substances.
4. Villus has a dense network of blood vessels that carry absorbed food substances.
5. Villus has lacteal that is more permeable to large molecules such as fatty acids and glycerol.

Fate of undigested materials.
Undigested materials that contain fibers, cellulose, bacteria, dead cells from gut mucus and water move to the large intestine.

5. Large intestine.
It is part of alimentary canal where most water and mineral salts are absorbed from undigested materials.
Water in large intestine is absorbed by **osmosis**.
Large intestine is divided into three main regions. These are:

i. Caecum.
ii. Colon
iii. Rectum.

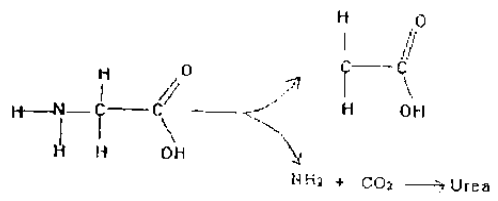
Colon is the longest part of large intestine as such large intestine is also called colon
After water absorption, the remains of food digestion form faeces that are stored temporary in the rectum, where they are ejected through the anus when anal sphincter muscles relax.

Fate of end products of digestion.
End products of digestion are taken to the liver where they are distributed to the body cells for **assimilation**.
Assimilation is the process in which body cells use food nutrients for different functions such as building their own molecules.

Fate of glucose.
Right amount of glucose is sent to body cells by the liver for respiration.
Excess glucose is changed by the liver into animal starch called **glycogen** and stored in the liver and the muscles.
When the body has inadequate glucose, glycogen is changed back to glucose by the liver for immediate use.

Fate of amino acids.
Right amount of amino acids are sent to body cells for formation of body proteins such as haemoglobin, keratin, enzymes, hormones, antibodies, collagen etc. Body proteins are used for building the body (growth).
Excess amino acids are **deaminated** by the liver. Deamination is the removal of amino group from amino acids. The amino group reacts with carbondioxide to form urea that is sent to kidneys for excretion. The remaining part of amino acid is changed to carbohydrates by the liver and stored in form of glycogen.

Deamination process.



Fate of fatty acids and glycerol.
Fatty acids and glycerol are changed to carbohydrates and used for respiration.
Excess fatty acids and glycerol are changed to animal fats and stored under the skin where they insulate the body.

Functions of the liver.

1. It regulates amount of glucose in the blood by converting excess glucose to glycogen and reconverting glycogen to glucose when the level of glucose in the blood is very low.
2. It produces bile that emulsifies lipids in duodenum.
3. It deaminates excess amino acids in the body.
4. It transaminates excess amino acids in the body. Transamination is the conversion of one amino acid into the other by changing the position of amino group.
5. It detoxifies poisonous substances taken into the body e.g. drugs and poison.
6. It stores vitamins and mineral salts for future use.

PROBLEMS ASSOCIATED WITH DIGESTION SYSTEM

A. DIARRHOEA.

It is a condition in which a person passes out watery faeces.
This disease is caused by bacteria and protozoa
These germs attack inner lining of large intestine, where they cause irritation.
This irritation makes intestine to produce more mucus and frequent peristalsis that sweep faecal matters. As a result little water is absorbed from undigested materials.

Signs and symptoms of diarrhea.

1. Dehydration since little water is absorbed from undigested materials in large intestine.
2. Fever.
3. Vomiting.
4. Watery faeces.
5. Blood in stools (faeces)

Prevention of diarrhea.

1. Personal hygiene eg washing hands before eating or after visiting toilets
2. Drink treated water.

B. CONSTIPATION.

It is the failure of the person to pass out faeces.
Constipation occurs when faecal matters move slowly in large intestine which makes more water to be absorbed from the faecal matters. As a result faecal matters become too hard and dry to be expelled out.

Causes of constipation.

1. Eating over refined food stuffs that have little fibers.
2. Drinking little water after meal.
3. Illness
4. Continuous suppressing the reflex of defaecation.

Signs and symptoms.

1. Abdominal pain.
2. Dry faeces.

Prevention of constipation.

1. Eat food stuffs that have fibers e.g. vegetables. Fibers stimulate peristalsis as such faecal matters move properly in large intestine.
2. Drink adequate water after meal so that some water should remain in faecal matter after absorption.
3. Do regular exercise that help to push bowels (faecal matters)

C. ULCERS.

These are sores or wounds that develop in alimentary canal.
Ulcers are caused by over production of gastric juice in the stomach that contains hydrochloric acid.
Hydrochloric acid damages the inner lining of alimentary canal.
The wounds become so painful after meal because they are attacked by acid.
Ulcers are associated with stress, worries and over working.

Ways of controlling ulcers.

1. Drink milk after meal to neutralize acid in gastric juice.
2. Take anti acidic tablets e.g. Phillips magnesium that neutralizes acid.

D. INDIGESTION.

It is the failure of the body to digest food.
This occurs when a person is eating too quickly as a result more gastric juice is produced which slows down chemical digestion of food.

Ways of controlling indigestion.

1. Drink milk to neutralize acid.
2. Take anti acidic tablets.

E. HEART BURNS.

It is the burning sensation that occurs in a gullet during belching.
Heart is caused by overproduction of gastric juice and it is associated with indigestion.

F. APPENDICTIS.

It is an inflammation of the appendix due to an infection or sand.
This problem is controlled by removing the infected appendix through a surgery

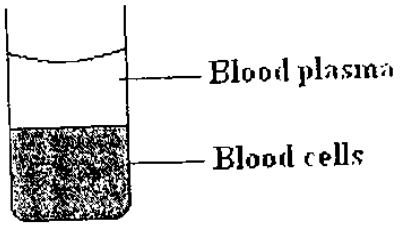
CIRCULATORY SYSTEM.

It is the system that is responsible for transportation of substances and body defence in the body.
This system consists of blood circulatory system and lymphatic system.

Blood system.
It is the body system that consists of blood, heart and blood vessels.

Blood
It is the fluid that has cells suspended in it.
Blood is the vital fluid of the body.
Normal human being has 5.5L of blood.

Composition of blood.
Blood is made up of plasma and blood cells.



Plasma.
It is the liquid part of the blood and it is almost colourless.

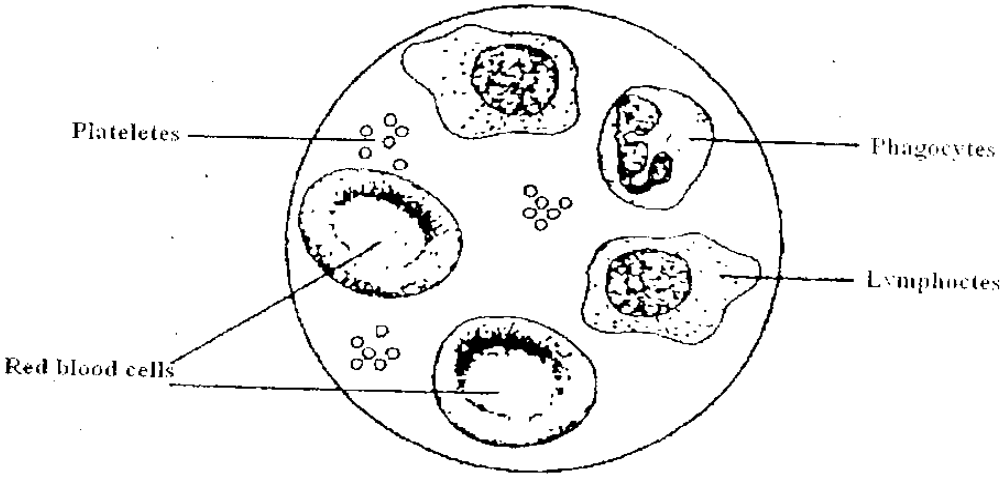
Functions of plasma.

i. It transports food nutrients eg glucose, amino acids from alimentary canal to all parts of the body.
ii. It transports waste matters eg urea and carbondioxide from body tissues to excretory organs such as kidneys and lungs.
iii. It transports antibodies to point of infection.
iv. It transports hormones from endocrine glands to target organs.
v. It transports heat energy from where it is produced to all parts of the body.

Blood cells.
These are cells that suspend in blood plasma.
They are three kinds of blood cells. These are:

i. Red blood cells (erythrocytes)
ii. White blood cells (Leukocytes)
iii. Platelets (Thrombocytes)

Blood sample as seen under light microscope.



RED BLOOD CELLS.

These are the most numerous blood cells that mainly transport oxygen in the body
Red blood cells are produced in bone marrow of short bones eg ribs, vertebrae and sternum.
Red blood cell is biconcave in shape and has no nucleus.

Function of red blood cells.

They transport oxygen in the body.

Adaptation of red blood cell for transportation of oxygen

i. They have haemoglobin that has higher affinity to oxygen
(Haemoglobin easily combines with oxygen to form **oxyhaemoglobin**)
Oxyhaemoglobin is formed when blood passes an area with high oxygen concentration eg lungs.
Oxyhaemoglobin dissociates/ break apart to release oxygen when blood passes through area of low oxygen concentration eg body tissues.

ii. Red blood cells are biconcave in shape that increases surface area for transportation of oxygen

iii. Red blood cells are numerous in number that increases surface area for transportation of oxygen.

WHITE BLOOD CELLS.

These are the largest blood cells that mainly fight against infections in the body
White blood cells have nucleus and most of them are irregular in shape.
White blood cells are produced in bone marrow, spleen and lymph nodes.

Kinds of white blood cells.

A. Phagocytes (Granocytes)
B. Lymphocytes (Agranocytes)

PHAGOCYTES.
These are white blood cells that engulf and digest germs in the body.
The process by which phagocytes engulf and digest germs in the body is called **Phagocytosis.**
Phagocytes are produced in the bone marrow.
Phagocytes that form 75% of white blood cells have irregular nucleus and have tiny granules in their cytoplasm as such they are called **granocytes.**
Granules contain enzymes used for digesting engulfed germs.
Phagocytes can sometimes leave blood vessel by squeezing between cells that form capillary wall and reach infected body tissues. This process is called **diapedisis**

LYMPHOCYTES.
These are white blood cells that are spherical in shape with large nucleus.
Lymphocytes that form 25% of white blood cells are produced in the lymph nodes
Lymphocytes have no granules as such they are called agranocytes.

Two kinds of lymphocytes.

i. T lymphocytes (T cells)
These are lymphocytes that destroy foreign cells in the body e.g. bacteria. Viral infected cells and cancer cells.

ii. B lymphocytes (B cells)
These are lymphocytes that produce antibodies in the body.
Antibodies are special proteins that destroy foreign substances in the body.

Ways in which antibodies fight against infection in the body.

1. Some kill germs by dissolving them. These antibodies are called **lysins**
2. Some neutralize toxins produced by germs. These antibodies are called **antitoxins.**
3. Some clump germs together so that they should easily be engulfed. These antibodies are called **agglutins.**
4. Some antibodies combine with the outer layer of the germ so that the germ should look more appetizing to phagocytes. These antibodies are called **Opsonins**

PLATELETS.
These are small fragments that become detached from the cells.
Platelets are produced in the bone marrow and have no nucleus.

Function of platelets.
Platelets are responsible for blood clot.
A clot is the lump of blood that seals a wound.

Importance of a blood clot.

1. It stops germs from entering into the body through the woud.
2. It reduces bleeding.

How a clot is formed.

When a blood vessel is cut, platelets are exposed to unfamiliar substances such as atmospheric air.

This makes platelets to react with calcium and vitamin K found in the blood and atmospheric oxygen to form a chemical called **Thromboplastin**.

Thromboplastin converts plasma enzyme produced by the liver called prothrombin to thrombin.

Thrombin changes plasma protein called fibrinogen to fibrin.

Fibrin then forms a mesh of fibers on the wound that traps blood cells to form a clot

BLOOD TRANSFUSION.

It is the process of transferring blood from external source into the body of the person.

Blood transfusion is done to people who have lost a lot of blood during accidents, delivery, surgery and severe malaria in order to prevent heart failure.

Factors to be considered before blood transfusion.

1. Sexually transmitted infections and HIV/AIDS.

Donated blood is always tested for STIs in order to prevent the transmition of STIs to recipient since STIs are transmitted through blood.

2. Hepatitis.

Hepatitis is the disease of the liver. This disease spreads through blood as such donated blood must be tested for hepatitis to prevent infecting the recipient.

3. Anaemia.

Anaemia is the condition of having insufficient blood in the body.

During blood transfusion, a blood donor is not supposed to be anaemic because this can worsen the condition of the blood donor.

4. Rhesus factor.

Rhesus factor is the protein found on red blood cells.

People who have rhesus factor are said to be rhesus positive whereas people who don't have rhesus factor are said to be rhesus negative.

Blood which is rhesus positive can not be donated to a person who is rhesus negative to avoid agglutination of recipient's blood.

Agglutination is the sticking together of red blood cells in the body. This can lead to death because blood vessels are blocked and the flow of blood is stopped.

5. Blood group.

There four kinds of blood groups. These are A, B, AB and O.

These blood groups are determined by two kinds of antigens found on red blood cells. These are:

i. Antigen A.
ii. Antigen B.
iii.

A person can have one kind of antigen, or both kinds of antigens or none of them.
If a person has antigen A only, his/ her blood group is A.
If a person has antigen B only, his/ her blood group is B.
If a person has antigen A and antigen B, his/ her blood group is AB.
If a person has neither antigen A nor antigen B, his or her blood group is O

Relationship between antigen and antibodies.

Blood group	Antigens on red blood cells	Antibodies in the plasma.
A	A	Anti B antibodies
B	B	Anti A antibodies
AB	A and B	None
O	None	Anti A antibodies and anti B antibodies.

* Antigens and antibodies are called **agglutinating proteins** because they are responsible for agglutination of blood in the body.

Donating and receiving blood.

Blood group	Donate to---	Receive from---
A	A and AB	A and O
B	B and AB	B and O
AB	AB	A, B, AB and O
O	A, B, AB and O	O

A person with blood group O is said to be Universal donor because he/ she can donate blood to all blood groups without causing agglutination. This occurs because blood group O has no antigens that can stimulate the production of antibodies in recipients' body

A person with blood group AB is said to be Universal recipient because he/ she can receive blood from all blood groups without any agglutination. This occurs because blood group AB has no antibodies in its plasma against antigen A and antigen B.

The process of giving blood to a patient.
During blood donation, 450ml of blood is collected from vein and drained into the bottle.
Blood is collected from vein because this blood vessel carries blood which has already performed its function as such its removal can have little effect on the body.
In the bottle, blood is mixed with an anticoagulant such as **sodium citrate** that prevents blood clotting.
A blood donor is then given soft drinks and iron tablets. Soft drinks maintain the volume of fluids in the blood whereas iron tablets speed up blood formation process in the body.
Donated blood is kept in refrigerator in order to reduce rate of metabolic activities of blood cells so that they should live longer.
Donated blood is drained into the vein of the patient during blood transfusion through a drip. This blood is drained into a vein because blood moves at low pressure in veins as such donated blood can easily enter into the blood vessel. The other reason is that vein

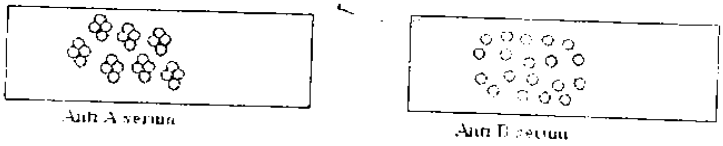
carries blood towards heart where it is pumped to excretory organs such as lungs and kidneys for excretion.
Donated blood is never used, if it stays for a month because most blood cells are dead and can not perform their functions.

Knowing the blood group of the person.
Doctors use serum to know the blood group of the person.
A serum is the blood plasma without fibrinogen.
Procedure.

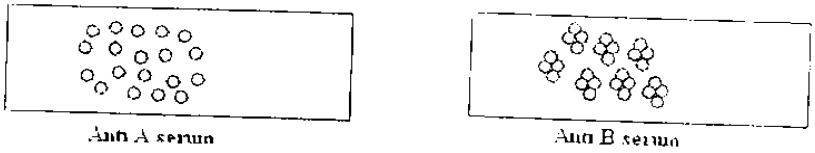
1. Anti A serum and anti B serum are dried on separate microscope slides.
2. Blood sample is placed on anti A serum and anti B serum.
3. Blood sample is mixed with sera and wait for a while.

Expected results.

1. If agglutination occurs on anti A serum but not on anti B serum as shown below, the blood sample has antigen A only.
   Therefore the blood group of the person is A.

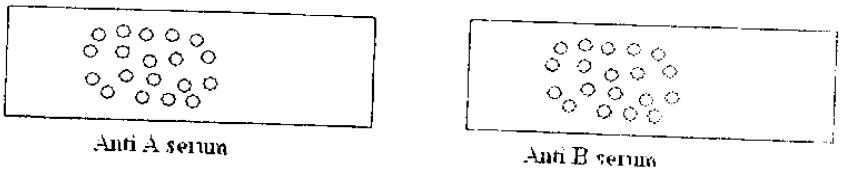


2. If agglutination occurs on anti B serum but not on anti A serum as shown below, the blood sample has antigen B only. Therefore the blood group is B.



3. If agglutination occurs on both anti A serum and anti B serum, the blood sample has both antigen A and antigen B. Therefore the blood group is AB.

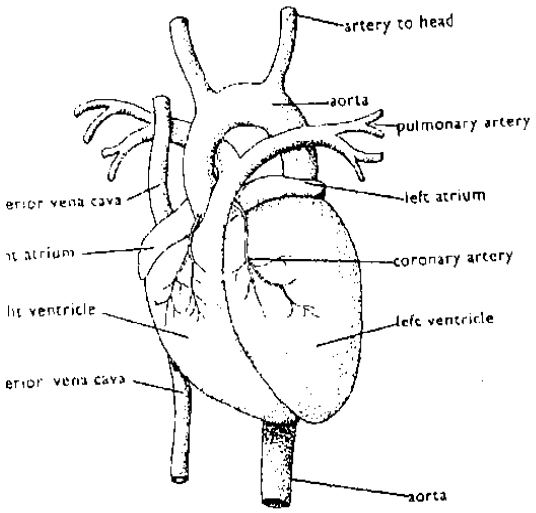
4. If agglutination does not occur on both anti A serum and anti B serum, the blood sample has neither antigen A nor antigen B. Therefore the blood group is O

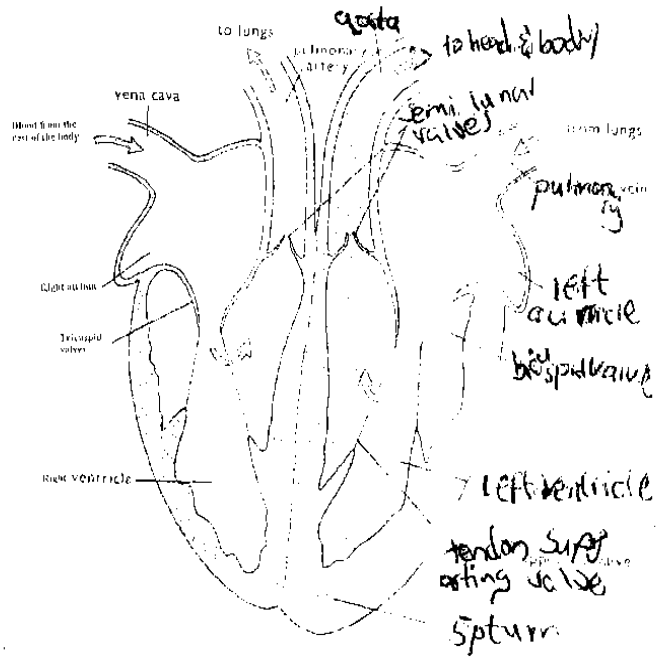


THE HUMAN HEART.

It is the special organ that pumps blood through out the body.
The human heart is made up of special muscles called **cardiac muscles.**
Cardiac muscles contract and relax rhythmically through out life time of the person without resting.
Cardiac muscles are supplied with blood full of food nutrients and oxygen by coronary **artery.**
The human heart lies in the **pericardial cavity,** which is filled with the fluid called **pericardial fluid.**
Pericardial fluid prevents friction between heart muscles and chest wall during heart beats.

Structure of the heart.





DESCRIPTION OF HUMAN HEART

The heart has four chambers. The two upper chambers are called **atria/ auricles**
The two lower chambers are called **ventricles.**
Atria receive blood from veins and pump it into ventricles.
Ventricles receive blood from atria and pump it to the rest of the body through arteries.
Ventricles have thicker muscular wall than atria because they pump blood to the rest of the body, which requires more force.
Left ventricle has thicker muscular wall than right ventricle because it pumps blood to the greater distance which requires more force.

Blood travels twice in the human heart before it goes back to the rest of the body. As such human blood system is also called double circulatory system.

How does heart work.

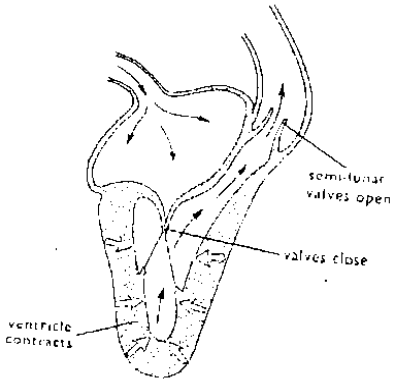
The human heart works by contracting and relaxing its muscles.

The contraction of heart muscles is called **systole**.

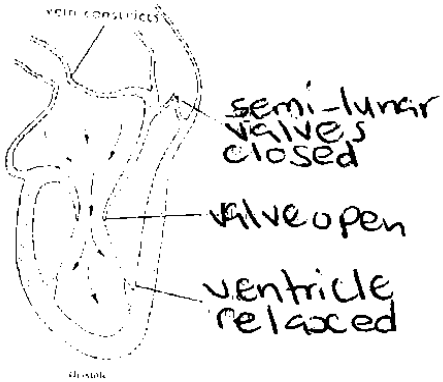
During systole, the heart becomes smaller. This increases blood pressure in the heart as a result; blood is forced out of the heart into arteries. As blood is moving out of the ventricle into arteries, Bicuspid and tricuspid valves close to prevent blood from flowing into atria whereas semi lunar valves open to direct blood into arteries.

The pressure that is created when heart muscles contract is called **systolic pressure** and its magnitude is **120mmHg.**

The relaxation of heart muscles is called **diastole**. During diastole, the heart becomes bigger. This reduces blood pressure in the heart as a result blood moves from veins into atria and ventricles. As blood moves from atria into ventricle, semi lunar valve close to prevent blood from flowing from arteries into ventricles whereas bicuspid and tricuspid valves open to direct blood into ventricles. The pressure of the blood that occurs when heart muscles relax is called **diastolic pressure** which has the magnitude of **80mmHg.** This is the reason why doctors write 120/80mmHg for the normal blood pressu



Systole



Diastole

BLOOD VESSELS

These are passages of blood in the body.

The wall of blood vessels is made up of smooth muscles.

Three kinds blood vessels.

i. Arteries.
ii. Veins
iii. Capillaries.

ARTERIES.

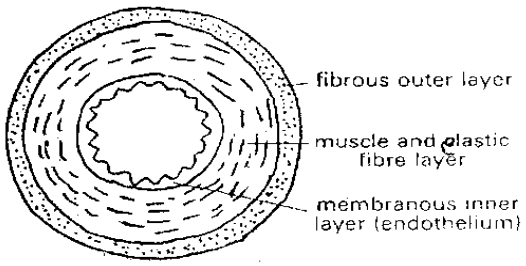
These are blood vessels that carry blood from the heart to the rest of the body.

Characteristics of arteries.

1. The carry blood at high pressure due to the pumping effect of the heart which is felt.
2. They have thick elastic muscular wall to with stand high blood pressure

3. They have narrow lumen for carrying blood at high pressure.
4. They don't have valves since blood always move at high pressure and in one direction.
5. They carry oxygenated blood except pulmonary artery and umbilical artery
6. Blood in arteries is bright red in colour due to presence of oxyhaemoglobin.
7. The largest artery in the human body is aorta.

Cross section of an artery.



a. Artery

Pulse rate.

Pulse is the expansion and contraction of the arterial wall due to heart beats.
Pulse is felt in arteries because arteries have elastic wall that bounces back when stretched.
Pulse rate shows the number of heart beats per minute.
Pulse rate increases during exercise because at this time heart pumps blood faster in order to supply food and oxygen to the muscles for respiration. This also removes lot carbondioxide released during respiration.

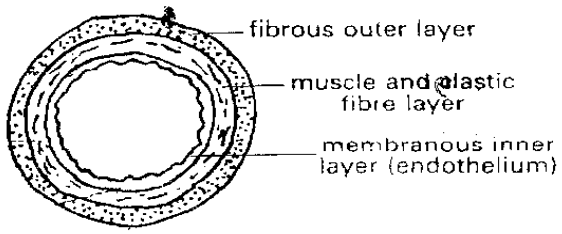
VEINS.

These are blood vessels that carry blood from the rest of the body towards the heart

Characteristics of veins.

1. They carry blood at low pressure because the pumping effect of the heart is not felt.
2. They have thin muscular wall.
3. They wide lumen that enables them to carry large volume of blood.
4. They have valves at intervals to prevent back flow of blood.
5. They carry deoxygenated blood except pulmonary vein and umbilical vein.
6. Blood in veins is dark red in colour due to absence of oxyhaemoglobin.
7. The largest vein in the human body is venacava.

Cross section of the vein.



b. Vein

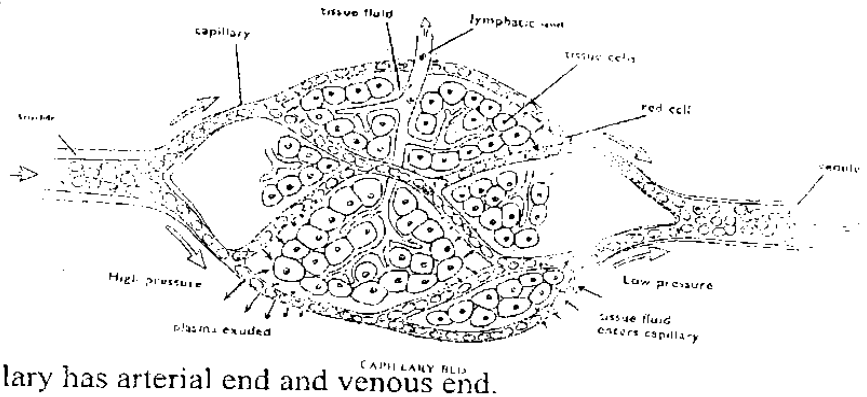
Mechanism that moves blood in veins.

1. Contraction of skeletal muscles that squeezes blood forward.
2. Action of valves that prevent backflow of blood.
3. Gravity that pulls blood from upper parts of the body.

CAPILLARIES

These are the smallest blood vessels that form a bridge between arteries and veins.
Capillaries provide an area for exchange of materials between blood and body cells. As such they are found between cells so that they should easily supply necessary materials to the cells.
Capillaries have narrowest lumen and very thin wall (one cell thick) for easy diffusion of materials between blood and body cells.
Blood in capillaries move at very low to give more time for diffusion of materials.

Structure of the capillary



CAPILLARY BED

Capillary has arterial end and venous end.
Arterial end has high blood pressure due to:

i. Pumping effect of heart is felt.
ii. Blood moves from wider lumen of arteries into narrow lumen of arterioles.

This high blood pressure forces out fluids from blood plasma, which diffuses to body tissues. This fluid is called tissue fluid.
This tissue fluid supplies food nutrients, oxygen antibodies and other necessary materials to the body cells.
As it is supplying necessary materials, tissue fluid carries waste matters such as carbondioxide, urea and uric acid and return into the blood stream at venous end

Factors that enable tissue fluid to return into blood stream at venous end.

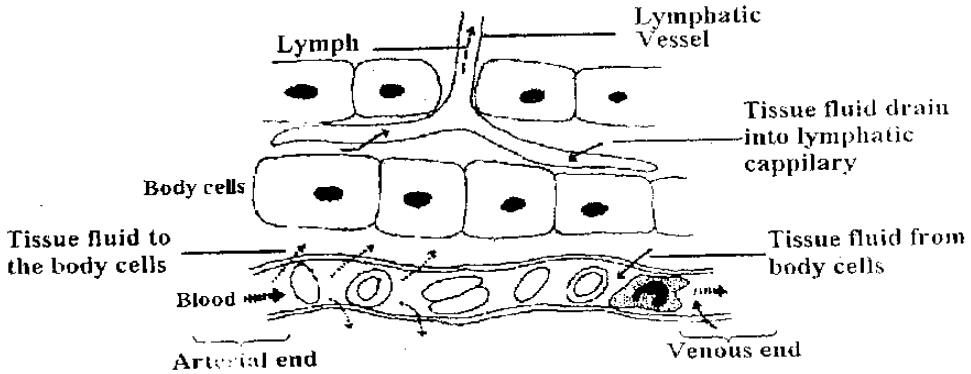
1. Blood at venous end is highly concentrated as such tissue fluid drains into blood stream by osmosis.
2. There is low blood pressure at venous end because:

i. Blood is moving from narrow lumen of venules into wider lumen of veins.
ii. The pumping effect of the heart is not felt.

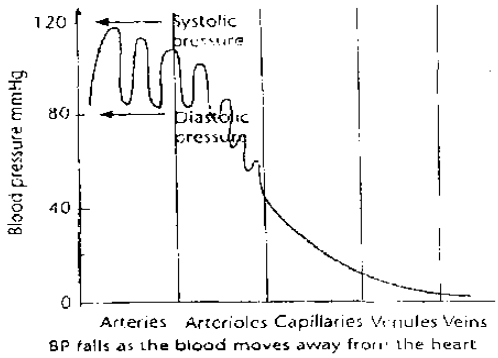
Some tissue fluids do not return into the blood stream instead they drain into lymphatic capillaries that join up to form lymphatic vessels.
Tissue fluid that drains into lymphatic capillaries is called lymph.

Tissue fluid and lymph are similar because both are colorless and they don't contain red blood cells.

EXCHANGE OF MATERIALS AT CAPILLARY BED



Blood pressure in different blood vessels.

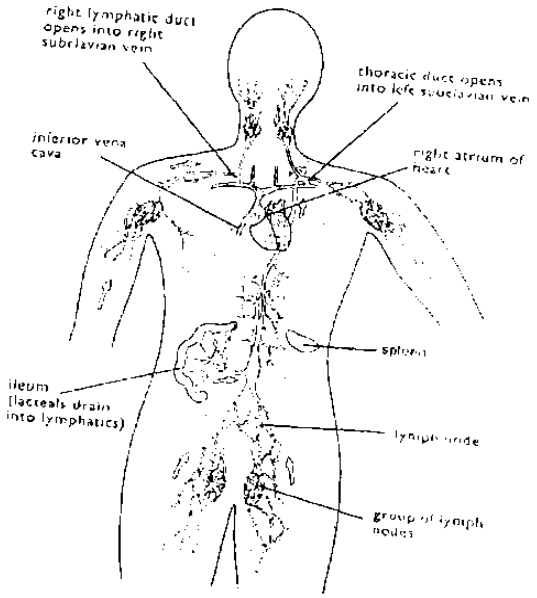


LYMPHATIC SYSTEM.

It is one of the body systems that transport substances in the body.
This system consists of lymph vessel and lymph.
Lymph vessels have thin wall and have valves like veins.
Lymph vessels have lymph nodes that filter/ purify lymph before it drains into blood stream
Tiny spaces of lymph nodes have white blood cells that engulf germs, cellular debris and other harmful substances that should not enter into the blood stream
Lymph nodes also produce lymphocytes that fight against infections in the body
Lymph vessels also transport fatty acids and glycerol from small intestine.
Lymph move by action of valves, contraction of skeletal muscles and gravity.
All lymph vessels in the body join up to form two major lymph vessels. These are

i. Right lymph duct.
ii. Thoracic duct.

Right lymph duct drains lymph into right subclavian vein whereas thoracic duct drains lymph into left subclavian vein.
Subclavian veins drain blood with lymph into venacava that empties blood into the heart
In the heart blood with lymph is pumped to excretory organs such as lungs and kidneys for excretion.
Lymph is also found in pleural cavity (cavity where lungs are found) and pericardial cavity. In these cavities, lymph reduces friction between organs enclosed and chest wall.
Figure below shows the lymphatic system



IMPORTANCE OF CIRCULATORY SYSTEM.

1. It transports substances in the body.
2. It fights against infections in the body.
3. It distributes heat energy in the body.

PROBLEMS ASSOCIATED WITH CIRCULATORY SYSTEM.

A. High blood pressure (hypertension)

It is the condition in which blood moves at high pressure in arteries all the time
The blood pressure of people who are suffering from high blood pressure is always higher than normal (120/80mmHg)
The cause of high blood pressure is not known but it is associated with stress and worries over eating, over drinking alcohol, over working and smoking.

Effects of high blood pressure.

1. It can cause heart failure since it puts an extra strain on the heart.
2. It can cause bursting of arteries. When arteries of the brain burst, the spillage of blood kills brain cells leading to paralysis. The blood clot in the brain is called **stroke**. Stroke is more common in elderly because they have fragile blood vessels.
3.

B. Heart attack (Cardiac arrest)

It is the sudden slowing down or stoppage of heart beats.
Heart attack occurs when coronary artery is blocked such that food nutrients and oxygen are no longer reaching the heart muscles. When this happens, heart muscles stop contracting.

Substances that can block coronary artery.

i. Cholesterol laid in coronary artery. Blockage of coronary artery by cholesterol is called **atheroma.**
ii. Blood clot in coronary artery. Blockage of coronary artery by blood clot is called **thrombosis.**

Bad habits that increase chances of heart attack.

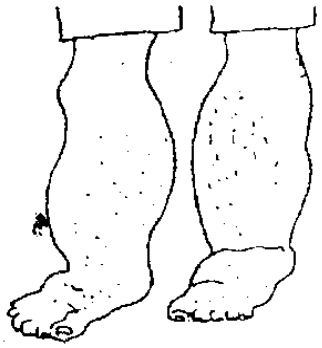
1. Eating food stuffs that contain cholesterol such as animal fats.
2. Inhalation of carbonmonoxide through smoking that makes cholesterol to be laid in coronary artery.

Ways of preventing heart attack.

i. Avoid smoking.
ii. Avoid eating food stuffs that contain cholesterol.
iii. Regular exercise.
iv. Regular check ups.

C. OEDEMA.

It is the swelling up of body tissues due to accumulation of tissues fluids in body tissues
Oedema occurs when tissue fluid is drained slowly.
Tissue fluid can be drained slowly when lymphatic vessels are blocked by filarial worms.
Filarial worms are injected into the blood stream by culex or anopheles mosquitoes in the blood stream filarial worms migrate to lymph vessels where they live in lymph nodes.
Adult filarial worms produce larvae called microfilariae, which migrate to the blood stream where it is sucked by mosquitoes.
Oedema can also occur in pregnant women, elderly and people who remain standing for along period of time.
Permanent blockage of lymph vessels results into elephantiasis.
Elephatiasis is the gross enlargement of arms, legs, breast and scrotum.



Elephantiasis

Signs and symptoms of elephantiasis.

1. Swollen and painful lymph nodes.
2. Swollen limbs such as legs and arms.
3. Skin of enlarged limbs becomes thick and hard like that of an elephant.

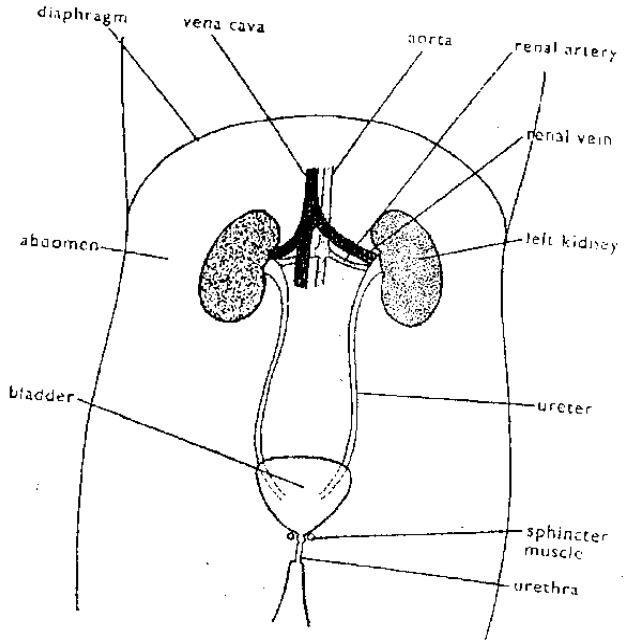
TOPIC 6: EXCRETION.

Excretion is the removal of waste products of the body cells.
All substances that are excreted are called excretory substances e.g. carbondioxide, urea and bile pigments.

Excretory substance.	Where produced.	Where excreted.
Carbondioxide.	Body cells during respiration.	Lungs.
Urea.	Liver during deamination	Kidney.
Bile pigment.	Liver from damaged red blood cells.	Gut through defaecation.

HUMAN EXCRETORY SYSTEM.

It is the body system that mainly removes urea from blood.
This system consists of kidneys, ureter, urinary bladder and urethra.



DESCRIPTION OF EXCRETORY SYSTEM

Kidneys receive 1/5 of blood from **aorta** through **renal artery**.
Kidneys filter 180*l* of blood per day.
Pure blood is returned into **venacava** through **renal vein**.
The filtered fluid that contains urea, excess water and salts form urine that flows to the **urinary bladder** through **ureter**.
When the bladder is full of urine, **sphincter muscles** relax at will to allow urine to pass out though **urethra.**

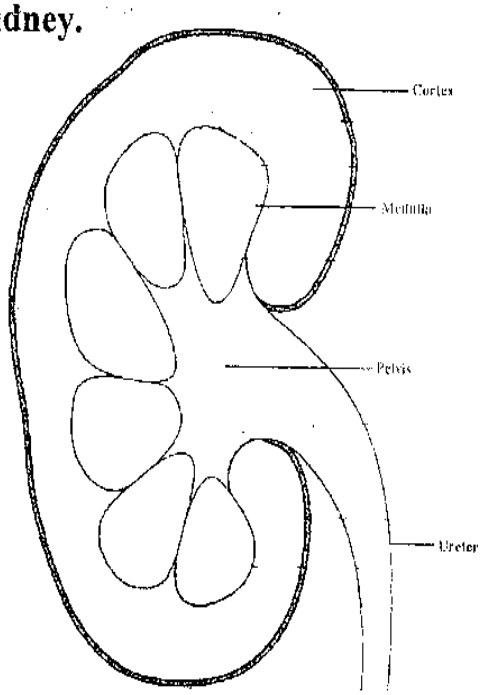
KIDNEYS

These are reddish brown bean shaped organs found at the back of the abdominal cavity of the waist.

Functions of the kidney.

i. It purifies/filters blood passing through it.
ii. It regulates amount of water in the blood.

Structure of the kidney.



Description of the kidney.

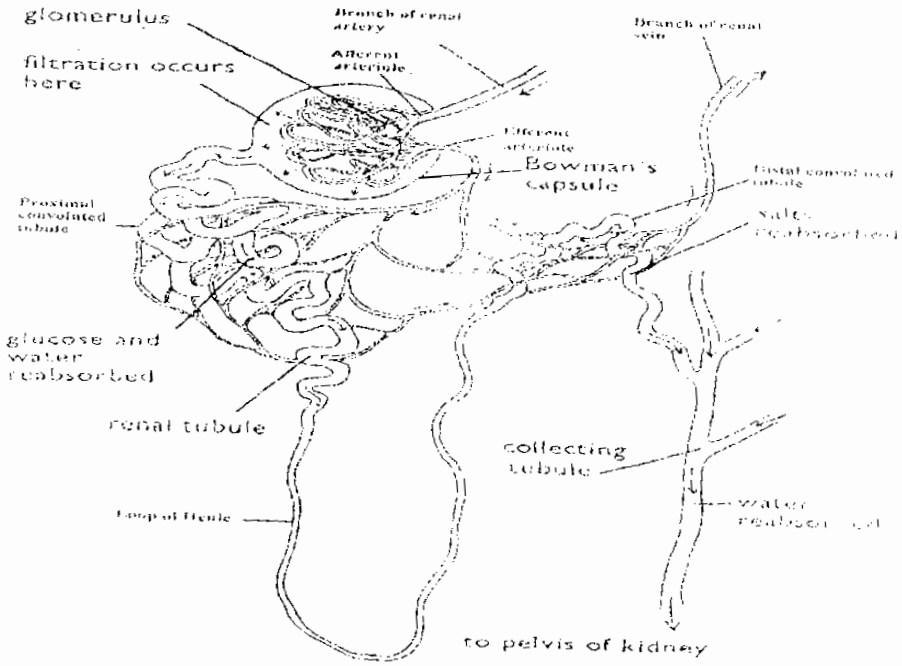
Kidney has three layers. These are:

i. Cortex. -Darker outer region of the kidney.
ii. Medulla-Light inner region of the kidney.
iii. Pelvis- White inner region where ureter leaves the kidney.

NEPHRONS.

These are several small tubules that are found in the inner part of the kidney. Nephron is the functional unit of the kidney as filtration of blood occurs in it.
Nephron begins from the cortex looping downwards into medulla, where it goes back into the cortex. From the cortex, it goes into the pelvis passing through medulla. In the pelvis nephrones join up to form collecting duct that joins to ureter.

Structure of the nephron.



HOW URINE IS FORMED IN KIDNEYS.

Nephron in the kidney has **Bowman's capsule** that surrounds a knot of blood vessel called **glomerulus**. In the glomerulus there is **high blood pressure** due to the pumping effect of the heart and blood flows from wider lumen of afferent arteriole into narrow lumen of efferent arteriole.

This high blood pressure forces out fluids from the blood into Bowman's capsule. This process is called **ultrafiltration.** The fluid that is forced out of the blood into bowman's capsule is called **glomerular filtrate.**

Glomerular filtrate contains both useful substances and waste substances. As the filtrate trickles downwards in the nephrone, useful substances such as food nutrients are reabsorbed into the blood stream by active transport and diffusion at the proximal convoluted tubule.

At loop of henle, water is reabsorbed by osmosis whereas mineral salts are reabsorbed at distal convoluted tubule. Water is also reabsorbed at the collecting duct under the influence of antidiuretic hormone (ADH)

The remains of glomerular filtrate, which are urea excess salts and water form urine which is lead to ureter by collecting duct. Ureter carries urine to the urinary bladder where it is stored temporary.

Functions of different parts of the nephrone.

i. **Bowman's capsule.**

It is the site for ultrafiltration.

ii. **Proximal convoluted tubule.**

It is the site for reabsorption of food nutrients (glucose, amino acids and mineral salts)

iii. **Loop of henle.**

It is the site for reabsorption of water. The longer the loop of henle, the more water is reabsorbed and the less water is lost in urine. Long loop of henle is an adaptation of desert animals that need to conserve water in order to survive in dry areas.

iv. **Distal convoluted tubule.**

It is the site where mineral salts are reabsorbed.
It is also a site where hydrogen ions are secreted and bicarbonate ions are reabsorbed.
This controls pH of the blood.
Drugs are also secreted at this part.

v. **Collecting duct.**

It collects urine and leads it to the ureter.
It also reabsorbs water under the influence of Antidiuretic hormone (ADH)

THE ROLE OF ADH IN OSMOREGULATION.

Osmoregulation is the process of controlling amount of water and mineral salts in the blood. This process is made possible because of the hormone called antidiuretic hormone (ADH).
ADH is secreted by pituitary gland of the brain, when the osmotic pressure of the blood has increased; thus increase in concentration of solutes in blood.
Blood becomes concentrated due to the following factors:

i. Little water is drunk.
ii. Too much sweating.
iii. Large amount of salts are ingested.

The rise in osmotic pressure of the blood is detected by receptors in the hypothalamus part of the brain that sends messages to pituitary gland. This prompts pituitary gland to release ADH that is carried by blood to the collecting duct of the kidney, where it increases permeability of collecting duct to water. As a result more water is reabsorbed from glomerular filtrate by osmosis in the collecting duct. An increase in reabsorption of water from glomerular filtrate causes low output of urine which is deep yellow in colour (highly concentrated). Such kind of urine is called **hypertonic urine**.

The decrease in osmotic pressure is also detected by hypothalamus that sends impulses to pituitary gland. Pituitary gland reduces the release of ADH into the blood as such the permeability of collecting duct to water becomes very low and little water is reabsorbed from the glomerular filtrate. A decrease in reabsorption of water from glomerular filtrate increases the out put of urine, which is pale yellow in colour (diluted). Such kind of urine is called **hypotonic urine.**

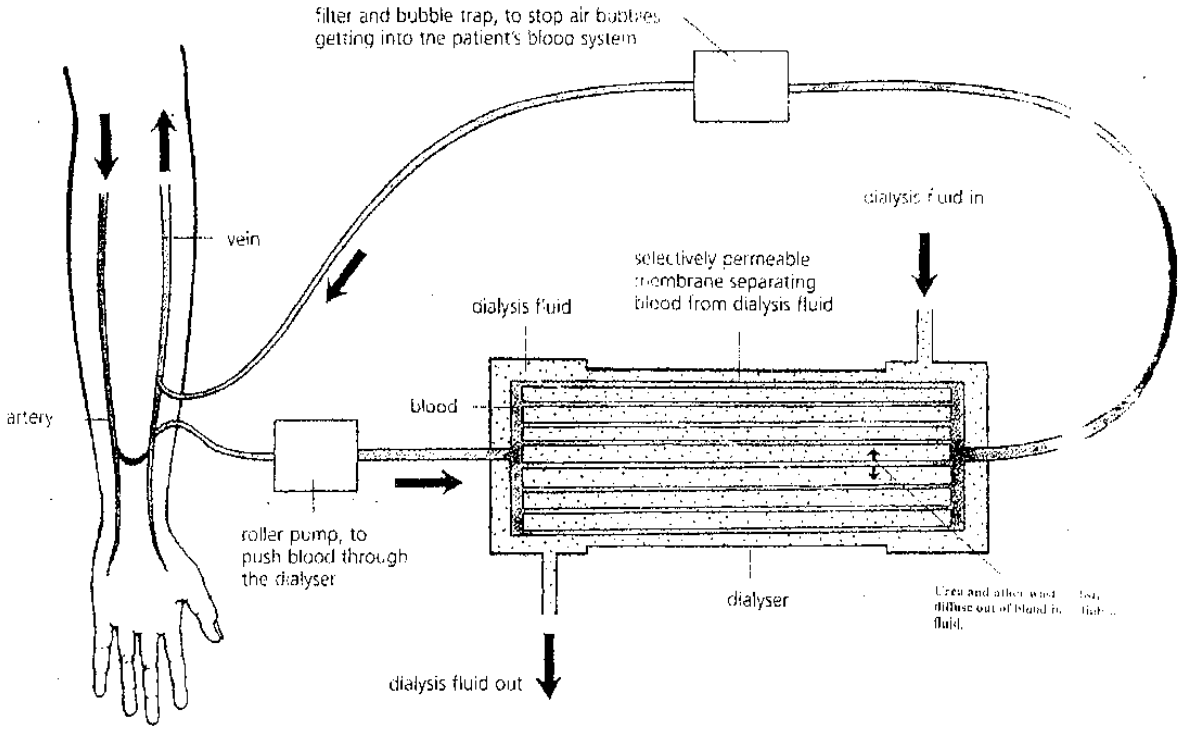
KIDNEY FAILURE.

It is the condition in which kidney fails to filter blood that passes through it due to an infection or poisonous substances.
Kidney failure results into death as wastes products such as urea and drugs accumulate in the blood and lower the pH of blood.

Solutions to kidney failure.

i. Use of dialysis machine.
ii. Kidney transplant.

DIALYSIS MACHINE



HOW DOES DIALYSIS MACHINE WORK?

Blood from the artery of the patient's arm is pumped into the dialysis machine through a tube. Doctors add **heparin** to blood in the tube to prevent blood clotting. In the machine the tube is divided into several tubes in order to increase surface area for diffusion of substances from the blood. These dialysis tubes have partially permeable wall that separates blood from dialysis fluid. Dialysis fluid has the same composition as blood plasma but it has no urea. This makes urea to diffuse from the blood into dialysis fluid where it is carried out. Blood and dialysis fluid move in opposite direction in order to maintain diffusion gradient of urea for fast and efficient diffusion.

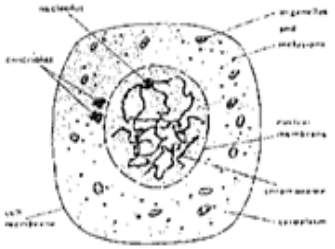
In the dialysis machine food nutrients don't diffuse from blood because the concentration of food nutrients in dialysis fluid and blood is equal.

Blood cells and blood proteins can not pass through the wall of dialysis tube because they are too large as such they can not diffuse from blood into dialysis fluid.

After dialysis, purified blood is returned into a vein of the patients arm through a tube. This tube has a roller that removes air bubbles that may block blood vessels and disturb normal flow of the blood in the body.

TOPIC 11: CELL BIOLOGY (CYTOLOGY)

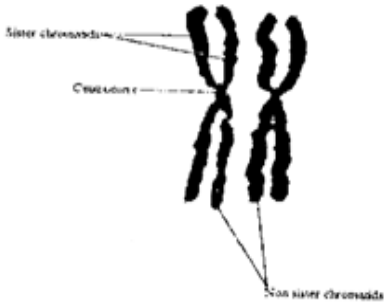
Cytology is the study of the living cells.
A cell is a smallest living unit of the body.
Cells that divide are only those that have nucleus, which contains **chromosomes.**
Chromosomes are threadlike structures that are found in the nucleus of the living cell.
Chromosomes carry genetic materials that control characters (traits) of organisms.



COMPONENTS OF A CHROMOSOME.
Chromosome is made up of Deoxyribonucleic acid (**DNA) molecule** and a protein called **histone.**

Structure of DNA molecule.

DESCRIPTION OF DNA
DNA consists of two strands that intertwine each other. The two strands that form DNA molecule are joined at nitrogen bases. These nitrogen bases are: Adenine, Thymine, Cytosine and Guamine.
Adenine on one strand pair with thymine on the other strand whereas cytosine on one strand pair with guamine on the other strand.
The arrangement of nitrogen bases on the DNA is very unique to every person as such every person has DNA molecule, which is different from other people.
DNA molecule wraps around a protein called **histone** to form a chromosome.
DNA carries genes that control a character of organisms.
A gene is a unit of inheritance that forms part of DNA molecule.
A chromosome consists of two chromatids that are joined together at a point called centromere.
Structure of a chromosome.

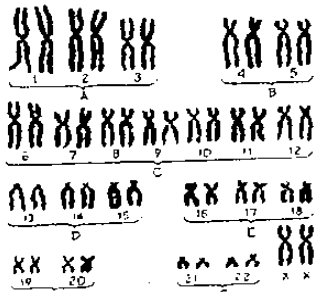


When are chromosomes visible?
Chromosomes can only be seen clearly under microscope when:
i. A cell is about to divide. At this time chromosomes become short and thick.
ii. A cell is stained with dye that gives colour to chromosomes such that they become conspicuous (visible)

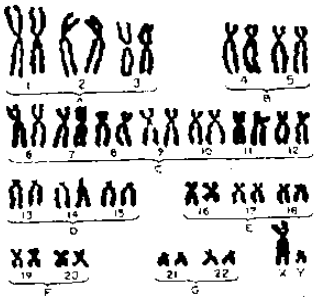
ARRANGEMENT OF CHROMOSOMES.

In all body cells, chromosomes are arranged in pairs.
A condition in which chromosomes are arranged in pairs is called **diploid condition.**
a cell that has chromosomes in pairs is called **diploid cell.** The number of chromosomes in diploid cell is called **diploid number** and it is denoted as **2n.**
A pair of identical chromosomes is called **homologous chromosomes.**

Arrangement of chromosomes in the cell of the woman and a man



Karyotype of a woman



Karyotype of the man.

In gametes chromosomes exist in singles. A condition in which chromosomes exist in singles is called **haploid condition**. A cell that has chromosomes in singles is called **haploid cell**. The number of chromosomes in haploid cell is called **haploid number** which is denoted as **n**

CELL DIVISION.

It is a process in which a cell divides and split into new cells.
A cell that divides is called **parent cell** where as new cells that are formed are called **daughter cells.**

Kinds of cell division
i. Mitosis.
ii. Meiosis.

MITOSIS

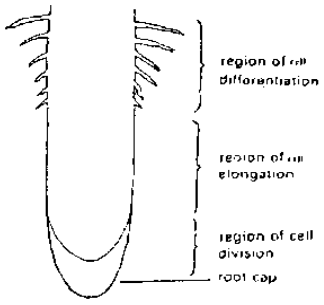
It is a process in which a cell divides and splits into two new cells.

Significance of mitosis.
i. It brings about growth in multicellular organisms.
ii. It repairs worn out tissues.
iii. It is a mode of reproduction in unicellular organisms.

REGIONS OF THE BODY WHERE MITOSIS OCCURS.

In animals mitosis occurs in all parts of the body where as in plants, mitosis occurs in root tips, shoot tips and cambium.
Regions of the plant where active mitosis occurs are called **meristems**.

Regions of the root.

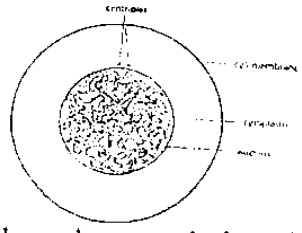


Stages of mitosis.

Mitosis is the continuous process but it is divided into stages for learning purpose.
These stages are:

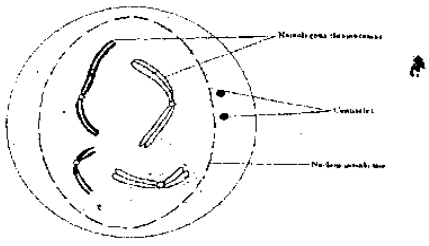
1. Interphase.
2. Prophase
3. Metaphase.
4. Anaphase
5. Telophase

Interphase.



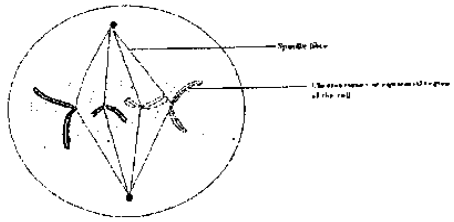
Interphase is regarded as the resting stage of the cell though a cell does not rest.
At this stage all the organelles remains intact.
At interphase, chromosomes replicate though they are too thread-like in structure to be seen.
Replication means production of exact copies of itself.

Prophase.



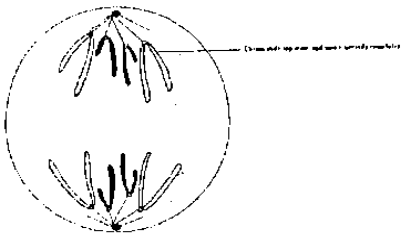
Prophase is a second stage of mitosis.
At this stage, chromosomes become short and thick such that they are visible.
All organelles and nucleolus disappear.
At prophase nuclear membrane dissolves such that chromosomes suspend in the cytoplasm.
The two centrioles that lie outside nuclear membrane separate and migrate towards opposite poles of a cell.

Metaphase.



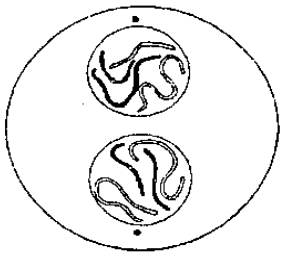
At metaphase, centrioles arrive at the opposite poles of the cell and spindle fibre is formed in the cell.
Chromosomes line up at equatorial region of the cell where they appear to be attached to spindle fibre at centromere.

Anaphase.

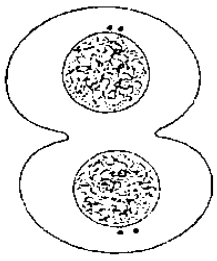


At anaphase, chromatids separate at centromere and move towards centrioles.
Chromatids appear to be pulled by the contraction of spindle fibre towards centrioles.

Telophase.



Early telophase



Late telophase

Telophase is the last stage of mitosis and it is divided into early telophase and late telophase.
During early telophase, chromatids arrive at opposite poles of the cell.

Each group of chromatids is surrounded by nuclear membrane and spindle fibres fade away (disappear)
During late telophase, Chromatids uncoil to form chromosomes.
Nucleolus and other organelles reappear in the cell.
Centrioles divide and cytoplasm constricts and divides into two new cells.

SUMMARY OF MITOSIS.

1. Two daughter cells are formed from one parent cell.
2. Number of chromosomes in each daughter cell is equal to the number of chromosomes in a parent cell.
3. Daughter cells and parent cell have same kinds of chromosomes.
4. Parent cell and daughter cells are diploid cells.
5. Parent cell and daughter cells are body cells.

MEIOSIS.

It is a process in which a cell divides and splits into four new cells called **gametes.**
This process produces gametes that are used in sexual reproduction.
In animals, meiosis occurs in testis and ovaries, where sperms and ova are produced respectively.
In plants, meiosis occurs in anthers and ovaries, where pollen grains and ovules are produced respectively.

STAGES OF MEIOSIS.

Meiosis is also a complex continuous process, which is divided into two main divisions. Each division has stages from interphase to telophase. These divisions are:
i. First meiotic division.
ii. Second Meiotic division.

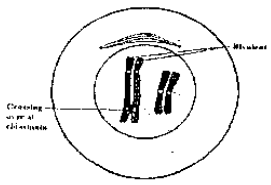
FIRST MEIOTIC DIVISION.

There are five stages under this division. These stages end with I (one) to show that they belong to first meiotic division

Interphase.

It is similar to interphase of mitosis.

Prophase I

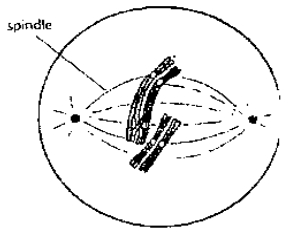


At prophase I, chromosomes become short and thick.
Homologous chromosomes pair up and appear to attract to each other at a point called **chiasmata**.
A pair of homologous chromosomes that appear to attract to each other is called **bivalent.**

These bivalents later repel each other but remain attracted at chiasmata.
At chiasmata, non sister chromatids, exchange portions of chromatids. This process is called **crossing over.**
Crossing over brings variations amongst organisms as genes are exchanged.

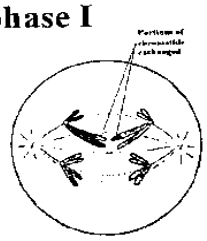
- All activities of prophase I occur whilst the nuclear membrane is still intact.

Metaphase I



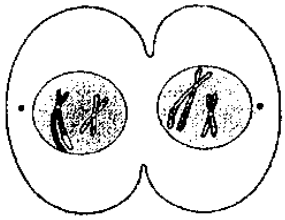
It is the stage when nuclear membrane dissolves, centrioles migrate to opposite poles of the cell and spindle fibres are formed in the cell.
Bivalents line up at equatorial region of the cell and appear to be attracted to spindles fibres at centromere.

Anaphase I



At this stage chromosomes that formed bivalents separate and move towards centrioles by the actions of spindle fibres.

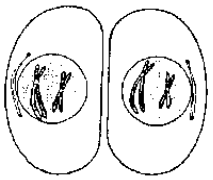
Telophase I



It is the last stage of first meiotic division.
At this stage, each group of chromosomes is collected at opposite poles of the cells.
Nuclear membrane is formed around the chromosomes and cytoplasm divides into two new cells.

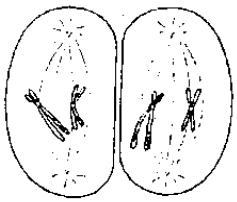
SECOND MEIOTIC DIVISION
There are four stages under this division. These stages end with II (two) to show that the belong to second meiotic division.

Prophase II



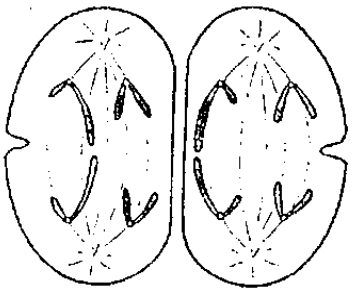
It is the first stage of second meiotic division.
This stage is similar to prophase under mitosis.
At prophase II, centrioles separate and spindle fibre is formed at right angle to the first one.

Metaphase II



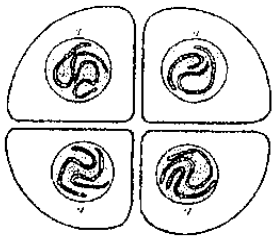
At this stage chromosomes line up at equatorial region of the cell.
Chromosomes appear to be attached to spindle fibre at centromere.

Anaphase II



At this stage, chromatids separate and move towards centrioles.
Chromatids seem to be pulled by contraction of spindle fibre.

Telophase II



It is a last stage of second meiotic division.
At this stage chromatids are collected at opposite poles of the cell.
Each group of chromatids is surrounded by nuclear membrane.

Cytoplasm then constricts and divide into four new cells each having half the number of chromosomes of parent cell.

SUMMARY OF MEIOSIS.

1. Four new cells are formed from one parent cell.
2. Daughter cells have half the number of chromosomes of parent cell as such meiosis is also called reduction division.
3. Daughter cells and parent cell have different kinds of chromosomes due to crossing over.
4. Parent cell is diploid cell whereas daughter cells are haploid cells.
5. Body cell produces gametes.

TOPIC 12: GENETICS

It is a study of how characters are transferred from parents to their offspring.
The process in which characters are transferred from parents to their offspring is called **Heredity.**
Offspring from same parents vary from each other due to several factors.

VARIATION.

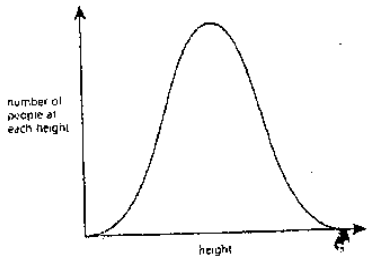
These are observable differences amongst organisms of the same **species.**
Species is a group of similar organisms that can mate and produce fertile offspring.
For instance, human beings belong to same species and they vary from each other in terms of height, intelligence, sex, skin colour, blood group etc.

TWO KINDS OF VARIATION

i. Continuous variation.
ii. Discontinuous variation

CONTINUOUS VARIATION

These are variations that have several intermediates for a character e.g. skin colour, intelligence, height and body mass.
These characters have several intermediates because they are controlled by several genes and are affected by environment.
When plotted on the graph, continuous variation produces a bell shaped graph as shown below.

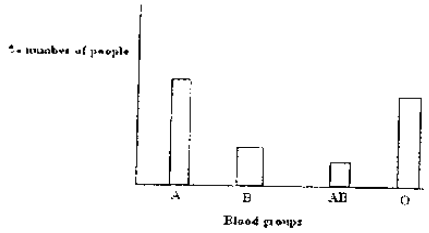


DISCONTINUOUS VARIATION.

These are variations that have no intermediates for a character e.g. sex, tongue rolling, blood group and Rhesus factor.

These characters have no intermediates because they are controlled by few genes and are never affected by environment.

Bar graph is usually used to show discontinuous variation.



CAUSES OF VARIATION.

Organisms of the same species vary from each other due to:

i. Heredity.
ii. Environment.
iii. Age.
iv. Sex.

Heredity.

Organisms may vary because they have inherited different genetic materials from their parents.

Genetic materials include chromosomes, DNA and genes.

These may be different due to mutation and crossing over.

Environment.

Organisms may also vary because they are exposed to different environmental factors such as food, diseases and climate.

Environmental factors affect ability of an organism to realize its genetic potential. For instance high yielding crop may not do so if it is grown on unfertile soil.

Age.

Most organisms vary from each other due to age.

This occurs because some characters of organisms change with age for instance tadpole has a tail whereas adult frog has no tail.

Sex.

Organisms also vary from each other due to sex. They are some characters that are commonly found in one sex. These characters make one sex to be different from the other sex group for instance men and women differ in terms of beards, breast and genitals.

INHERITANCE.

It is the process in which characters are transferred from parents to their offspring.

Characters are inherited from parents by the use of **genes**.

A gene is a unit of inheritance that forms part of DNA molecule.

Genes carry actual information about a character of an organism. Each character is controlled by a pair of genes called **alleles.** Alleles are different forms of a gene e.g. a gene for skin colour may have two alleles i.e. allele for black skin and allele for white skin. Agene for height may have allele for tallness and allele for shortness.
Alleles of the same character are found on the same loci on homologous chromosomes.

REPRESENTATION OF GENES

Genes are represented by letters e.g
i. **B** can represent allele for black skin whereas **b** can represent allele for white skin.
ii. T can represent allele for tallness whereas **t** can represent allele for shortness.
*Alleles of the same gene are represented by same letters and the final appearance of an organism for a character depends on the combination of genes as shown in table below.

Genetic combination.	**Final appearance.**
BB	Black skin
Bb	Black skin
bb	White skin

GENETIC TERMS WITH REFERENCE TO THE TABLE.

Genotype.
It is a combination of genes for a character e.g. **BB** and **Bb** are genotypes for black skin whereas **bb** is a genotype for white skin.

Phenotype.
It is a final appearance of organism e.g. black skin and white skin.

Homozygous condition.
It is a condition in which a character is controlled by a pair of similar alleles e.g. **BB** and **bb**.
Organism that has a character which is controlled by a pair of similar alleles is called **homozygote** or **pure breed.**

Heterozygous condition.
It is a condition in which a character is controlled by a pair of different alleles of the same gene e.g. **Bb**
Organism that has character which is controlled by a pair of different alleles is called **heterozygote**.

Dominant allele.
It is the allele that expresses itself in both homozygous condition and heterozygous condition e.g. allele for black skin.
Dominant allele is represented by a capital letter e.g. **B**

Recessive allele.
It is the allele that expresses itself in homozygous condition only e.g. allele for white skin.

Recessive allele is represented by small letter e.g. **b**

Homozygous dominant.
It is the condition in which a character is controlled by the pair of similar dominant alleles e.g. **BB**

Homozygous recessive.
It is the condition in which a character is controlled by the pair of similar recessive allele e.g. **bb**.

REPRESENTATION OF INHERITANCE.
Inheritance can be represented by the use of:
i. Crosses.
ii. Punnet square.
* Crosses and punnet square are called **genetic diagrams.**

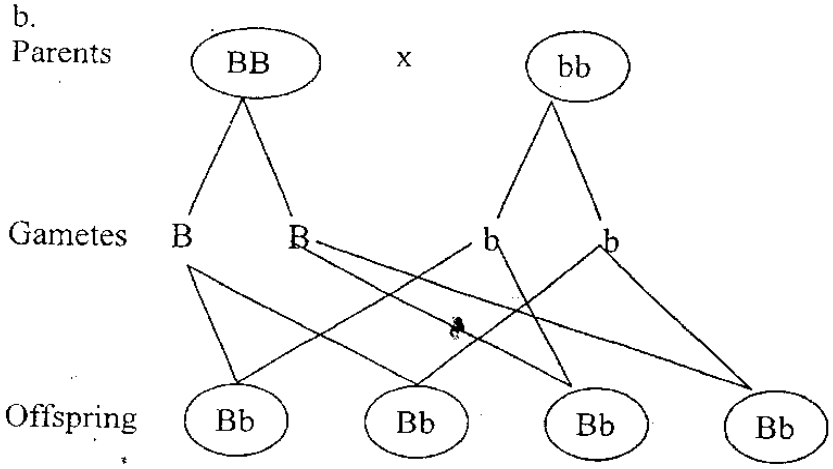
CROSSES
These are straight lines that show how genes are transferred from parents to their offspring.

POINTS TO CONSIDER WHEN USING CROSSES.
i. Parents have a pair of alleles for a character.
ii. Gametes carry single allele for a character from parents due to meiosis.
iii. Offspring formed after fertilization carry pair of alleles for a character.

Example involving crosses.
Pure breed black rat was crossed with pure breed white rat and all the offspring produced were black. Use **B** to represent dominant allele to answer the following questions.
a. Write down the genotypes of two parents.
b. Use genetic diagram to show the cross of two parents.
c. Use genetic diagram to show the cross of two offspring.
d. What is the ratio of black rats to white rats in the offspring produced in the second cross?

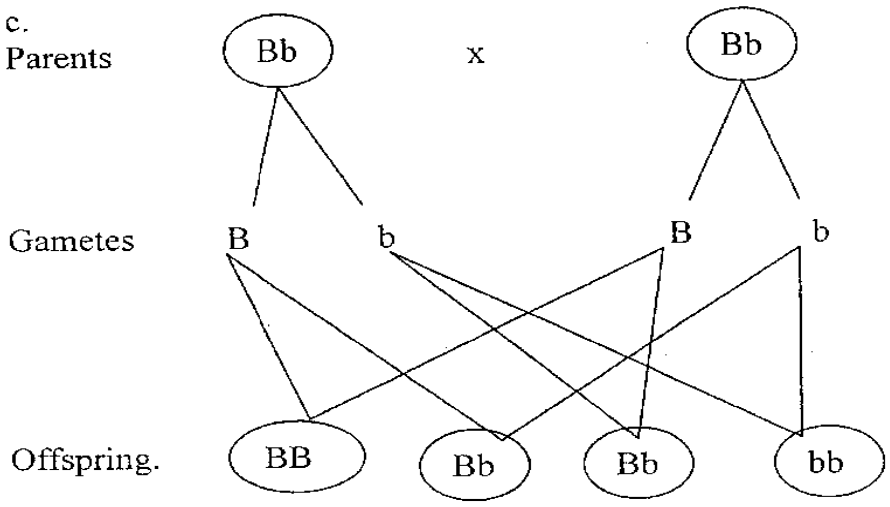
Solution.
a. BB for black rat and bb for white rat.

b.



All offspring are black.

c.



There are three black rats and one white rat.

d. Ratio of Black to white is 3:1

TERMS USED IN CROSSES

First filial generation (F_1)

These are offspring that are produced in the first cross when two pure breed parents are crossed.

All F_1 take the phenotype of dominant allele since they are heterozygote.

Second filial generation (F_2)

These are offspring that are produced when f_1 are self fertilized (crossing each other).

The ratio of phenotype of dominant allele to phenotype of recessive allele is always 3:1 in F_2

GREGOR MENDEL

He is the father of genetics.

Mendel discovered the law of inheritance when he crossed peas in his garden.

Principles of Mendelian genetics.

After crossing peas, Gregor Mendel came up with the following principles:

1. Characters are controlled by a pair of genes called alleles.
2. Alleles of the same gene are passed into separate gametes during meiosis.
3. Alleles of the same gene don't blend.
4. Alleles of the same gene are inherited independently.

Exercise.

*Pure breed hornless cattle were crossed with pure breed cattle with horns and all the F_1 were hornless. Use **H** for dominant allele to answer the following questions:*

i. Write down the genotypes of the two parents and F_1

ii. Use genetic diagram to show the cross between two F_1

iii. If there were 24 cattle in F_2, how many cattle were hornless?

CO DOMINANCE.

It is a condition in which a character is controlled by a pair of different dominant alleles
In co dominance, a character shows the phenotype of two dominant allele e.g. AB blood group and variegated leaf.

Inheritance of blood group.

There are four different kinds of blood groups. These are A, B, AB and O
Blood group is determined by three kinds of alleles. These are **A, B** and **o.**
A person has a pair of alleles for his or her blood group.
Allele **A** and allele **B** are dominant whereas allele **o** is recessive.
Table below shows the possible genotypes for each blood group.

Genotype	Blood group.
AA	A
Ao	A
BB	B
Bo	B
AB	AB
oo	O

*Presence of AB blood group is the sign of co dominance since the phenotype of two dominant alleles (A and B) express themselves in one character.

Exercise.

*Use genetic diagram to show if a child with blood group **O** may be produced from the family in which the blood group of the mother is **A** whereas the blood group of the father is **B**.*

Incomplete dominance.

It is a condition in which the effects of recessive alleles are not completely masked by dominant allele in a character.
In incomplete dominance, a character shows the mixture of the phenotypes of dominant allele and recessive allele e.g. pink flower colour in Camellias plant.

Characters that show incomplete dominance.

i. Sickle cell anaemia.
ii. Flower colour in Camellias plants.

SICKLE CELL ANAEMIA.

It is an inheritable disease in which the body produces abnormal haemoglobin that makes red blood cells to be sickle in shape.
Sickle cell anaemia occurs when a gene that controls production of normal haemoglobin changes.

Two alleles used to represent haemoglobin.
i. Hb^A represents allele for normal haemoglobin.
ii. Hb^s represents allele for sickle haemoglobin.

Table below shows the condition of the person for each genotype of the haemoglobin.

Genotype.	Condition of the person
Hb^AHb^A	Normal.
Hb^AHb^s	Carrier.
Hb^sHb^s	Sickle cell anaemic.

Difference between normal red blood cell and sickle red blood cell

Normal red blood cell.	Sickle red blood cell.
It is biconcave in shape	It is sickle shaped.
It has large surface area.	It has small surface area.
It carries more oxygen	It carries less oxygen
Plasmodia can multiply rapidly	Plasmodia can multiply slowly
Susceptible to malaria.	Resistant to malaria.

DESCRIPTION OF GENOTYPES OF HAEMOGLOBIN.

Homozygous dominant (Hb^AHb^A)
People with this genotype have normal red blood cells.
These people are resistant to anaemia because of normal red blood cells that have large surface area, which carry more oxygen in the body.
Homozygous dominant people are susceptible to malaria because plasmodia easily multiply on their red blood cells.

Homozygous recessive (Hb^sHb^s)
People with this genotype have sickle red blood cells.
These people are susceptible to anaemia because sickle red blood cells carry little amount of oxygen. The other reason is that sickle red blood cells are rapidly destroyed by the liver and spleen.
Homozygous recessive people are resistant to malaria as plasmodia fail to multiply rapidly on sickle red blood cell since it has small surface area.

Heterozygous (Hb^AHb^s)
People with this genotype have red blood cells that show characters of both normal red blood cells and sickle red blood cells.
These people are resistant to anaemia and malaria.
The existence of effects of recessive Hb^s in heterozygous shows incomplete dominance.

Exercise.
Use genetic diagram to show all possible genotypes of offspring produced when heterozygotes marry each other.

FLOWER COLOUR IN CAMELLIAS PLANTS.

Camellias plants produce two kinds of flowers. These are red and white.
Red flowered Camellias plant is homozygous dominant (**RR**) whereas white flowered Camellias plant is homozygous recessive (**rr**)
When a red flowered Camellias plant is crossed with a white flowered Camellias plant a the F1 produce **pink flowers** instead of red flowers, which is the phenotype of dominan allele. Pink flowers are heterozygote (**Rr**)
Failure of allele for red flower to mask completely the effects of recessive allele for whi in heterozygous is the sign of incomplete dominance.

Exercise

a. Use genetic diagrams to show the cross between:
i. White flowered Camellias plant and red flowered Camellias plant.
ii. Two pink flowered Camellias plants.

b. Write down the genotypic ratio and phenotypic ratio in the offspring produced when two pink flowered Camellias plants are crossed.

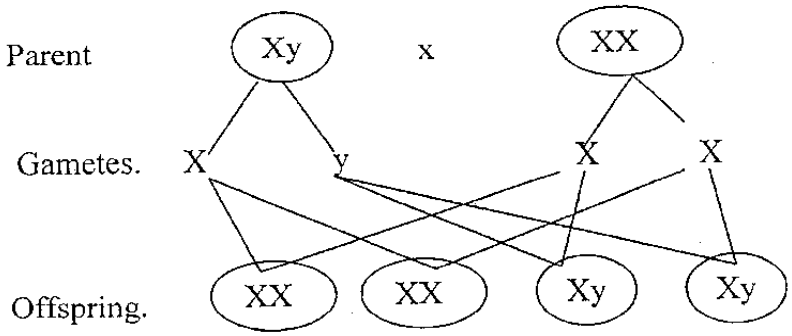
SEX CHROMOSOMES.

The nucleus of human cell has 23 pairs of chromosomes.
The first 22 pairs of chromosomes are called **autosome chromosomes** as they control general characteristics of the person.
The 23rd pair of chromosomes is called **sex chromosomes** as they determine the sex of the person.
They are two kinds of sex chromosomes. These are:
i. X chromosome.
ii. y chromosome.
X chromosome is larger than y chromosome as such they are some genes that are found on X chromosome but not on y chromosome. These genes bring about **sex linked characteristics.**
Each person has a pair of sex chromosomes in his or her cells. All women have a pair of X chromosomes in their cells (XX) whereas all men have X chromosome and y chromosome in their cells (Xy)
During meiosis sex chromosomes separate and pass into separate gametes as such all ova (eggs) carry one X chromosome whereas some sperms carry X chromosomes and others carry y chromosome.
During fertilization, the fusion of a sperm carrying X chromosome with an egg result into a **baby girl** as zygote formed will have two X chromosomes in its cell (XX). The fusion of a sperm carrying y chromosome with the ovum result into a **baby boy** as zygote will have one X chromosome and one y chromosomes in its cell (Xy). This shows that sex of the baby is determined by the sperm not the ovum.

Problem.

Use genetic diagram to show chances of producing male child in the family.

Solution.



The chances of producing male child are 50% or ½

SEX LINKED CHARACTERISTICS.

These are characteristics that are controlled by genes that are inherited differently in males and females.
Genes that control sex linked characteristics are found on X chromosome only but not on y chromosome as y chromosome is smaller than X chromosome.

Examples of sex linked characteristics.
i. Haemophilia.
ii. Red green colour blindness.
iii. Duchenne muscular dystrophy.

HAEMOPHILIA

It is the disease in which blood fails to clot.
People suffering from haemophilia die due to excess loss of blood.
Haemophilia occurs when a gene for normal blood clot changes as such a person lacks a protein that is responsible for blood clot thus protein factor VIII and factor IX
Allele for haemophilia, which is recessive and allele for normal blood clot which is dominant have same locus on the upper part of X chromosome.
Y chromosome does not have a gene for haemophilia and normal blood clot because it is smaller than X chromosome.
Haemophilia is more common in men than women because men have one X chromosome and one y chromosome as such when X chromosome has a gene for haemophilia, it is very hard to be suppressed since y chromosome does not have a counter part gene.
Women suffer from haemophilia when they have allele for haemophilia on both of their X chromosomes. Chances of women suffering from haemophilia are very low because men who suffer from haemophilia don't reach reproductive age as such they can't pass a gene for haemophilia to their daughters.

Alleles used in blood clot.
X^H represents allele for normal blood clot.
X^h represents allele for haemophilia.

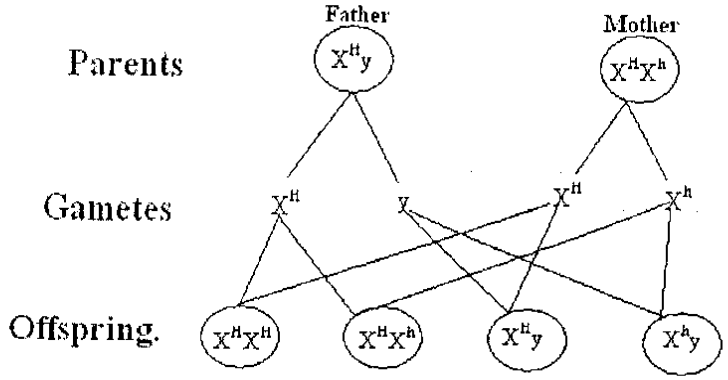
Table below shows the condition of the person for different genotypes.

Genotype.	Condition of a person
X^HX^H	Normal woman
X^HX^h	Carrier
X^hX^h	Haemophiliac woman
X^Hy	Normal man
X^hy	Haemophiliac man

Problem.

Haemophiliac child was born in a family in which both parents had no sign for haemophilia. Use genetic diagrams to show how the child inherited a gene for haemophilia.

Solution.

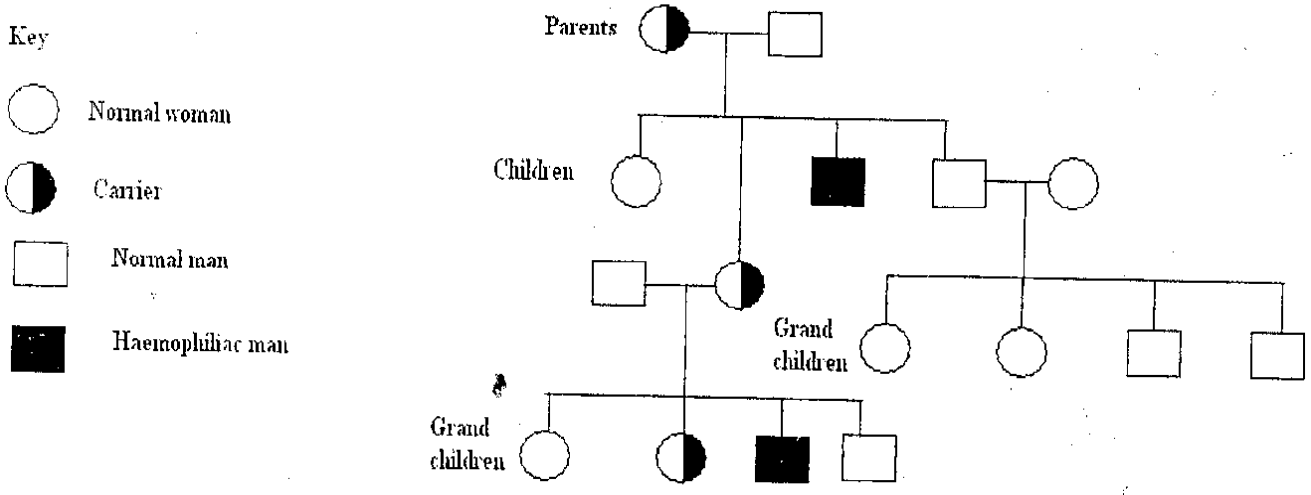


FAMILY TREE.

It is the other way of showing inheritance of sex linked characteristics such as haemohilia.

In the family tree, a key is given to represent conditions of different people.

Example.



DUCHENNE MUSCULAR DYSTROPHY.

It is a condition in which muscle tissues deteriorate (wither) at a certain age of a person.
Duchenne muscular dystrophy occurs when a gene responsible for normal development of muscles changes.
The child who is suffering from duchenne muscular dystrophy becomes wheel chair bound and dies in early teenage years.
Allele for duchenne muscular dystrophy which is recessive and allele for normal development of muscles which is dominant have same loci on X chromosome. As it is in the case of haemophilia, y chromosome does not carry a gene for duchenne muscular dystrophy.
Duchenne muscular dystrophy is more common in men than women because men have no counterpart gene on y chromosome that can suppress effects of duchenne on their X chromosome.

RED GREEN COLOUR BLINDNESS.

It is a disease in which a person fails to distinguish between red and green colours.
Red green colour blindness occurs when a gene for colour coding changes. The allele for red green colour blindness is recessive whereas allele for normal vision is dominant and they both have same loci on X chromosome.
This disease is more common in men than women but it is not lethal (kills) as such men suffering from red green colour blindness can reproduce.

MUTATION.

It is a sudden change in genetic materials in a cell.
Genetic materials (DNA, Genes and chromosomes) may change in terms of:
i. Number.
ii. Arrangement.

Mutation may occur in a body cell or a gamete. When mutation occurs in body cell, all cells that arise from it carry changed genetic materials. When mutation occurs in a gamete, an offspring produced from this gamete carry changed genetic materials in all of its cells.

An organism that has changed genetic materials in its cells is called a **mutant**.
When a gene changes, it becomes recessive as such for changed genes to be expressed, the mutant must be **homozygous recessive.**

TWO KINDS OF MUTATION.

i. Chromosome mutation.
ii. Gene mutation.

CHROMOSOME MUTATION.

It is the mutation in which the number of chromosomes in the nucleus changes.
In chromosome mutation, a cell may have extra chromosome or may lack a chromosome.
The condition in which a cell is having extra chromosome is called **trisomic** where as a condition in which a cell is lacking a chromosome is called **monosomic.**

Chromosome mutation occurs when chromatids fail to separate at anaphase II of meiosis as such one daughter cell carry extra chromosome that is supposed to be in the other cell. Failure of chromosome to separate during meiosis is called **non disjunction.**

DOWN'S SYNDROME.

It is a disease that occurs when a child has 47 chromosomes in his cells instead of 46 chromosomes.

Signs and symptoms of Down's syndrome.

i. Moonlike face.
ii. Abnormally short (stunted growth)
iii. Mentally retarded (dullness)

Exercise.
How many chromosomes would be in a zygote if a sperm carrying 22 chromosomes fertilize an ovum with 23 chromosomes?

GENE MUTATION.

It is a mutation in which genes change chemically.
In gene mutation, the arrangement of nitrogen bases on DNA molecule changes as such the body produces wrong proteins which change characters of organisms.

Examples of gene mutation.

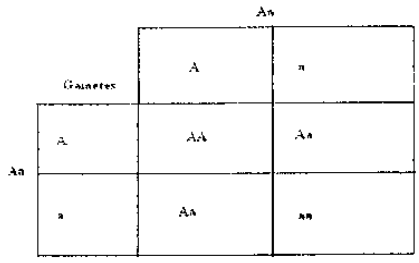
i. Albinism.
ii. Haemophilia.
iii. Sickle cell anaemia.
iv. Red green colour blindness.

ALBINISM.

It is lack of pigments in the body.
Albinism can occur in both plants and animals.
Albino plant lacks chlorophyll as such it fails to manufacture its own food and it dies.
In human beings, albinos lack the black pigment called **melanin**.
Melanin is a black pigment which is responsible for the colour of skin, hair and eyes.
This pigment is very useful as it absorbs ultraviolet light from the sun which can damage the skin.
In humans, albinism occurs when a gene for production of melanin changes (mutates) as such the body fails to produce melanin.
Allele for albinism is recessive as such all albinos are homozygous recessive (aa)
People with normal skin may either be homozygous dominant (AA) or heterozygous (Aa)
Heterozygotes are carriers of albino gene as such they may produce albino child when they marry each other.

Problem.
An albino child was born in family in which both parents had normal skin. Use punnet square to show how the child inherited a gene for albinism.

Solution using punnet square



FACTORS THAT AFFECT RATE OF MUTATION

i. Exposure to high energy radiation e.g. x-rays, γ- rays and β-rays, which damage DNA molecule.
ii. Exposure to mutagens that replace nitrogen bases on DNA molecule.

EFFECTS OF MUTATION.

i. It causes variations amongst organisms of the same species since mutants tend to look different from normal organisms.
ii. It can make an organism to be well adapted to its environment e.g. mutants may be more resistant to certain drugs or chemicals than normal organisms.
iii. It may cause death especially in homozygous recessive.

CROP AND ANIMAL BREEDING.

Breeding is the process of allowing crops and animals to mate and produce offspring.
In breeding, only organisms that have desirable characters are allowed to mate so that they should pass their desirable character to their offspring.
Breeding involves crossing **pure lines (pure breeds)** in order to produce **hybrids.**
Hybrids carry the combination of desirable characters from two parents
Breeding improves quality and quantity of products as hybrids tend to:
i. Produce more milk, eggs and meat.
ii. Be resistant to diseases.
iii. Be resistant to drought.
iv. Grow fast and mature early.

SELECTION.

In the population, organisms compete for limited resources such as water, food, mineral salts, pollinators and mates. As they compete some organisms survive whilst others die.
Organisms that survive are only those that are well adapted to their environment.
Organisms that are well adapted to their environment are said to have **strong genes** whereas those that are not adapted are said to have **weak genes.**
Organisms that have strong genes reproduce successfully and pass their advantageous gene to the next generation. For instance if a tree survived in dry area because of having deep roots, the gene for deep roots is passed to its offspring.
Organisms that have weak genes die and their genes are lost or eliminated from population **(extinction)**

The process by which weak genes are eliminated whilst strong genes survive in the population is called **Selection.**

TWO KINDS OF SELECTION.
i. Natural Selection.
ii. Artificial selection.

NATURAL SELECTION.
It is a process in which nature selects fittest organisms and rejects weak organisms thus survival of the fittest.

Examples of natural selection.
i. Elimination of albino plants.
ii. Survival of black moth and elimination of white moth on black wall.
iii. Survival of fast running zebras.
iv. Survival of long necked giraffe.

ARTIFICIAL SELECTION.
It is a process in which human beings choose organisms of desirable characters for breed and kill the weak ones.

Examples.
i. Choosing strong bull for breeding and castrate or kill weak bulls.
ii. Choosing crops that produce large fruits and weed out crops that produce small fruits

TOPIC 13: EVOLUTION.

It is a gradual change of organisms over a long period of time.
It is believed that organisms that exist today are different from organisms that existed long time ago for instance long time ago human beings were looking like monkeys.

THEORIES OF EVOLUTION.
These are statements that try to explain how organisms evolved.

THEORY OF EVOLUTION BY CHARLES DARWIN.
It states that all organisms evolved from common ancestor by natural selection. This theory can be summarized as follows:
i. Organisms produce more offspring to increase chances of survival.
ii. Offspring vary from each other due to mutation.
iii. Variations make some organisms to be well adapted to their environment.
iv. Organisms compete for limited resources and they struggle to survive.
v. Organisms that well adapted to their environment survive whereas those that are not adapted die and their genes are lost.
vi. Organisms that survive reproduce successfully and pass their advantageous gene to their offspring.

vii. With time the population of organisms with weak genes disappear leaving behind the population of organisms with strong genes only- hence evolution.

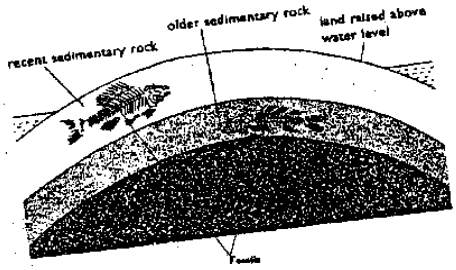
Problem
Using Charles theory of evolution, describe how a population of black peppered moth evolved from white peppered ancestor in areas where most walls were black and there were more birds feeding on moth.

Solution.
In the first place, there were white peppered moths, which produced more offspring to increase chances of survival. These offspring varied from each other due to mutation such that some were white and others were black. White peppered moths were easily seen by birds on black walls and killed and their genes were lost whereas the black moths were camouflaged and survived.
These black peppered moths reproduced successfully and passed a gene for black coat to their offspring. With time the population of white moths disappeared leaving behind the population of black peppered moth only.

Exercise.
Using Charles theory of evolution, describe how fast running zebras evolved from slow running ancestors in areas where there were more lions that feed on zebras.

EVIDENCE OF EVOLUTION BY NATURAL SELECTION.

i. Fossil record.



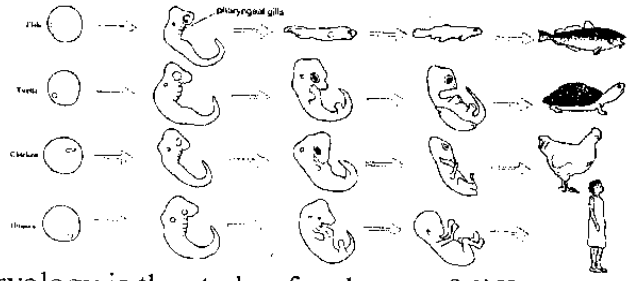
Fossils are remains of dead organisms that existed long time ago.

How fossils are formed.
i. Hard parts of dead organism must be covered by sediments.
ii. Sediments form sedimentary rock.
iii. Sedimentary rock is pushed upwards by earth movement after millions of years.
iv. Remains of dead organism form fossil in a rock and become exposed when rock is eroded.

How fossils provide evidence of evolution.
Fossil of new organisms are found in upper sedimentary rocks whereas fossils of old organisms are found in the lower sedimentary rocks.

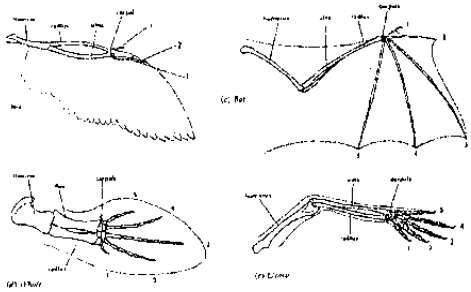
Fossils of new organisms show more complex structures than fossils of old organisms. This shows that new organisms evolved from old organisms by natural selection.

ii. Embryology.



Embryology is the study of embryos of different vertebrates.
Embryos of different vertebrates have similar structures at a certain stage of development such as tail and pharyngeal gills.
These similar structures show that all vertebrates evolved from common ancestor by natural selection.

iii. Comparative anatomy.



It is a study of structures found in different organisms especially vertebrates.
Vertebrates have some structures with same design such as **pentadactly** limbs in fish, amphibians, reptiles, birds and mammals.
Structures that have same design but found in different organisms are called **homologous structures**. These structures show that organisms evolved from common ancestor by natural selection.
There are some structures that are believed to be used by organisms long time ago which are no longer used by the same organisms such as appendix in humans and claws in snakes. These structures are called **vestigial structures.**

iv. Geographical Distribution.
It is the distribution of different organisms in different areas on earth.
Organisms found in one area have similar structures that make them different from organism of the same class but found in other areas. For instance African monkeys have short tail whereas American monkeys have long tail. This shows that organisms evolved from common ancestor by natural selection.

ochemistry.

s the study of differen molc s found in living organisms e.g. proteins an DNA molecule.

Organisms that are closely related have similar proteins and DNA molecule, which shows that they evolved from common ancestor. For instance human beings and chimpanzees have similar biomolecules.

SPECIATIO

formation of new species from already existing species.

Species is a group of similar organisms that can mate and produce fertile offspring.

New species arise from existing species by:

i. Isolation.

ii. Natural selection.

iii. Hybridization.

ISOLATION.

It is the process by which two groups of similar organisms are separated by a barrier such as lake, sea, mountain and desert.

These barriers make the separated environments to be different as such organisms found in these environments develop structures that enable them to survive in their environment.

These structures make the two groups of organisms to be too different from each other such that no fertile offspring is produced when mate- hence speciation.

NATURAL SELECTION

It is a process in which nature allows fittest organism to survive and rejects weak organisms.

Fittest organisms that survive develop structures that make them different from their ancestors such that no fertile offspring is produced when fittest organisms are mate with their ancestors. This shows that fittest organisms and their ancestors belong to different species.

HYBRIDIZATION.

It is a process in which two pure breeds are crossed to produce hybrids.

Hybrids produced may develop some structures that may be different from their parents such that no fertile offspring is produced when hybrids are mate with their parents. This shows that hybrids and their parents belong to different species.

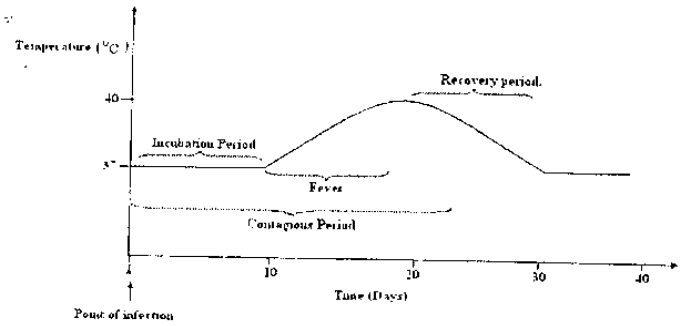
TOPIC 14: HUMAN DISEASES.

A disease is any disorder of the body. Diseases are caused by several factors such as microorganisms and environment. Diseases that are caused by microorganisms are called infectious diseases such Malaria, Cholera, HIV etc. Microorganisms that cause diseases are called pathogens.

PARASITE, HOST AND VECTOR.

A parasite is any living organism that depends on the other living organisms for food and shelter e.g. pathogens.
A host is a living organism that keeps parasites e.g. human beings are the host of plasmodia.
Vector is a living organism that transmits pathogens from one organism to the other e.g. tsetsefly and mosquito.

COURSE OF INFECTIOUS DISEASE.



Infection.
It is the entry of the pathogen into the host

Incubation period.
It is a period between the entry of the pathogen and appearance of signs and symptoms of the disease.
During incubation period, the pathogen fights against the defence of the body as such the body temperature remains normal. If the defence is defeated, the pathogen multiplies and get adapted to the body.

Fever.
It is a period when the host starts showing signs and symptoms of the disease. At this period the body temperature starts rising.

Contagious.
It is a period when the disease can be spread to other people. This period begins from infection to the beginning of recovery.

Recovery.
It is a period when the host becomes free from pathogens due to treatment.
At this period, the pathogens are destroyed by drugs and the defence of the body as such the body temperature drops back to normal.

GROUPS OF DISEASES.

Diseases are classified into several groups according to:

i. Causative agents

a. Protozoan diseases, which are caused by protozoa e.g. Malaria and Sleeping sickness.

b. Bacterial disease, which are caused by bacteria e.g. Tuberculosis, Cholera and pneumonia.

c. Fungal diseases, which are caused by fungus e.g. Ring worm and athlete's foot.

d. Viral diseases, which are caused by virus e.g. HIV/AIDS, Measles and common colds.

e. Worm infections, which are caused by parasitic worms e.g. Bilharzia and elephantiasis.

ii. Mode of spread.

a. Water (food) borne diseases, which spread by drinking contaminated water/ eating contaminated food e.g. Cholera, typhoid and dysentery.

b. Air borne diseases, which spread by inhalation of contaminated air e.g. Tuberculosis, common colds and pneumonia.

c. Contagious diseases, which spread by contact e.g. scabies, ring worm and athlete's foot.

d. Sexually transmitted infections, through spread through sexual intercourse.

e. Vector transmitted diseases e.g. malaria and sleeping sickness.

iii. Body system attacked.

a. Respiratory diseases, which attack lungs and respiratory tract e.g. Tuberculosis and bronchitis.

b. Nervous diseases, which attacks nerves, brain and spinal cord e.g. leprosy, polio and mengatis.

c. Locomotory diseases that attack bones, muscles, tendons and ligaments e.g. tuberculosis and arthritis.

DISEASES CAUSED BY PROTOZOA.

1. MALARIA

It is an infectious disease that is caused by protozoa called **Plasmodia.**

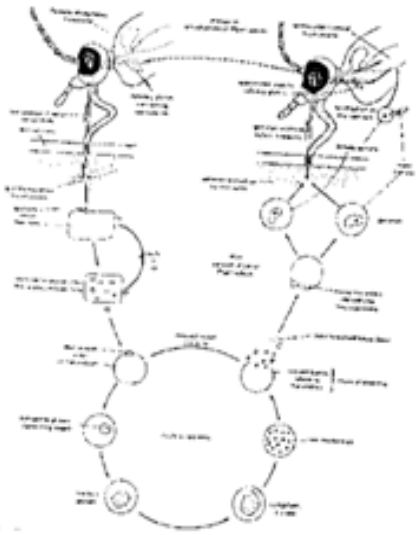
Plasmodia live in human blood system, where it attacks red blood cells, which burst and leave the patient anaemic.

Mode of spread.

Malaria spreads through female anopheles mosquito bites.

When this mosquito bites an infected person, it sucks blood together with plasmodia and when it bites a health person it injects saliva that contains plasmodia.

Life cycle of plasmodia.



DESCRIPTION OF THE LIFE CYCLE

i. Gametes of plasmodia are sucked by mosquito together with blood.
ii. Gametes fuse to form **cyst** in the stomach of mosquito.
iii. Cysts hatch into **sporozoites** that migrate to salivary glands of mosquito.
iv. Sporozoites are injected into the blood stream of the person by mosquito bites.
v. Sporozoites are carried by blood to the human liver.
vi. Sporozoites multiply asexually to form **merozoites** in human liver.
vii. Merozoites enter human blood system where it attacks red blood cells.
viii. Merozoites form male and female gametes that are sucked by mosquito together with human blood.

Signs and symptoms of malaria.

i. High body temperature and fever due to toxins released when red blood cells burst.
ii. Anaemia due to destruction of red blood cells by plasmodia.
iii. General body pain and severe headache due to toxins released from destroyed red blood cells.
iv. Excess sweating due to toxins.
v. Less urine which is deeply coloured due to excess sweating.
vi. Rapid pulse due to insufficient oxygen in the blood.
vii. vomitting
viii. collapse

Ways of preventing Malaria.

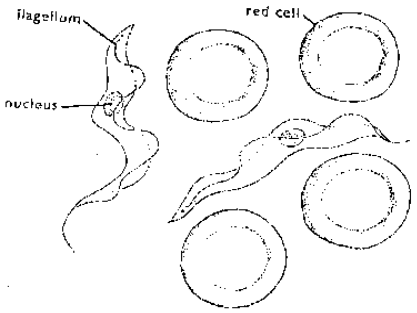
i. Apply oil on stagnant water in order to suffocate mosquito larvae.
ii. Drain stagnant water in order to kill mosquito larvae.
iii. Clear bush around homes to destroy breeding places of mosquito.
iv. Spray insecticides in the house in order to kill adult mosquitoes.
v. Sleep under treated mosquito nets in order to avoid mosquito bites.
vi. Introduce ducks and fish on water reservoir in order to destroy mosquito larvae.
vii. Introduce parasitic bacteria called Bacillus thuringiensis on stagnant water that infects mosquito larvae when fed by the larvae.

2. **SLEEPING SICKNESS (TRYPANOSOMIASIS)**

It is an infectious disease that is caused by a protozoan called **Trypanosome.**

Trypanosome lives in the blood of human beings and wild animals such as buffaloes and antelopes.

TRAPANOSOMES IN THE BLOOD STREAM



Mode of spread.

It spreads through tsetse fly bites.

When tsetse fly bites infected animal, it sucks blood together with trypanosomes. When this tsetse fly bites health person it injects saliva with trypanosomes into the blood stream.

Signs and symptoms.

i. Frequent sleeping during the day and restless at night.
ii. Severe headache when awake.
iii. The face looks dull and stupid.
iv. Swollen lymph nodes.
v. Fever.
vi. Emaciation (thinness)
vii. Deterioration of memory and intelligence when trypanosomes enter the brain.

Ways of preventing sleeping sickness.

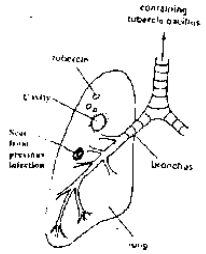
i. Spray insecticides to kill tsetse flies.
ii. Clear bush along river banks to destroy breeding places and habitats of tsetse fly.
iii. Kill buffaloes to destroy reservoir of trypanosome.
iv. Wear protective clothes when visiting tsetse fly infested areas to avoid tsetse fly bites.
v. Erect fly traps that catch and kill tsetse flies.

DISEASES CAUSED BY BACTERIA.

TUBERCULOSIS

It is a respiratory disease that is caused by a bacillus bacterium called **mycobacterium tuberculosis.** This bacterium attacks lungs. When lungs are attacked, phagocytes form a mass around the bacteria, which later become a tubercle. When bacteria are surrounded by phagocytes, they release a toxin called Tuberculins, which destroy cells around

bacteria. Thereafter a tubercle bursts and release bacteria into bronchiole. The bursting of tubercles leave a scar in the lung.



Mode of spread.
It spreads through inhalation of air contaminated with mycobacterium tuberculosis. Air becomes contaminated when an infected person coughs, laughs, talks, exhales or sneezes.

Signs and symptoms of TB.
i. Chronic cough.
ii. Blood in sputum.
iii. Slight fever.
iv. Weight loss.
v. Thinness.
vi. Fatigue.
vii. Chest pains.

Ways of preventing TB.
i. Vaccinate children against TB using BCG.
ii. Isolate the patient so that health people should not inhale contaminated air.
iii. Avoid living in overcrowded areas where chances of inhaling contaminated air are very high.
iv. Burry sputum in the ground.
v. Live in well ventilated rooms so that germs should not accumulate in the air.

PNEUMONIA.
It is a respiratory disease in which fluids build up in lungs.
Pneumonia is caused by a bacterium called pneumonococcus or streptococcus.

Mode of spread.
It spreads through inhalation of air contaminated with pneumonococcus. Air becomes contaminated when infected person coughs, exhales or sneezes.

Signs and symptoms of Pneumonia.
i. Chest pains.
ii. Coughing .
iii. Fever.
iv. Headache.

Prevention of pneumonia.
i. Live in well ventilated house.
ii. Avoid living in overcrowded areas.

DISEASES CAUSED BY VIRUS

MEASLES.
It is an infectious disease that mostly attacks children.
Measles is caused by virus.

Mode of spread.
It spreads through direct contact with air droplets from nose and throat.

Signs and symptoms of measles.
i. Running nose.
ii. Rash inside the mouth.
iii. Rash behind ears spreading to the whole body.
iv. Sore eyes.
v. Fever.

Ways of preventing measles.
i. Vaccinate children against measles.
ii. Isolate the patient.

COMMON COLD.
It is the respiratory disease that is caused by the group of virus.

Mode of spread.
It spreads through inhalation of air contaminated with virus that cause common cold. Air becomes contaminated when infected person coughs, sneezes or exhales.

Signs and symptoms of common cold.
i. Sneezing and coughing.
ii. Running nose.
iii. Sore throat.

Ways of preventing common cold.
i. Avoid living in overcrowded areas.
ii. Live in well ventilated areas.

DISEASES CAUSED BY FUNGUS.

RING WORM.
It is a skin disease caused by a fungus called **Tinea**. Tinea lives in moist parts of the body.

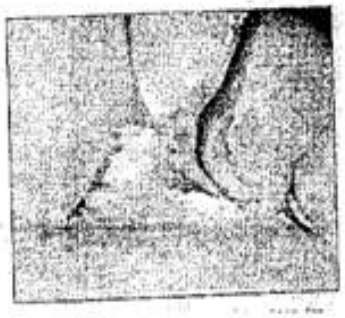
Ring worm attacks both children and adults.

Mode of spread.
Ring worm spreads by direct or indirect contact with skin of infected person or items used by infected person.

Signs and symptoms of ring worm.
i. Breaking off of the hair on head as circle enlarges.
ii. Red patch on thigh, arm pits, belly and face.
iii. Itching on red patch as it spreads.

Ways of preventing ring worm.
i. Ensure personal cleanliness.
ii. Avoid any contact with infected person.
iii. Avoid sharing dresses with infected person.

ATHLETE'S FOOT.
It is a skin disease that is caused by a fungus called Tinea.
Tinea lives and feeds on dead sweaty skin on the toes. This feeding damages skin underneath causing sores and inflammation.
Athlete's foot is common to people who put on plastic shoes during hot weather.



Mode of spread.
It spreads through direct and indirect contact with skin lesions of infected person, contaminated floors and other articles used by infected person.

Signs and symptoms of athlete's foot
i. Blisters and splitting of skin between toes.
ii. Itching between toes.

Ways of preventing athlete's foot.
i. Personal cleanliness.
ii. Dry areas between toes thoroughly.
iii. Avoid sharing items such as towels, socks and shoes.
iv. Apply fungicides between toes.

WAYS OF PREVENTING DISEASES AT HOUSE HOLD AND COMMUNITY LEVEL.

i. Water treatment.
Boil water or add chlorine to water before drinking to kill pathogens found in water.

ii. Food treatment.
This involves killing pathogens in food by boiling it.

iii. Personal hygiene.
This involves bathing and washing clothes that reduces the multiplication of pathogens on the skin.

iv. Proper disposal of human and domestic wastes.
This reduces the multiplication of vectors that spread diseases.

v. Pest control.
This involves spraying pesticides in the house in order to kill pests that can transmit diseases.

vi. Health services.
This involves seeking medical service when a person is sick. This reduces the spread of disease to health people.

IMMUNITY.

It is the resistance of the body against infections.

How the body fights against infections.
i. By preventing the entry of pathogens into the body.
ii. By killing pathogens that have entered into the body.
iii. By neutralizing toxins released by pathogens.

How the body prevents entry of pathogens
The body uses natural barriers (first line of defence).
The first line of defence includes the following structures:
i. Skin.
ii. Mucus and cilia.
iii. Blood clot.
iv. Hydrochloric acid and enzymes in stomach.
v. Ear wax.
vi. Symbiotic defence.

Skin.
It is the outer most layer of the body. The skin has cornified layer that form water proof and germ proof layer thereby blocking germs from entering into the body.

Mucus.
It is the sticky substance found in respiratory tract. Mucus traps germs from inhaled air thereby preventing germs from entering into the body through respiratory tracts.

Cilia.
These are hair like structures found in respiratory tracts. The beating of cilia drive out trapped dust that contains germs towards throat where it is coughed out or swallowed.

Hydrochloric acid in stomach.
It is the acid that is found in gastric juice. HCl kills germs taken together with food thereby preventing germs from entering the body through gut.

Digestive enzymes in gut.
These digest germs taken together with food thereby preventing germs from entering the body through gut.

Blood clot.
It forms a hard cover on the wound that prevents germs from entering the body through the wound.

Tears
They contain lysozyme that kills germs on the eye surface. This prevents germs from entering the by through eyes. Tears also remove dust on eye surface.

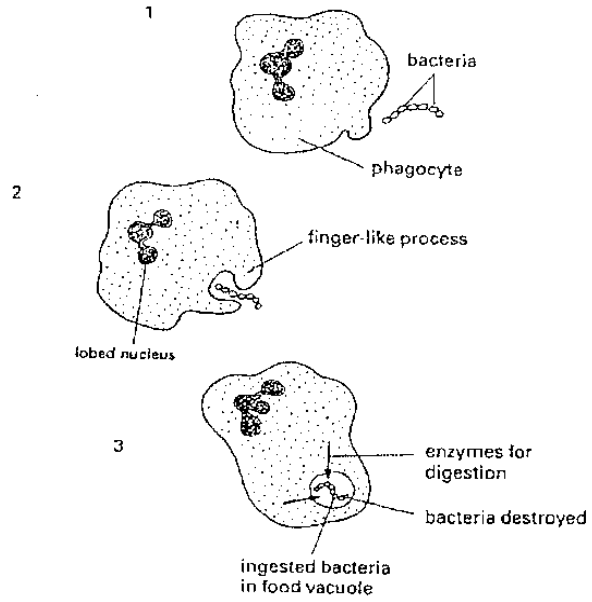
Ear wax.
It is the sticky substance found in auditory canal. Ear wax traps dust and germs in auditory canal so that they should not enter the body through ears.

Symbiotic defence.
This is the relationship between the body and harmless microbes found in the body. These microbes secrete substances that kill harmful germs thereby providing protection to the body.

SECOND LINE OF DEFENCE.
It is the defence that the body uses when germs have managed to cross first line of defence. This defence is provided by white blood cells (phagocytes and lymphocytes)

Phagocytes.
These are white blood cells that engulf and digest germs in the blood or infected tissues. The process by which phagocytes engulf and digest germs is called **phagocytosis/ engulfing**

phagocytosis



Lymphocytes.
These are white blood cells that mainly produce antibodies in the body.

Two kinds of lymphocytes.
i. B- Lymphocytes (B-cells)
ii. T-Lymphocytes (T-cells)

B lymphocytes
These are lymphocytes that are produced in lymph nodes but activated in bone marrow-hence the name B-cells.
B-lymphocytes produce antibodies. Antibodies are special proteins that destroy foreign substances in the body.
The production of antibodies is triggered by the presence of antigen in the body. Antigen is the foreign protein in the body such as germs. Each antigen stimulates the production of specific antibodies that destroy it as such antibodies are specific. For instance plasmodia stimulate the production of antibodies against plasmodia that destroy plasmodia only.

How B cells produce antibodies.
When a pathogen enters into the body, a specific type of B cells is stimulated. These B cells start multiplying rapidly and form a clone that produces abundant antibodies.
These antibodies spread quickly in the body and destroy the antigen that stimulated their production.
When all the pathogens have been destroyed, some B cells die and others remain in the body and form **memory cells.**
Memory cells keep the information about the pathogen which was destroyed such that when it reappears in the body they quickly produce more antibodies against it before it causes any disease.

HOW ANTIBODIES WORK.

i. Some destroy germs by dissolving them. These antibodies are called **Lysins.**
ii. Some neutralize toxins released by germs. These antibodies are called **antitoxins.**
iii. Some clump germs together so that they should not spread and they should be easily engulfed by phagocytes. These antibodies are called **agglutins.**
iv. Some coat outer layer of the germ so that the germ should look more appetizing to phagocytes. These antibodies called **opsonins.**

T LYMPHOCYTES.

These are lymphocytes that are produced in lymph nodes but activated in the thymus at the neck. T- Cells destroy foreign cells such as pathogens, cancer cells and virus infected cells.

Two kinds of T-Cells.

i. Killer T-Cells.
ii. Helper T-Cells.

Killer T-Cells.

These are T-Cells that kill foreign cells in the body.

Helper T-Cells.

These are T-Cells that support and amplify the response of killer T-Cells. Helper T cells also stimulates B cells to produce antibodies.
Helper T-Cells have specific glyco-protein on their surface called CD_4 (cluster of destiny), which detects the presence of pathogens in the body.
When CD_4 has detected a pathogen in the body, it stimulates killer cells to destroy the pathogen before it causes any disease.
CD_4 is easily recognized by HIV and destroyed as such helper T cells fail to support killer T-Cells. This makes the person to be vulnerable to several diseases- hence AIDS.

TWO KINDS OF IMMUNITY.

i. Natural immunity.
ii. Artificial immunity.

NATURAL IMMUNITY.

It is the kind of immunity in which the body develops defence against infection on its own.
Natural immunity can be acquired passively or actively.
Natural passive immunity includes already made antibodies that are transferred from mother to the baby through placenta during pregnancy or through breast feeding.
Natural passive immunity has short life span (3-6 months)

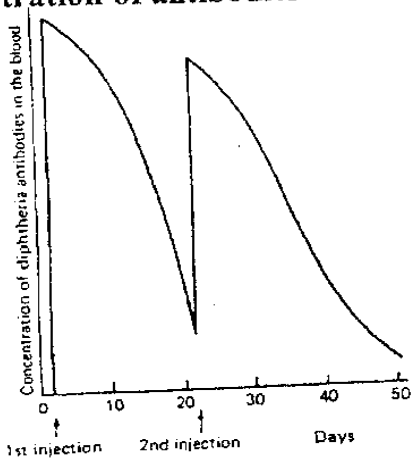
Natural active immunity includes antibodies that are produced by the body against natural infection.
These antibodies remain in the body for a long period of time where they destroy any pathogen similar to the one that stimulated their production.

This is a reason why it takes a long period of a time for a person to suffer from the same disease he or she has just recovered from.
Natural active immunity has long life span.

ARTIFICIAL IMMUNITY.
It is the kind of immunity in which the body develops defence against infection through the actions of man.
Artificial immunity can be acquired passively or actively.

Artificial passive immunity includes already made antibodies that introduced into the body of the patient in form of serum. A serum is a blood plasma without fibrinogen.
Serum can be obtained from animals that are able to produce antibodies against infections that attack human beings. For instance serum against snake venom is obtained from horses.
Serum can also be obtained from a person who has just recovered from a disease that someone else is suffering from.
Artificial passive immunity has short life span.

Graph showing concentration of antibodies after injecting a patient with serum



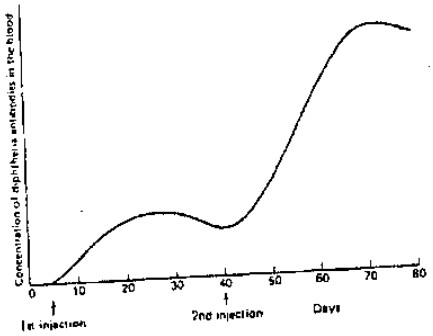
According to the graph the level of antibodies rises after injection and later drops. This occurs because they are used up during the fight against infections.

Artificial active immunity includes antibodies that are produced by the body against harmless germs that have been introduced into the body by man.
These harmless germs are introduced into the body in form of vaccines. A vaccine is a dosage of weak, killed germs or harmless toxins (toxoids).
Vaccines are introduced into the body through injections or mouth swallowing. The process in which vaccines are introduced into the body is called Vaccination or immunization or inoculation.

How vaccines work in the body.
Vaccines stimulate the production of antibodies and memory cells.

Memory cells quickly produce antibodies against a pathogen similar to vaccine before it causes any disease in the body.
Vaccines stimulate the production of specific antibodies as such vaccine against TB stimulates the production of antibodies against TB only that destroy TB bacteria but not pneumonia bacteria.
Artificial active immunity has long life span.

Graph showing concentration of antibodies after vaccination



According to the graph the level of antibodies increases slowly after first injection but later it increases rapidly after second injection because memory cells have been formed, which are producing vast amount of antibodies.

Importance of vaccinating children.
It helps the body of children to produce antibodies and memory cells in readiness for future infection. It is advised to vaccinate children as many times as you can so that they should have strong immunity.

ORGAN TRANSPLANT.
It is the process in which damaged organ is replaced with health organ from a donor.
The donor can be a relative or a person who has just died in an accident.
Organs that can be transplanted include: skin, cornea of the eye, kidneys, bone marrow and the heart.
Donated organ is kept at a cool place so that they should not deteriorate.

Problem with organ transplant.
The donated organ may be rejected by the immune system of the recipient due to genetic incompatibility.
This problem is usually addressed by getting organ from a person who is closely related to the recipient such as twin sister or brother.
The recipient is also given immuno-suppressant drugs that stop immune system from attacking donated organ. The problem with these drugs is that they weaken the immune system of the person thereby making him or her vulnerable to diseases.

Factors to be considered before organ transplant.

i. Age.

The donor and recipient must be of the same age so that the donated organ meets the needs of recipient's body.

ii. Blood group.

The blood group of the donor and recipient must be compatible so that the donated organ is not rejected by the recipient.

iii. Rhesus Factor.

The donor and recipient must have same Rhesus factor so that the donated organ is not rejected.

CANCER.

It is the uncontrollable division of cells which forms a ball of cells called tumour. Tumour can be felt as hard lump because cells forming it are more packed together than normal cells. Cells that form tumour are called cancer cells and they differ from normal cells in terms of size, arrangement, life span (they don't die quickly) and shape.

Two kinds of tumour.

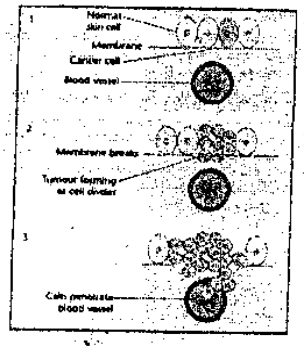
i. Benign tumour.

It is a tumour that grows slowly and does not attack surrounding tissues e.g. warts. Benign tumour does not spread through the body as such it is harmless.

ii. Malignant tumour.

It is the tumour that grows rapidly and attacks surrounding tissues. Cells forming malignant tumour may break away and spread to other parts of the body by blood, where they can cause secondary tumour.

The spreading of cancer cells from one part of the body to other parts of the body is called **metastasized.**



Causes of cancer.

It is caused by mutation of cells.

When cells mutate, the mechanism that controls cell division breaks down as such cells divide uncontrollably.

Factors that increase risk of cancer.
i. Exposure to cigarette smoke, which damages DNA molecule of cells forming respiratory tract leading to lung cancer.
ii. Exposure to high energy radiation such as x-rays and y-rays that damage DNA molecule.
iii. Viral infection that change the normal functioning of the cell.
iv. Exposure to ultraviolet light from the sun that damages DNA molecule of cells forming the skin leading to skin cancer.
v. Exposure to chemicals such as benzene and benzopyrene that damage DNA molecule.

- all substances that are capable of causing cancer are called **Carcinogens.**

Effects of cancer.
i. It may lead to death when it attacks vital organs such as lungs, liver and the brain.
ii. Cancer cells compete with normal cells for nutrients thereby depriving normal cells some food nutrients.
iii. It may cause malfunction of the organ since cancer cells disturb normal cells.

Prevention of cancer.
Avoid any exposure to carcinogens such as cigarette smoke, benzene and radiations.

Treatment of cancer.
Cancer can be treated at early stage through:
i. Surgery in which the tumour is removed.
ii. Radiotherapy in which cancerous cells are killed by radiation since they are more sensitive to radiation than normal cells.
iii. Chemotherapy in which cancer cells are destroyed by drugs.
iv. Amputation, in which the affected limb is removed so that cancer cells should not spread to health parts of the body.

TOPIC 15: ENVIRONMENTAL BIOLOGY.

ECOLOGY
It is the study of living things in relation to their environment. Environment is anything that surrounds living things and influences them.

TERMS USED IN ECOLOGY.

Habitat.
It is a place where living organisms live. For instance the habitat of earthworms is soil where as water is the habitat of fish.

Population.
It is a group of organisms of the same species living in a particular place at a particular time. For instance a group of dogs forms a population of dogs whereas the group of mango trees forms the population of mangoes.

Population density.
It is the number of organisms of the same species per unit area. For instance 500 people per km^2 or 5 black jacks per m^2.

Community.
It is a group of organisms of different species living in particular place at a particular time. A community consists of plants and animals.

Ecosystem.
It is a community of living things and non living things that interact each other in a habitat. For instance Lake Malawi is an example of fresh water ecosystem because living things such fish interact with non living things such as water and oxygen in the lake. Nyika national park is example of savanna woodland ecosystem because living things like zebras interact with lions, grass and water in the park.

COMPONENTS OF ECOSYSTEM.

Ecosystem consists of the following:
i. Plant community
ii. Animal community.
iii. Physical factors.

- Plant and animal communities form biotic component of ecosystem as they are living things whereas physical factors form abiotic component of ecosystem as they are non living things.

PHYSICAL FACTORS IN SAVANNA WOODLAND ECOSYSTEM AND FRESHWATER ECOSYSTEM.

These are non living things that form savanna woodland and fresh water ecosystem. These are: soil, water, light, air, wind, humidity, temperature, soil pH, mineral salts and oxygen content.
Physical factors affect distribution of organism in the ecosystem.

Ways in which each physical factor affects distribution of organisms in ecosystem.

i. Soil.
Most living organisms are found in well drained fertile soil because:
a. soil provides anchorage to plants.
b. soil provides mineral salts and water to plants.
c. soil is the home of living organisms.
d. soil provides good environment for microorganism that decompose organic matter.

ii. Water.
Most organisms are found in areas that have enough water because:
a. water is the raw material for photosynthesis in plants.
b. water dissolves mineral salts in the soil for easy absorption by plants.
c. water cools both plants and animals.

d. water is also a habitat of other living organisms.
e. animals drink water.
*The main sources of water in ecosystem are rainfall and under ground water.

iii. Light intensity.
Most organisms are found in areas that have enough light because:
a. light is used by plants for photosynthesis.
b. light helps animals to manufacture vitamin D on their skin.
c. light helps animals to look for food.
*The main source of light in ecosystem is sunlight.

iv. Temperature.
Most organisms are found in warm places because:
a. warmth is essential in seed germination.
b. warmth is necessary for microbial activities.
c. warmth helps in maturity and drying of seeds.
d. animals become active when it is warm as metabolic activities occur rapidly.

v. Humidity.
Most living organisms are found in areas with high humidity because:
i. Rate of evapo-transpiration is very low as such living organisms have enough water.
ii. Living organisms don't lose more water thereby increasing chances of survival in smallest organisms such as microorganisms.

vi. Soil pH
Most living things are found in areas with neutral soil pH because:
a. microbes that decompose organic matter become active.
b. most soil nutrients become available in the soil.
c. plants grow well in neutral soil pH.

vii. Mineral salts.
Most living organisms are found in areas with more mineral salts because mineral salts are required by plants for formation of organic compounds such as proteins which are needed for growth.
In savanna woodland ecosystem, mineral salts come from decomposed rocks and organic matter whereas the main source of mineral salts in fresh water ecosystem is surface run off.
An increase in amount of mineral salts in a water body is called **eutrophication**.
Eutrophication leads to **algal bloom** which is the excessive growth of aquatic plants

Dangers of algal bloom.
i. Algal bloom uses more oxygen from the water for respiration at night thereby depleting oxygen for aquatic animals
ii. Decomposition of algal bloom requires more oxygen thereby depleting oxygen for aquatic animals

iii. Aquatic weeds block light from penetrating into the water as such aquatic animals lack light for formation vitamin D.
iv. Algal bloom causes drying up rivers and lakes as they lose more water through transpiration.

viii. Oxygen content.
Most living organisms are found in areas with enough oxygen because oxygen is used for aerobic respiration in living organisms.
In savanna woodland oxygen comes from terrestrial plants during photosynthesis whereas in fresh water ecosystem oxygen comes from aquatic plants and atmosphere through diffusion.

Factors that affect amount of oxygen in a water body.

i. Presence of aquatic plants that produce oxygen during photosynthesis thereby increasing amount of oxygen in the water body.

ii. Presence of aquatic animals that use a lot of oxygen thereby decreasing amount of oxygen in the water body.

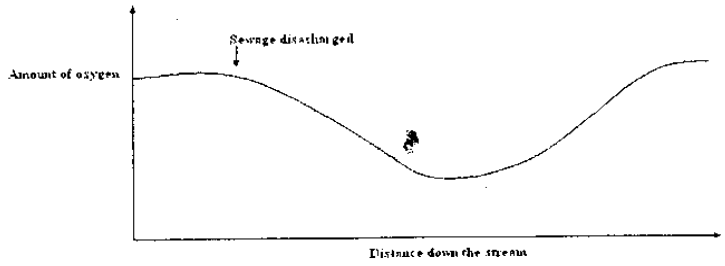
iii. Temperature of the water. Cold water has more oxygen than hot water because more oxygen dissolves in cold water than hot water.

iv. Depth of the water body. Surface water has more oxygen than bottom water because :
a. Most plants that release oxygen are found on the surface water.
b. Oxygen easily diffuses from atmosphere into the water at the water surface.

v. Water turbulence. Turbulent water has more oxygen than smooth flowing water as turbulence help to mix bottom water with surface water.

vi. Presence of organic matter.
Water that has more organic matter has less oxygen because more oxygen is used by microbes to decompose organic matter.
The amount of oxygen required by microbes to decompose organic matter is called **biochemical oxygen demand (BOD)**

Effects of discharging raw sewage in the river on oxygen content.



According to the graph, oxygen content decreases immediately raw sewage is discharged into the stream. This occurs because more oxygen is used by microorganisms to decompose organic matter in the stream.
As we are going down the stream, amount of oxygen starts increasing because decomposition has released mineral salts that has encouraged the growth of aquatic plants that release oxygen into the water.

PLANT COMMUNITY IN FREASH WATER ECOSYSTEM.
Fresh water ecosystem has diversity of plants. These plants include both flowering plants such as reeds, water hyacinth, elephant grass and non flowering plants such as spirogyra, ferns liverworts, horn worts and mosses.
Most plants in fresh water ecosystem are found in areas that have enough light, air, mineral salts and optimum temperature and pH.

Groups of aquatic plants.

i. Submerged plants.
These are plants that are found below water surface such as algae and horn worts.

ii. Surface floating plants.
These are plants that are found on water surface such as water hyacinth, aquatic ferns, water lettuce, water lilies and duck weeds

iii. Marginal plants.
These are plants that grow along the margin of the water body e.g. reeds, elephant grass and ferns.

PROBLEMS FACED BY AQUATIC PLANTS.
i. Water turbulence.
ii. Insufficient light.
iii. Insufficient oxygen.

ADAPATATIONS OF AQUATIC PLANTS.
i. They have more stomata on upper surface of their leaves for easy gas exchange with the atmosphere.
ii. Some roots are modified into aerial roots that can absorb oxygen from atmosphere.
iii. They have several air spaces in their stems and leaves that store oxygen released during photosynthesis.
iv. Air spaces also make the plant light/less dense so that it should float on water and expose its leaves to sunlight.
v. They have flexible stems that can not easily break in turbulent water.
vi. They have waxy leaves that repel water so that leaves are exposed to direct sunlight.
vii. They have adventitious roots for anchorage.

PLANT COMMUNITIES IN SAVANNA WOODLAND ECOSYSTEM

Savanna woodland ecosystem has diversity of plants. These plants range from flowering plants such as tridax procumbene, grass, shrubs and trees to non flowering plants such as ferns.

Most plants in savanna woodland are found in areas with enough water, air and well drained fertile soil with optimum pH

PROBLEMS FACED BY PLANTS IN SAVANNA WOODLAND ECOSYSTEM

i. Drought.
ii. Overgrazing.
iii. Bush fire.
iv. Soil erosion.

ADAPTATIONS OF PLANTS FOUND IN SAVANNA WOODLAND ECOSYSTEM.

i. Their leaves have thick and hairy cuticle that reduce rate of transpiration.
ii. Some have small leaves which may be modified into spines in order to reduce rate of transpiration.
iii. Most plants shed/ lose their leaves during dry season in order to reduce water loss from plants.
iv. Most plants have deep roots that can absorb water deep layers of soil.
v. Spines, thorns and hairs (trichomes) also protect plants from predators such as herbivores.
vi. Some trees such as Baobab have large trunks that store water which is used during dry season.
vii. Some plants have underground stems such as tubers and rhizomes that remain dormant during dry season thereby enabling the plant to survive during dry season.

ESTIMATING PLANT POPULATION.

Plant population is estimated using quadrants. A quadrant is a rectangular flame of known dimensions. The dimensions can be 1m x 1m or 50cm x 50cm.

How to estimate plant population.

i. Choose the place where a population of a certain plant e.g. tridax would be estimated.
ii. Measure the dimensions of the place and calculate the area of the place. Record the results obtained.
iii. Measure the dimensions of the quadrant to be used and calculate its area. Record the results obtained.
iv. Throw the quadrant at random several times on the chosen place. Record the number of plants in the quadrant each time it is thrown.
v. Calculate the average number of plants in each quadrant by dividing total number of plants recorded by the number of times a quadrant was thrown. Record the results obtained.
vi. Calculate the total population of the plants by multiplying total area of the place by average number of plants in each quadrant.

Example.
Use the following information to calculate the total population of Bonongwe in the school garden.
Dimensions of school garden: 50m x 20m.
Dimensions of quadrant: 50cm x 50cm
Number of times a quadrant thrown: 7 times.
Total number of Bonogwe recorded: 28.

Solution.
Total area of school garden= 50m x 20m
$= 1000m^2$
Total area of quadrant= 50cm x 50cm
$= 0.5m \times 0.5m$
$= 0.25m^2$
Number of times a quadrant thrown= 7 times.
Number of Bonongwe recorded= 28
Average number of Bonongwe in each quadrant= 28/7
= 4 Bonongwe/ quadrant
Total population of Bonongwe= 4 Bonongwe/ quadrant x $1000m^2$

$$= \frac{4 \text{ Bonongwe}}{0.25m^2} \times 1000m^2$$

= 16000 Bonongwe.

- The population density of Bonongwe can be obtained by dividing total population by total area of the school garden. Thus;

$$\text{Population density} = \frac{16000 \text{ Bonongwe}}{1000m^2}$$

$= 16$ Bonongwe/ m^2

ANIMAL COMMUNITY IN FRESH WATER ECOSYSTEM.

Fresh water ecosystem has diversity of animals. These animals include invertebrates such as worms, insects and crustaceans and vertebrates such as fish, amphibians, birds and reptiles.
These animals are found in areas with enough oxygen, food and less predators.

Problems faced by aquatic animals.
i. Insufficient oxygen.
ii. Drag.
iii. Insufficient light.
iv. Insufficient mineral salts.
v. Predation.

Adaptations of aquatic animals.
i. Some aquatic animals are streamline in shape to reduce drag.
ii. Some slippery skin to reduce drag.

iii. Some aquatic animals have gills for gas exchange in water.
iv. Their gills have special structures that absorb mineral salts from water.
v. Animals that live in fresh water produce dilute urine to conserve mineral salts in their body.
vi. Some aquatic animals have bright colours to scare away predators.

ANIMAL COMMUNITIES IN SAVANNA WOODLAND ECOSYSTEM.

Savanna woodland ecosystem like any other ecosystem has diversity of animals. These animals range from invertebrates such as worms, insects, millipedes, centipedes and arachnids to vertebrates such as mammals, birds, reptiles and amphibians. These animals are found in areas with enough water, food, air, shelter and less predation.

Problems faced by animals in savanna woodland ecosystem.

i. Drought.
ii. High temperatures.
iii. High levels of silica in grass.
iv. Bush fires.
v. Predation.

Adaptations of animals found in savanna woodland ecosystem.

i. Some have tough skin that reduces sweating thereby conserving water in the body.
ii. Some have reduced number of sweat glands to reduce water loss through sweating.
iii. They produce little urine, which is highly concentrated to conserve water in the body.
iv. Mammals have reduced fur to speed heat loss from the body.
v. They pant when it is hot to speed up heat loss from the body.
vi. Animals hide in caves or under shed when it is hot.
vii. They have long extreme body parts such as ears and tail to speed up heat loss from the body.
viii. The teeth of herbivores have strong enamels that can withstand high levels of silica.
ix. The teeth of herbivores grow continuously so that they can easily chew grass.

ESTIMATING ANIMAL POPULATION.

Animal population can be estimated using several methods. These include:
i. Capture, mark, release and recapture method.
ii. Pellet or dung count.
iii. Foot print count.
iv. Direct count.

Estimating animal population using capture, mark, release and recapture method.
Procedure.

i. Choose the animal that you want to estimate its population.
ii. Measure the dimensions of the place where estimation would take place and calculate its area. Record the results obtained.
iii. Capture several animals you are interested in knowing its population.
iv. Mark the captured animals and count them. Record the results.

v. Release the marked animals in areas where they were captured and wait for some days so that they should mix with unmarked animals.
vi. After a certain period of time, go back to a place where marked animals were released and capture as many animals as you can.
vii. Count the total number of animals recaptured and record the results.
viii. Count the number of marked animals in recapture and record the results.
*The total population is obtained using this formula:

$$\text{Total population} = \frac{\text{Number of animals first marked x Number of animals recaptured.}}{\text{Number of marked animals in recapture.}}$$

Example.
Use the following information to calculate the estimated population of grasshoppers in the school garden:
Area of school garden: $150m^2$
Number of grasshoppers captured and marked: 100.
Number of grasshoppers recaptured: 300
Number of marked grasshoppers in recapture: 20.

Solution.

$$\text{Total population} = \frac{\text{Number of animals first marked x Number of animals recaptured.}}{\text{Number of marked animals in recapture.}}$$

$$\text{Total population} = \frac{\text{100 grasshoppers x 300 grasshoppers}}{\text{20 grasshoppers}}$$

Total population= 1500 grasshoppers.

- Population density of grasshoppers can be obtained by dividing total population by total area. Thus;

$$\text{Population density} = \frac{\text{1500 grasshoppers}}{150m^2}$$

$$= 10 \text{ grasshoppers}/ m^2$$

PRODUCTIVITY.
It is the rate at which food is being produced in ecosystem.
In the ecosystem, plants manufacture organic food substances from inorganic compounds. This is called **primary productivity.**
Animals use already made food to make their own biomass. This is called **secondary productivity.**

Factors that affect primary productivity.
i. Water.
ii. Carbondioxide.

iii. Light intensity.
iv. Temperature.
v. Mineral salts.

Water.
Primary productivity increases when amount of water increase because water is the raw material for photosynthesis.

Carbondioxide.
An increase in carbondioxide increases primary productivity because carbondioxide is the raw material for photosynthesis.

Light intensity.
Primary productivity increases when light intensity increases because light provides energy used during photosynthesis.

Temperature.
Primary productivity increases when temperature increases because enzymes involved in photosynthesis become active. However primary productivity decreases at high temperature because enzymes are denatured.

Mineral salts.
Primary productivity increases when amount of mineral salts increases because mineral salts are used for organic compounds such as proteins, vitamins and lipids.

ENERGY TRANSFER IN THE ECOSYSTEM.
It is the flow of energy from one organism to another in form of food in the ecosystem.. In the ecosystem, sunlight is the main source of energy. Light energy is trapped by chlorophyll and converted to chemical energy. Chemical energy is used by plants for making their own food as such energy from the sun is stored in the food.
When herbivores eat plants, energy is transferred from plants into herbivores. In the herbivores the energy is used for making their biomass.
When herbivores are eaten by carnivores, energy is transferred from herbivores into carnivores where it is used for building the biomass of the carnivores.
When plants and animals die, they are either eaten by detrivores or decomposed by microorganisms. In this case energy is transferred from dead organisms to detrivores and microorganisms.

- Not all energy from the food is used for building the biomass of the organism. Some energy is lost through heat.

FOOD CHAIN
It is a simple food relationship showing dependence of organisms in the ecosystem.
In the food chain, plants form the starting point because they are food producers.

Food chain in fresh water ecosystem.
Phytoplankton ⟶ zooplankton ⟶ small fish ⟶ large fish ⟶ crocodile.

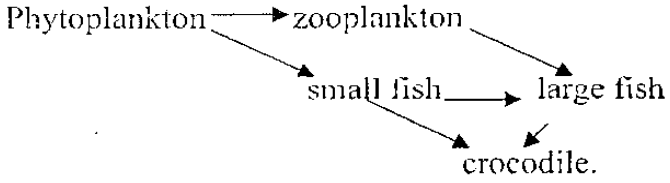
Food chain in savanna woodland.

Grass ⟶ grasshopper ⟶ birds ⟶ snakes

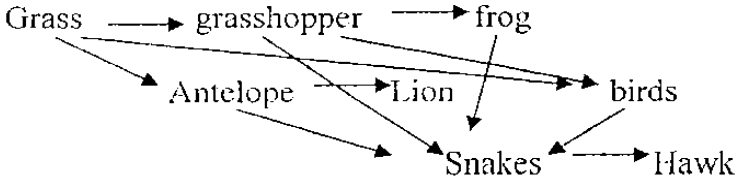
Food web.

It is a complex food relationship showing dependence of organisms.
Food web consists of several food chains that are linked together.

Food web in fresh water ecosystem.



Food web in Savanna woodland ecosystem



TROPHIC LEVEL

It is a position that an organism occupies in the food web.
In the food web, plants occupy the first trophic level because they are producers.
Herbivores that feed on plants directly occupy second trophic level. These herbivores are also called **primary consumers** or **first order consumers.**
Carnivores occupy third trophic level because they feed on primary consumers as such carnivores are called **secondary consumers.**
All organisms the feed on secondary consumers are called **tertiary consumers.**

- Food chains can not support more than four trophic levels because energy is lost when transferred from one trophic level to another trophic level. This energy is lost in form heat and undigested materials that are expelled out of the body.
- Microorganisms do not occupy any trophic level because they feed on organisms found in all trophic levels.

ADAPTATIONS OF ANIMALS FOR FOOD CAPTURE.

Herbivores. (plant eaters)

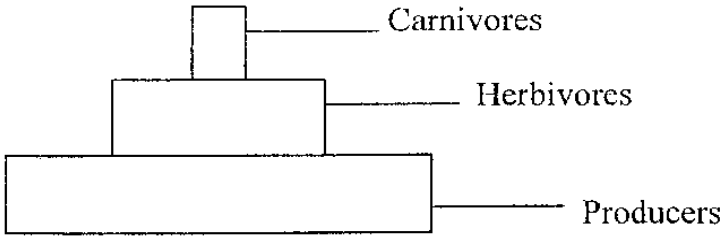
i. They have long alimentary canal for digesting cellulose in plant materials.
ii. They have flat ridged teeth for chewing plant materials thoroughly.
iii. They have microorganisms such as bacteria, fungi and protozoa in their alimentary canal that help them to digest cellulose in the plant materials.
iv. Nector eating birds have long slender beak for collecting nector from flowers.
v. Seed eating birds have conical beaks for picking seeds and blunt nails for scratching the ground.

Carnivores. (Flesh/ meat eaters)
i. They have good sight for stalking prey from a distance.
ii. They have sharp and strong canines for tearing flesh from bones.
iii. They have long claws for seizing and holding prey.
iv. They have strong jaws for breaking bones.
v. Carnivorous birds have curved beaks for tearing flesh from bones.
vi. Snakes have loose jaws that enable them to swallow a prey bigger than their heads.
vii. Insect eating animals such as chameleon and frogs have sticky tongue for trapping insects.

FOOD PYRAMID
It is the representation of quantity of organisms or energy at each trophic level.

Three kinds of food pyramids.
i. Pyramid of numbers.
ii. Pyramid of biomass.
iii. Pyramid of energy.

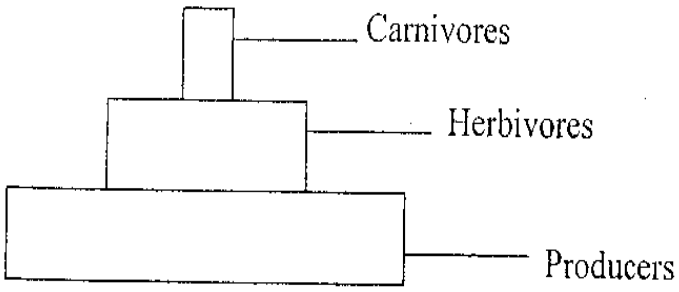
Pyramid of numbers.
It is a pyramid that shows the number of organisms at each trophic in the food chain.
Pyramid of numbers is obtained by counting all organisms at each trophic level and record it.
In the ecosystem, there are more producers than herbivores and more herbivores than carnivores as such the pyramid of numbers looks like the figure below.



- The problem with pyramid of numbers is that an inverted/ odd pyramid may be produced when they are more herbivores than producers.

Pyramid of biomass.
It is a pyramid that shows the dry mass of all organisms at each trophic level.
Pyramid of biomass is obtained killing all organisms at each trophic level and dry them. After drying the organisms are weighed in order to get their mass.
Dry mass is recommended because water which is not part of biomass is excluded in the mass of organisms.
In the ecosystem, producers have more biomass than herbivores and herbivores have more biomass than carnivores. This occurs because energy is lost when transferred from one trophic level to the other.

Figure below shows the pyramid of biomass.



Problem.
In the school garden there are two trees, 10000 caterpillars and one bird.
a. construct the food chain.
b. construct the pyramid of
i. numbers
ii. biomass

NUTRIENT CYCLE.

It is the flow of mineral elements in nature. These elements include carbon, nitrogen, oxygen and sulphur.

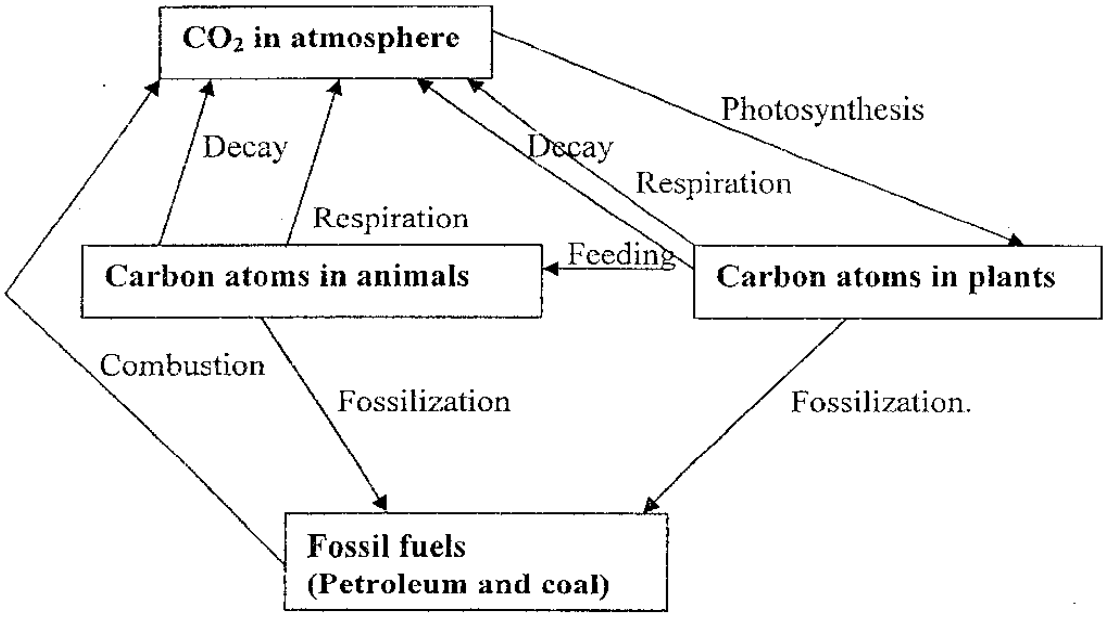
Examples of nutrient cycles.

i. Carbon cycle.
ii. Nitrogen cycle.
iii. Hydrological cycle.

Carbon cycle.

It is the flow of carbon atoms in nature.
Carbon atoms are found in atmosphere in form carbondioxide and in living organisms in form of organic substances such as food.
From atmosphere, carbondioxide is absorbed by plants and used for making organic food. When plants are eaten by animals, carbon atoms are transferred into animals. When plants and animals respire or decompose, carbon atoms are released back into atmosphere in form of carbondioxide. Plants and animals may also form fossil fuels such as petroleum and coal which when burnt, they release carbondioxide into atmosphere.

Figure below shows the carbon cycle.



How human beings disturb carbon cycle.

i. Deforestation that removes vegetation that absorbs carbondioxide from atmosphere.
ii. Burning of fossil fuels that increases amount of carbondioxide in the atmosphere.

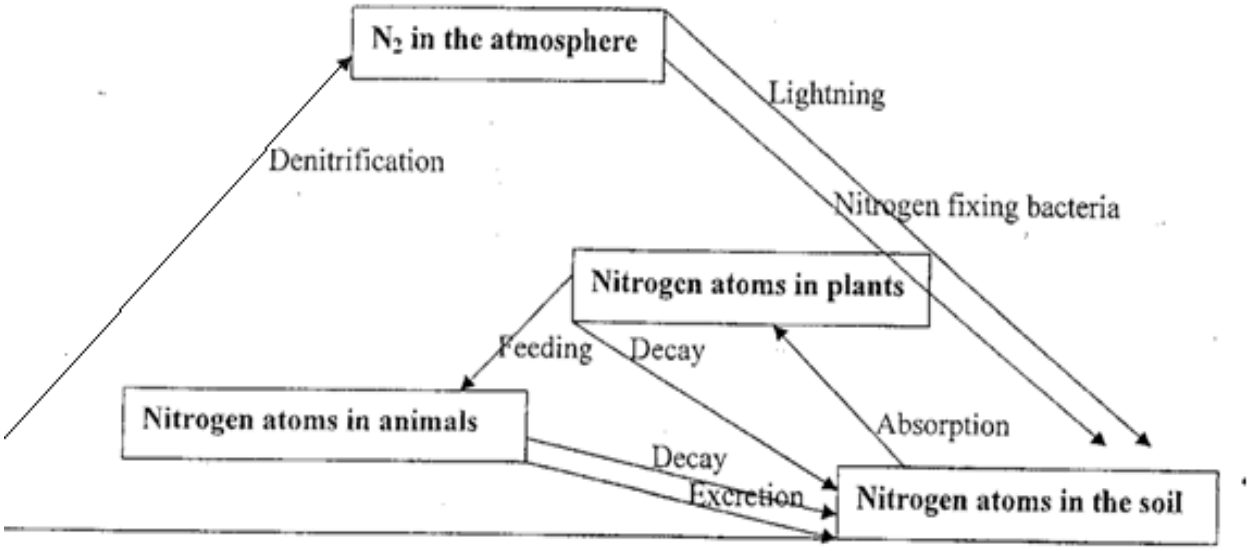
Nitrogen cycle.

It is the flow of nitrogen atoms in nature.
Nitrogen atoms are found in atmosphere in form of nitrogen gas and living organisms in form of proteins.
Nitrogen gas is stable compound as such it can not be used directly for making proteins. This gas is firstly fixed (changed) into ammonia and nitrates by lightning and nitrogen fixing bacteria. Some bacteria live in the soil such as azotobacter, azomonas and clostridium and others live in nodule of leguminous plants such as rhizobium.
After nitrogen fixation, nitrates and ammonia are absorbed by plants and used for making proteins that form the biomass of plants.
When plants are eaten by animals, proteins that contain nitrogen atoms are transferred into animals and used for making biomass of animals.
When animals excrete urea into the soil, nitrifying bacteria such as nitrozomonas and nitrobacter change urea into nitrates that are absorbed by plants.

When plants and animals die, they are decomposed in which ammonia is released into the soil. This ammonia is changed into nitrates by nitrifying bacteria.

In the soil, there are some bacteria such as paracoccus and pseudomonas that change ammonia and nitrates into nitrogen gas that escapes into atmosphere. This process is called **denitrification**.

Figure below shows the nitrogen cycle.



How human beings disturb nitrogen cycle.

i. Burning plant residues that cause evaporation of nitrogen gas.
ii. Crop removal that takes away nitrogen absorbed by plants from the field.
iii. Application of chemical fertilizers that increases amount of nitrates into the soil.

IMPORTANCE OF FRESH WATER ECOSYSTEM.

i. It attracts tourists that bring foreign currency.
ii. It is the habitat of aquatic organisms such as fish and amphibians.
iii. It provides water for irrigation, domestic use and hydroelectric power.
iv. It eases transportation of goods.
vi. It provides food such as fish, arthropods, which are source of proteins.

IMPORTANCE OF SAVANNA WOODLAND ECOSYSTEM.

i. It provides food in form of fruits and roots that are source of vitamins.
ii. It is the habitat of terrestrial animals such as lions, lizards and birds.
iii. It attracts tourists that bring foreign currency.
iv. It provides timber and fuels such as fire wood.
v. Plants in savanna woodland absorb carbondioxide thereby reducing global warming.
vi. It provides medicines that are used for treating different diseases.

ENVIRONMENTAL STRESS.

It the sudden event or occurrence that threatens living organisms in the ecosystem. These include:

i. Diseases.
ii. Floods.
iii. Fire. ,
iv. Drought.

Effects of environmental stress on ecosystem.

Diseases.
These occur when they are more pathogens in the area. Diseases kill a lot of living organisms by damaging their cells.

Floods.
These occur when these is a lot of rainfall, which makes river banks to burst. Floods destroy living organisms by suffocating them. Floods also cause soil erosion that makes the soil to lose its fertility as such soil can not support plant growth.

Fire.
Fire kills plants and animals in the ecosystem. It also destroys the habitat of animals.

Drought
It occurs when there is shortage of rainfall in the area. Drought kills plants and animals as they lack water for their metabolic activities.

IMPACTS OF HUMAN ACTIVITIES ON ECOSYSTEM
Human activities have caused the following environmental problems:
i. Deforestation.
ii. Soil erosion
iii. Pollution.
iv. Over fishing
v. Introduction of alien species.

Deforestation.
It is the loss of vegetation especially trees.

Human activities that cause deforestation
i. Clearing bush for cultivation, construction and settlement.
ii. Cutting down trees for firewood and timber.
iii. Cutting down trees for making curios (Ziboliboli)
iv. Cutting down trees for medicine.

Effects of deforestation.
i. It causes global warming as trees that absorb carbondioxide are removed.
ii. It causes soil erosion as land is left bare.
iii. It causes desertification as land becomes degraded by soil erosion.
iv. It causes siltation of water bodies due to increase in surface run off.
v. Death of aquatic animals due to silt that choke them
vi. Erratic rainfall since hydrological cycle is disturbed.
vii. Rivers dry up due to lack of rainfall and lack of trees that enable soil to hold water.
viii. Extinction and loss of wildlife as habitats are destroyed.

Ways of controlling deforestation.
i. Reforestation and afforestation that replace lost trees.
ii. Use of alternative source of energy such as electricity, solar energy that reduces dependency on trees.
iii. Practicing family planning that reduces the demand for trees and land for cultivation.
iv. Construction of fire breaks that reduces the spread of fire in the forest.
v. Practice proper methods of farming such as agroforest that conserve trees.
vi. Civic education that reduces the behaviour of cutting trees carelessly.

Soil erosion.
It is the loss of top fertile soil from the earth surface.

Human activities that cause soil erosion.
i. Deforestation that leaves land bare thereby exposing it to wind and running water.
ii. Poor methods of farming that increases the speed of surface run off.
iii. Overgrazing that leaves land bare.
iv. Bushfire that destroys vegetation and leave the land bare.
v. Use of heavy machine that destroy soil structure and loosen the soil.

Effects of soil erosion.
i. Siltation of water bodies.
ii. Death of aquatic organisms due to siltation.
iii. Flooding due to siltation of rivers.
iv. Poor crop production due to loss of soil fertility.
v. Algal bloom due to surface run off that increase amount of soil nutrients in the water body.
vi. Desertification due to land degradation.

Ways of controlling soil erosion.
i. Plant vegetative cover that binds soil particles.
ii. Practice proper methods of farming that reduces surface run off.
iii. Avoid cultivating in marginal lands such as hills and along river banks.

Pollution.
It is the contamination of the environment.
Polluted environment fails to support the life of living things as such living organisms die.
Substances that pollute the environment are called **pollutants**. There are two kinds of pollutant. These are:
i. Biodegradable pollutants.
ii. Non biodegradable pollutants.
Biodegradable pollutants can be decomposed by microorganisms. These include plant and animal materials such as human wastes. Non biodegradable pollutants can not be decomposed by microorganisms. These include plastics, metals and chemicals such as acids and oils.

Kinds of pollution.
i. Air pollution.
ii. Water pollution.
iii. Land pollution.
iv. Noise pollution.

Air pollution.
It is the contamination of air.

Causes of air pollution.
i. Fumes and gases from motor vehicles and industries.
ii. Dust from quarries and wind erosion.
iii. Gases from volcanic eruption.
iv. Smoke from bush fires.
v. Gases from decomposing organisms.

Effects of air pollution.
i. It can lead to formation of acid rains that damages plants and kill aquatic animals.
ii. It causes respiratory infections such as asthma, bronchitis and TB.
iii. Chloroflorocarbons (CFCs) destroy ozone layer that protects living organisms from ultraviolet rays from the sun.
iv. Green house gases such as Carbondioxide and methane cause global warming as they absorb a lot of heat from the sun and emit it at night.

Ways of controlling air pollution.
i. Reduce the use of fossil fuels that release a lot of carbondioxide into atmosphere.
ii. Use of catalytic converters in cars that remove nitrogendioxide from car exhaust fumes.
iii. Use of scrubbers on factory.
iv. Put filters on chimney that removes nitrogendioxide.

Water pollution.
It is the contamination of water.

Causes of water pollution.
i. Discharge of human and industrial wastes into water bodies such as rivers.
ii. Use of fertilizers that are carried to the river by surface run off.
iii. Use of herbicides and pesticides that are carried to the river by surface run off.
iv. Air pollution that cause acid rains that acidifies water.

Effects of water pollution.
i. Death of aquatic animals due to lack of oxygen and change in water pH.
ii. Spread of water borne diseases that kill human beings.
iii. Lack of potable water for drinking.
iv. Algal bloom due to eutrophication.

v. Heavy metals and pesticides accumulate in the food chain and kill the top feeder organisms.

Ways of controlling water pollution.
i. Treat sewage before it is discharged into the stream.
ii. Plant trees along river banks to reduce soil erosion.
iii. Industries must have dumping sites where they can dump their industrial wastes.
iv. Reduce the use of chemical fertilizers, herbicides and pesticides.

Land pollution.
It is the contamination of land (soil)

Causes of land pollution
i. Dumping domestic and industrial wastes on bare land.
ii. Application of acidic fertilizers.
iii. Discharge of fossil fuels on bare land.

Effects of land pollution.
i. It creates breeding places for pathogens and vectors.
ii. Radioactive materials damage DNA molecule and cause cancer.
iii. Plastics and metals make the soil unfertile as they can not be decomposed.
iv. Acidic soil becomes unfertile as soil nutrients become unavailable.
v. Metals can injure children.

Over fishing.
It is a situation in which fish is caught more than it can replenish itself.

Causes of over fishing.
i. High human population that increases the demand for fish.
ii. Poor methods of fishing that kill young fish.
iii. Failure to observe closed season of lakes that disturb breeding of fish.
iv. Deforestation that increases siltation of lakes.
v. Poor methods of farming that increases surface run off.
vi. Clearing of marshes, which provide breeding places of fish.

Effects of over fishing.
i. Decline of fish species as more young fish are killed.
ii. Malnutrition due to lack of proteins from fish.
iii. Unemployment due to scarcity of fish.
iv. Loss of foreign currency.
v. School drop outs due to unemployment of the parents

Ways of controlling over fishing.
i. Family planning that reduces population growth.
ii. Fish farming that reduces dependency of fish from lakes.
iii. Observe closed season of lakes to allow fish to breed.

iv. Use nets with large mesh size to avoid killing young fish
v. Avoid fishing using poison that kills young fish.

Introduction of alien species.
Alien species are species of living organisms introduced from other countries.
People bring alien species for:
i. boosting agricultural production.
ii. beautifying their surroundings.
iii. education purpose.

Effects of alien species.
i. They compete with local species for nutrients, water and space.
ii. They kill local species.
iii. They may bring new diseases that can wipe out local species.
iv. They may change genotype of local species when they interbreed.

MANAGING RESOURCES IN ECOSYSTEM.
Resources in the ecosystem can be managed through the following ways:
i. Conservation that protects living organisms from destruction.
ii. Preservation that keeps resources for future use. Resources may be kept in form seeds, vegetative materials or sperms. These materials are stored in gene banks.
iii. Practice better methods of farming that conserve resources e.g. agroforest.
iv. Establish game reserves and national parks that protect resources from destruction.
v. Restoration of damaged habitats through afforestation and reforestation.

TOPIC 16: HUMAN POPULATION.

It is the number of people living in a particular area at a particular time.
Human population is obtained through census.

Human population growth.
It is the increase in number of people living in a particular area.

Factors that affect population growth.
i. Birth rate.
ii. Death rate.
iii. Migration.
iv. Urbanization.
v. Fertility rate.
vi. Population age structure.

Birth rate.
It is the number of live children born per 1000 women.
An increase in birth rate increases human population more new people are added into the population.

Factors that affect birth rate.

i. Average age of marriage.
Birth rate increases when average age of marriage is low as people start producing young ones at early age.

ii. Religious belief.
Birth rate increases in religion that encourages its members to produce more children.

iii. Education.
Birth rate is very low in educated people as they spend much of their time at school and there are conversant with contraceptive methods.

iv. Importance of children.
Birth rate increases in people who value in children.

v. Sex preference.
Birth rate increases in families that value in one sex of children.

vi. Living cost.
Birth rate increases in areas where the cost of living is very low as it is easy to take care of large families.

vii. Availability of contraceptive methods.
Birth rate increases in areas where contraceptive methods are scarce as there are a lot of unprepared pregnancies.

Death rate.
It is the number dead people per 1000 people.
Death rate decreases human population as more people are being eliminated from the population.

Factors that affect death rate.
i. Diseases.
Death rate increases when there is an outbreak of a disease that kills a lot of people.

ii. Nutrition.
Death rate increases when there is food shortage as more people die due to malnutrition.

iii. Medical services
Death rate increases in areas where medical services are scarce as people don't get treatment when they are sick.

iv. Natural disasters.
Death rate increases when natural disasters such as earth quakes and floods strike. These kill a lot of people at a short period of time.

Migration.
It is the movement of people from one place to another. The movement of people out of the population is called **emigration** where as movement of people into the population is called **immigration**.
Human population increases when immigration is higher than emigration as more people join already existing population.

Fertility rate.
It is the number of people who are capable of producing young ones.
Human population growth becomes high when fertility rate increases because children are produced by more people.

Population age structure.
It is the number of people in different age groups.
Human population growth becomes high when there are more people in the child bearing age as more children are produced.

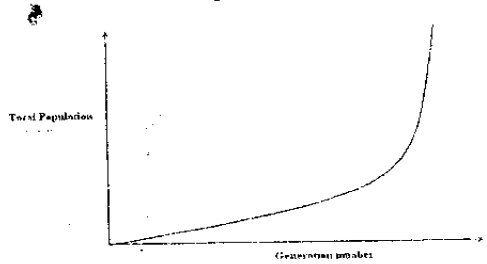
Urbanization.
It is the development or formation of towns and cities.
Urbanisation makes people to migrate fro rural areas to urban areas where the increase the population of people.

DESCRIPTION OF HUMAN POPULATION GROWTH.
Human population growth can easily be understood if we look at how the population of rats increases.

Problem
Assume that the birth rate of rats is eight rats per pair and their death rate is four rats per pair. How many rats would be in the 5^{th} generation if there were two rats in the first generation?

Generation number	Numbers of rats born.	Numbers of dead rats	Total population of rats.
1	0	0	2
2	8	4	6
3	24	12	18
4	72	36	54
5	216	108	162

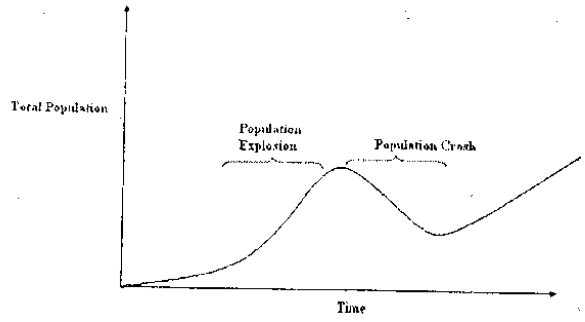
- 5^{th} generation would have 162 rats.
- If the total population of rats is plotted against generation number, the graph will produce J shaped curve as shown in figure below.



Human population also produces a J shaped curved when the total population of human beings is plotted against time. In J shaped curve graph, the population begins by increasing slowly and later starts increasing rapidly. Rapid increase in population of organisms is called **population explosion**. This occurs when all conditions are favorable.

In real situation, the population of organisms does not keep on increasing due to limited factors such as space, food, diseases and toxic substances. As a result there is a time when a lot of organisms die due to lack of food, space and out break of diseases and this decreases the population. Rapid decrease in the population of organisms is called **Population crash.**

Figure below is the graph showing the population of organisms in real situation.



PROPBLEMS ASSOCIATED WITH RAPID POPULATION GROWTH.

i. Depletion of resources such as vegetation and land.
Rapid population growth increases demand for resources such as land for cultivation and settlement and forest resources that become depleted when they are over used.

ii. Famine.
Rapid population growth increases demand for food as a result food reserves are depleted and people die due to lack of food.
Famine can also occur when people have no land for cultivation as such little food is produced to support large families.

iii. Pollution.
When the population increases rapidly, more wastes matters are produced which can not be properly managed as a result they are dumped any where causing pollution.

iv. Spread of diseases.
Rapid population growth leads to pollution of water and air that encourages the spread of water and air borne diseases.

v. Pressure on social services.
Rapid increase in human population increases the demand for social services such as schools, hospitals which result into overcrowding.

SOLUTIONS TO PROBLEMS ASSOCIATED WITH RAPID POPULATION GROWTH.

i. Child spacing that reduces birth rate thereby slowing down human population growth.
ii. Personal hygiene that reduces the spread of diseases.
iii. Recycling of materials such as plastics and metals so that they should not pollute land and water.
iv. Building more social service providers that can support high population growth.
v. Introduce new farming technologies that lead to high agricultural production.
vi. Conserve resources such as trees through afforestation and reforestation.
vii. Reduce over consumption of resources such as food and fuels so that they should be available all the time.

WISHING YOU THE BEST AS YOU ARE TAKING YOUR LAST JOURNEY TOWARDS PROSPERITY.

TOPIC 7: RESPIRATORY SYSTEM.

TISSUE RESPIRATION.

It is the chemical reaction that occurs in the living cell in which energy is released from food (glucose)

Two kinds of respiration.

i. Aerobic respiration.
ii. Anaerobic respiration.

AEROBIC RESPIRATION.

It is the kind of respiration in which energy is released from food using oxygen.
This process occurs in plants and animals when Oxygen is in abundance.
During this process carbondioxide and water are released as by products.

Word equation of aerobic respiration.

Glucose + Oxygen ⟶ Carbondioxide + water + Energy.

Chemical equation of aerobic respiration.

$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O$ + Energy

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 2898$ (kJ of energy (38 ATP)

Points about aerobic respiration

i. Aerobic respiration produces more energy (2898Kj)
ii. Energy released during respiration is stored in living cells in form of ATPs (Adenosine triphosphates)
iii. Aerobic respiration produces 38 ATPs from one glucose molecule.

Functions of energy released during respiration.

i. It is used for muscle contraction that brings about movement.
ii. It is used for formation of new cells that bring about growth.
iii. It is used for conduction of nerve impulses in neurons.
iv. It is used for production and secretion of enzymes that speed up chemical reactions.
v. It is used for active transport.

ANAEROBIC RESPIRATION.

It is the kind of respiration in which energy is released from food without using oxygen.
This process occurs in Microbes e.g. Yeast and in muscles when there is insufficient oxygen in the cell.
Anaerobic respiration produces less energy as compared to aerobic respiration.

Anaerobic respiration in yeast.

Yeast is the unicellular organism that lives in sugary solutions.
Yeast can break down glucose into energy without using oxygen in the process called **fermentation.**
During fermentation Carbondioxide and ethanol (alcohol) are produced. Apart from these, little energy (298Kj) is also produced.

Word equation of fermentation process in yeast.
Glucose ⟶ Carbondioxide + Ethanol + Energy

Chemical equation of fermentation process in yeast.
$C_6H_{12}O_6 \longrightarrow CO_2 + CH_3CH_2OH$ + Energy

Anaerobic respiration in muscles.
During extraneous work, muscle cells break down glucose into energy without using oxygen. This occurs because the supply of oxygen to muscles during exercise is lower than its demand.
During this process, lactic acid and little energy (105Kj) are released.
When lactic acid accumulates in muscles, muscles stop contracting and a person stops what so ever he/she was doing.
The process in which muscles break down glucose into lactic acid is called **lactic acid fermentation.**
Word equation of lactic acid fermentation.
Glucose ⟶ Lactic acid + Energy

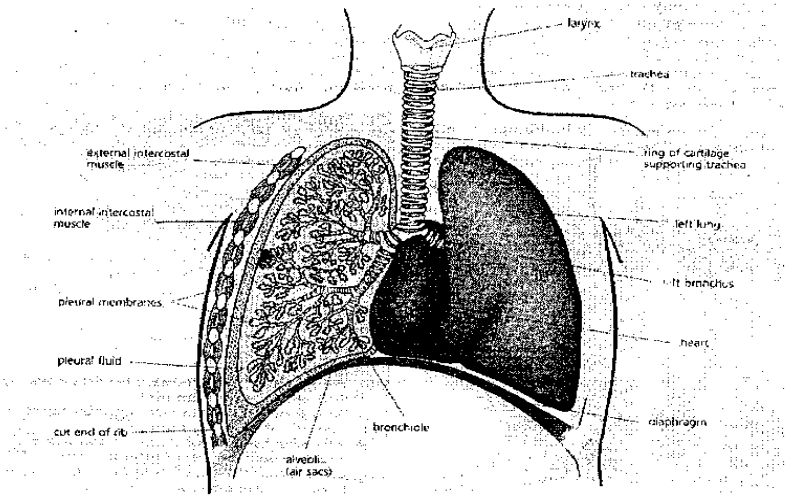
Chemical equation of lactic acid fermentation.
$C_6H_{12}O_6 \longrightarrow CH_3CHCOOH$ + Energy

OXYGEN DEBT.
It is an extra amount of Oxygen required by the body to break down lactic acid into carbondioxide and water when a person is resting.
During the breaking down of lactic acid, more energy is released, which is stored in form of ATPs.

Differences between aerobic and anaerobic respiration.

Aerobic respiration.	**Anaerobic respiration.**
Uses Oxygen	Doesn't use Oxygen
Produces more Energy.	Produces less Energy
Does not produce ethanol and lactic acid.	Produces lactic acid and ethanol.

HUMAN RESPIRATORY SYSTEM.



DESCRIPTION OF HUMAN RESPIRATORY SYSTEM

It is the body system that is responsible for gas exchange in human beings. This system consists of the following:

i. Nostrils.
ii. Trachea.
iii. Bronchi and bronchioles.
iv. Alveoli.

NOSTRILS

These are openings that allow air to enter or leave the lungs from atmosphere.
Nostrils have mucus and hairs that trap germs and dust from inhaled air.
Nostrils also moisten and warm inhaled air.

TRACHEA.

It is the hollow tube that runs from the back of the neck into the lungs.
The opening of trachea has a flap called epiglottis.
Epiglottis closes the opening to the trachea when swallowing so that food particles should not slip into the trachea.
Trachea has rings of cartilage that protect the trachea from collapsing so that it should be open all the time.
Trachea has mucus that traps dust and germs from inhaled air. It also has cilia that drive out trapped dust towards the throat, where they are coughed or swallowed.

INNER LINING OF THE TRACHEA.

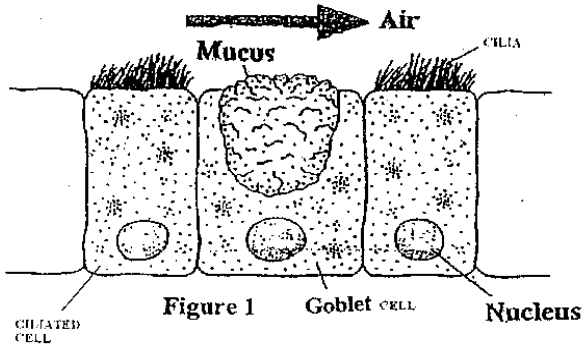


Figure 1

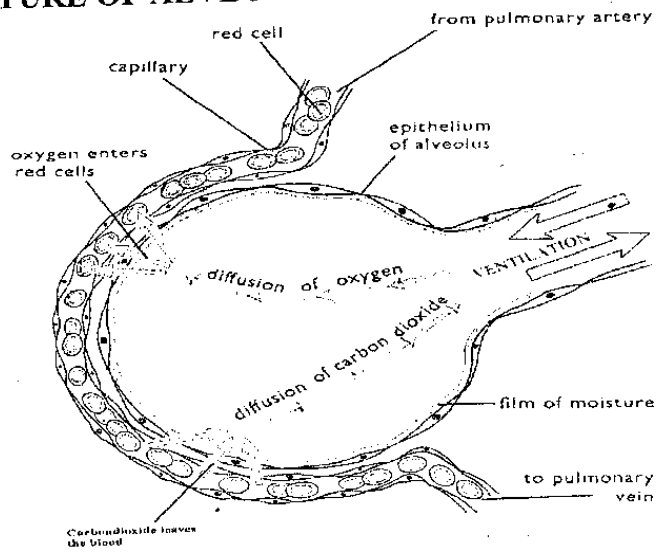
BRONCHI AND BRONCHIOLES.

Bronchi are two branches formed from trachea.
In the chest cavity, one bronchus enters into one lung, where it divides into several branches called **bronchioles**.
Bronchi and bronchioles have same structures found in the trachea such as mucus, cilia and rings of cartilage.

ALVEOLI.

These are small air sacs found at the end of each bronchiole.
Alveoli provide an area for gas exchange between blood and atmosphere in lungs. This is a reason why alveoli are said to be respiratory surface of human beings.

STRUCTURE OF ALVEOLUS



HOW DOES GAS EXCHAGE OCCUR IN ALVEOLI?

It occurs by diffusion.

In alveolus, alveolar air has more oxygen than carbondioxide whilst blood capillaries around alveolus have more carbondioxide than oxygen. This makes oxygen to diffuse from alveolus into the blood whereas carbondioxide diffuses from blood into alveolus, where it is exhaled.

ADAPTATIONS OF ALVEOLI FOR GAS EXCHANGE.

i. Alveolus has thin epithelium (one cell thick) for easy and fast diffusion.
ii. Alveolus has thin layer of moisture in its inner lining that dissolves gases for easy diffusion.
iii. Alveolus is surrounded by net work of blood capillaries that transport gases.
iv. Alveoli are numerous in number, which increases surface area for gas exchange.
v. Alveolus is able to maintain diffusion gradient of gases that ensures fast and efficient diffusion of gases.

HOW IS DIFFUSION GRADIENT MAINTAINED IN ALVEOLUS?

1. By breathing.

During breathing, oxygen is inhaled whilst carbondioxide is exhaled. This makes alveolar air to have more oxygen than carbondioxide.

2. By continuous flow of blood.

This brings blood full of carbondioxide and carries away blood full of oxygen. This makes region around alveolus to have more carbondioxide than oxygen.

BREATHING

It is the movement of air in and out of the lungs.

The movement of air from atmosphere into the lungs is called **inhalation** whereas the movement of air out of the lungs into atmosphere is called **exhalation**

IMPORTANCE OF BREATHING.

i. It supplies oxygen to the body tissues necessary for aerobic respiration
ii. It removes carbondioxide produced by body tissues during respiration

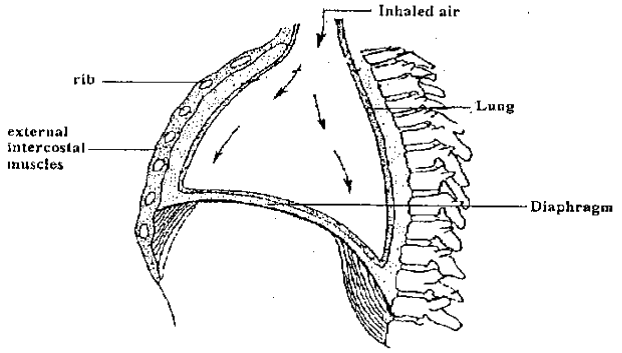
BREATHING MECHANISM IN HUMAN BEING.

These are events that happen in the human body which lead to movement of air in and out of the lungs.

Mechanism behind inhalation.

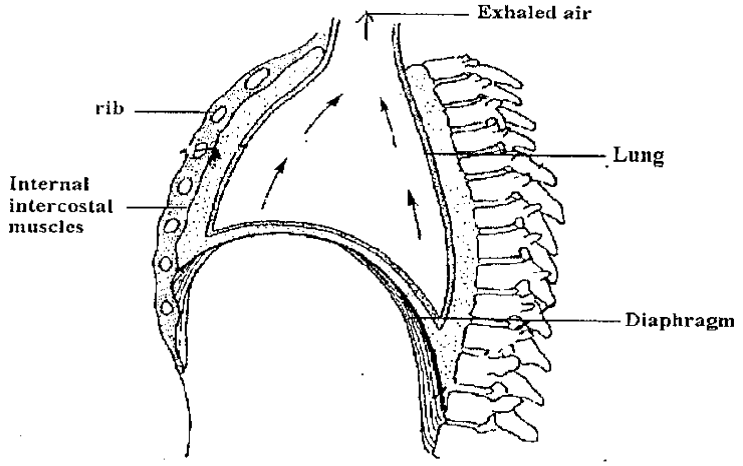
During inhalation, external intercostal muscles contract whereas internal intercostal muscles relax. This pulls the ribcage outwards and upwards. Apart from this, diaphragm muscles also contract that pulls diaphragm downwards such that it flattens. The upwards and outwards movement of ribcage and the downwards movement of diaphragm increase the volume of the chest cavity and reduce air pressure in lungs. As a result, air moves from atmosphere where air pressure is high into lungs. This is called **inhalation.**

Diagram showing inhalation



Mechanism behind exhalation.

During exhalation, internal intercostal muscles contract whereas external intercostal muscles relax. This pulls the ribcage downwards and inwards. At the same time, diaphragm muscles relax and diaphragm moves upwards such that it forms domed shape. The downward movement of the rib cage and the domed shape of diaphragm decrease volume of chest cavity and increase air pressure in lungs. As a result air moves from lungs into the atmosphere. This is called **exhalation.**



Breathing rate in human beings.
Breathing rate is the number of complete breath per minute.
A complete breath consists of one inhalation and one exhalation

Investigating the effects of exercise on the breathing rate of the person.
Procedure.
i. Count the number of breath per minute of a person at rest and record it.
ii. Let the same person run for a while and count the number of breath per minute immediately after running.
iii. Compare the results obtained at rest and those obtained after exercise.

Expected results.
The breathing rate of the person at rest will be 18 breaths per minute whereas after running the breathing rate will increase to 27 breaths per minute.

Explanation of results.
Breathing rate increases during exercise because more oxygen is needed by the muscles for aerobic respiration, in which energy released is used for running.
Secondly, an increase in breathing rate helps to remove more carbondioxide released during aerobic respiration in muscles.

REGULATION OF BREATHING.
Breathing is regulated by medulla oblongata of the brain.
Medulla oblongata receives impulses from nerve ending that lies in arteries.
This nerve ending detects the concentration of carbondioxide in the blood. When the concentration of carbondioxide in the blood is above normal, medulla oblongata sends impulses to diaphragm and intercostal muscles that increase the breathing rate until the concentration of carbondioxide is brought back to normal. When this happens, breathing rate is also normalized.

TERMS USED IN BREATHING.

Lung capacity.
It is the total volume of air in lungs when they are inflated. Lung capacity is measured by **spirometer**.
The average lung capacity of the person is 5*l*

Tidal air.
It is the amount of air that a person inhales and exhales during normal breathing.
During normal breathing, a person inhales and exhales 0.5*l* of air.

Complementary and supplementary air
Complementary air is the amount of air inhaled during deep breathing. The volume of complemental air is 1.5*l*. Supplementary air is the amount of air exhaled during deep breathing. The volume of supplementary air is also 1.5*l*.

Vital capacity.
This is the amount of air exhaled and inhaled during exercise. The volume of vital capacity is 3.5*l*.

Residual air.
It is the amount of air that remains in lungs during exercise and can never be expelled out. The volume of residual air is 1.5*l*.

CARBONMONOXIDE POISONING.

Carbonmonoxide is the poisonous gas that is produced during incomplete combustion of fuels such as petroleum and charcoal.
Incomplete combustion occurs when fuels are burnt in areas with inadequate oxygen.
Carbonmonoxide is odourless (no smell) as such it is very hard to detect it during inhalation.

Dangers of carbonmonoxide.
Carbonmonoxide has higher affinity to haemoglobin than oxygen. This makes blood to carry more carbonmonoxide than oxygen as a result a person suffocates (death due to lack of oxygen)

First aid to carbonmonoxide poisoning.
i. Take a person to a well ventilated area where he or she can get more oxygen.
ii. If the person is not breathing, try artificial respiration eg mouth to mouth resuscitation.
iii. Loosen all tight clothes to allow free circulation of blood.

Ways of preventing carbonmonoxide poisoning.
i. Allow charcoal burner to burn to red before it is taken into the house.
ii. Open windows when the burning charcoal burner is introduced in the house.
iii. Don't sleep with a burning charcoal burner.

SMOKING.

It is the inhalation of smoke from burned materials such as tobacco and Indian hemp
Cigarette smoke has three ingredients that are hazardous to life. These are:
i. Tar.
ii. Nicotine.
iii. Carbonmonoxide.

NICOTINE.

It is a drug that stimulates brain cells (making a person more alert/active)
Nicotine is very dangerous because:
i. It constricts blood vessels thereby raising blood pressure.
ii. Nicotine increases the level of cholesterol in the blood thereby increasing chances of heart attack.
iii. Nicotine is also addictive such that when body gets used to nicotine, it becomes very difficult to do without it.

TAR.

It is the brownish sticky substance found in cigarette smoke.
Dangers of tar include the following:
It thickens inner lining of respiratory tract thereby causing lung cancer.
It irritates inner lining of respiratory tract and cause inflammation that result into bronchitis.

Tar also damages cilia. This makes goblet cells to produce more mucus that trickle downwards towards alveoli. Presence of mucus in alveoli causes coughing that breaks delicate alveoli leading to **emphysema**.

Tar may also build up in alveoli and disturbs gas exchange.

CARBONMONOXIDE

This is the most dangerous gas that causes suffocation as it combines easily with haemoglobin as such a person lacks oxygen.

Dangers of smoking during pregnancy.

Pregnant women who smokes produce smaller and under developed babies because:

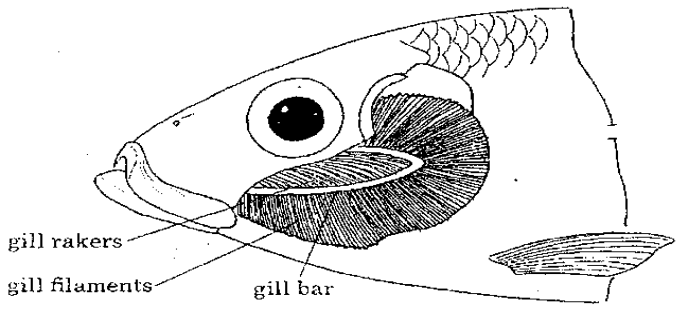
i. Nicotine constricts placental blood vessels thereby reducing the flow of food nutrients to the baby.
ii. Nicotine also increases heart beats of the embryo.
iii. Carbonmonoxide reduces amount of oxygen in the mother's blood as such the baby gets little oxygen.

RESPIRATION IN FISH.

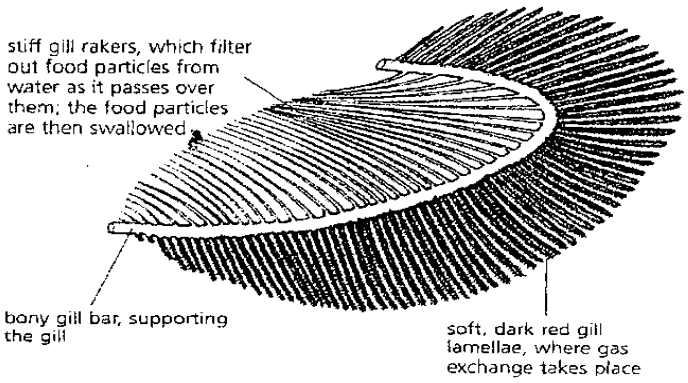
Fish is an aquatic animal that uses gills for gas exchange in water.

Fish has four gills on each side of its head, which are covered by operculum (gill cover)

FISH'S HEAD SHOWING GILLS.



STRUCTURE OF A GILL.



PARTS OF A GILL.

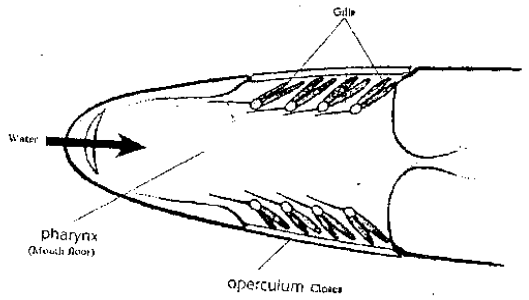
Gill bar.
It is a bony part of the gill.
Gill bar supports gill filaments and provides passage for the blood vessels.

Gill rakers.
These are small but hard structures that grow from gill bar.
Gill rakers trap dirty that passes through gill so that they should not clog up gills.
Gill rakers also traps food from the water that passes through gills.

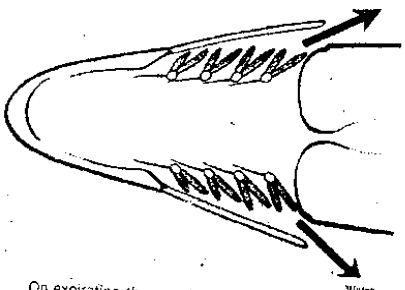
Gill filaments (Lamellae)
These are red and soft gill labella that grow from gill bar.
Gill filaments provide an area for gas exchange between water and blood as such they are respiratory surfaces of the fish.

BREATHING MECHANISM IN FISH.

During inspiration (inhalation), the fish opens its mouth, lowers its pharynx (mouth floor) and closes its operculum. This increases volume of buccal cavity/ mouth cavity and the water pressure in fish's mouth decreases. As a result water moves from outside into fish's mouth.
During Expiration, the fish closes its mouth and raises its mouth floor. This decreases the volume of buccal cavity and the water pressure in the mouth increases. As a result water is forced out of fish's mouth passing through the gills. At this time operculum opens.
As water passes through the gills, oxygen from water diffuses into gill filaments where it is carried by blood to the body tissues whereas carbondioxide from the blood diffuses into water where it is carried out.



(a) Inspiration — In inspiration the mouth opens. The floor of the pharynx is pulled down, increasing the space inside it. Water therefore flows into the mouth and pharynx.



(b) Expiration — On expiration the mouth closes. The floor of the pharynx goes up, squeezing the water out past the gills.

IMPORTANCE OF WATER THAT ENTERS INTO FISH'S MOUTH.

It provides food to the fish.
It supplies oxygen to the fish for respiration.
It removes carbodioxide released during respiration
Part of it is swallowed.
It propels the fish forward when expelled from gills.

ADAPTATIONS OF GILLS FOR GAS EXCHANGE.

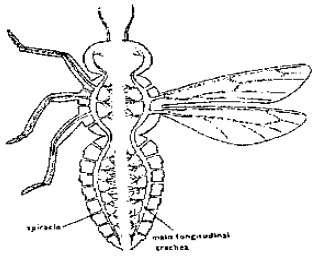
a) Gills have numerous gill filaments that increase surface area for gas exchange.
b) Gill filaments have thin wall (one cell thick) for easy diffusion of gases.
c) Gill filaments have a network of blood capillaries that transport gases.
d) Gill filaments are always moist. This dissolves gases for easy diffusion.
e) Gills are able to maintain diffusion gradient for fast and efficient diffusion.
f) Gill filaments overlap each other to reduce the speed of water for efficient diffusion of gases.
g) Blood and water move in opposite direction (counter current movement) in gills for efficient diffusion of gases.

NOTE: Fish suffocates when taken out of the water despite having more oxygen in the air than water because gill filaments stick together thereby reducing surface area for gas exchange. The other reason is that the breathing mechanism of fish does not work in the air.

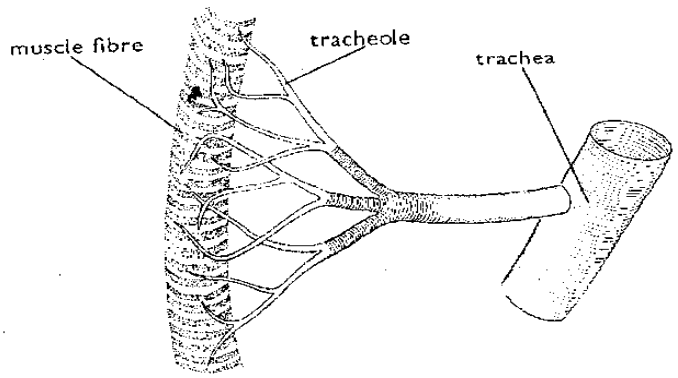
RESPIRATION IN INSECTS.

Insects have segmented body. Each segment has a pair of small openings called **spiracle**. Spiracles lead to a tube called **trachea**. Trachea has rings of **chitin** that keep it open by protecting it from collapsing. Trachea run through out the body of an insect and divides into several branches called **tracheoles**.
Tracheoles grow between cells where they supply oxygen and carry away carbondioxide released by the cells. These gases are exchanged by diffusion as there is higher oxygen concentration in tracheoles than body cells and higher carbondioxide concentration in muscles than tracheoles.
Since respiratory system of an insect consists of trachea and tracheoles, it is called **tracheal system.**

DIAGRAM OF INSECT SHOWING TRACHEAL SYSTEM.



TRACHEAL SYSTEM OF AN INSECT



Adaptations of tracheoles for gas exchange.

It has thin wall (one cell thick) for easy diffusion.
It has moisture that dissolves gases for easy diffusion.
It is in close contact with body cells for fast diffusion.

BREATHING MECHANISM IN INSECT.

When abdominal muscles of an insect contract, the body of the insect is squeezed. This decreases the volume of the insect and increase air pressure in the tracheal system. As a result air is forced out of the tracheal system into atmosphere through spiracles.
When abdominal muscles relax, the body of the insect inflates. This increases volume of insect's body and decrease air pressure in tracheal system. As a result, air moves from atmosphere into tracheal system through spiracles.

TOPIC 8 : LOCOMOTION

Locomotion is the movement of organisms from one place to the other.
Locomotion is common in animals.
Animals move in order to do the following:

i. Look for food.
ii. Look for shelter.
iii. Look for mates.
iv. Run away from danger.

REQUIREMENTS FOR LOCOMOTION.

Locomotion requires the following factors:

i. Skeletons.
ii. Muscles.
iii. Energy.

SKELETON

It is the frame work of the body.

Functions of mammalian skeletons.

i. They provide areas for muscle attachment that bring about movement.
ii. They support the body and give its definite shape.
Short skeletal parts support heavier body mass than long skeletal parts. This is a reason why most heavy animals have short legs.
iii. They protect delicate organs of the body. For instance; skull protects the brain, ribcage protects lungs, heart and the liver and vertebral column protects spinal cord.
Most bones that protect delicate organs are curved in shape in order to withstand greater force before collapsing.
iv. They produce blood cells such as red blood cells, phagocytes and platelets.
v. They store important minerals such as calcium and phosphorus required by the body for metabolic processes.

KINDS OF SKELETON

There are three major kinds of skeleton. These are:

Hydrostatic skeleton.
Exoskeleton.
Endoskeleton.

HYDROSTATIC SKELETON.

It is a kind of skeleton that consists of a fluid (watery solution) filled in a closed cavity.
This skeleton is found in soft bodied animals such as worms.
A worm has a cavity called **coelom** that is filled with a fluid called **coelomic fluid**.
Coelom is surrounded by two sets of muscles. These are:

Longitudinal muscles that run down the length of the worm
Circular muscles that run around the circumference of the worm

How an earthworm moves.

Earthworm moves using its longitudinal and circular muscles.
When longitudinal muscles contract and circular muscles relax coelomic fluid is squeezed and the worm becomes short and thick. When circular muscles contract and longitudinal muscles relax, coelomic fluid is also squeezed and the worm becomes long and thin. These cyclic changes in shape of the worm due to contraction and relaxation of circular and longitudinal muscles allow a worm to move from one place to the other.

EXOSKELETON.

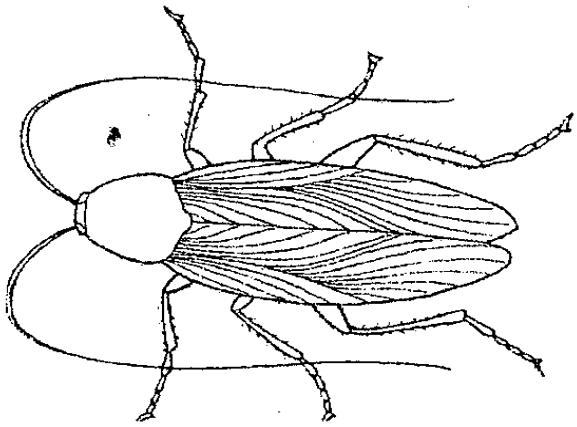
It is the hard substance that covers outer parts of the animal.
This skeleton is found in arthropods such as insects, millipedes, crustacean, centipedes and arachnids.
Exoskeleton is made up of chitin and calcium. Chitin is a polysaccharide that contains nitrogen.
Exoskeleton provides maximum protection to the body of the arthropod as every part of its body is covered.

Problems with exoskeleton.

i. It limits movement.
ii. It limits growth as it is very hard to be stretched.

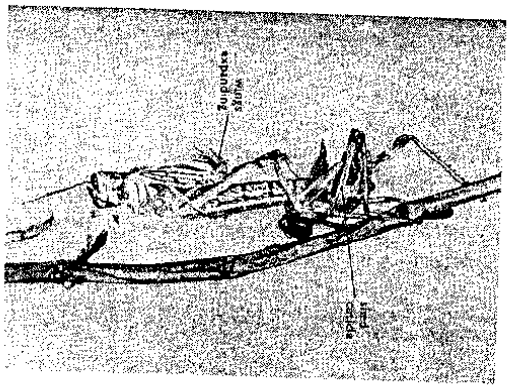
Solutions to the problems associated with exoskeleton

The skeleton of the arthropod has several joints and muscles that move the body parts are around the joint. These muscles are attached to the inner surface of the exoskeleton. This ease movement in insects.



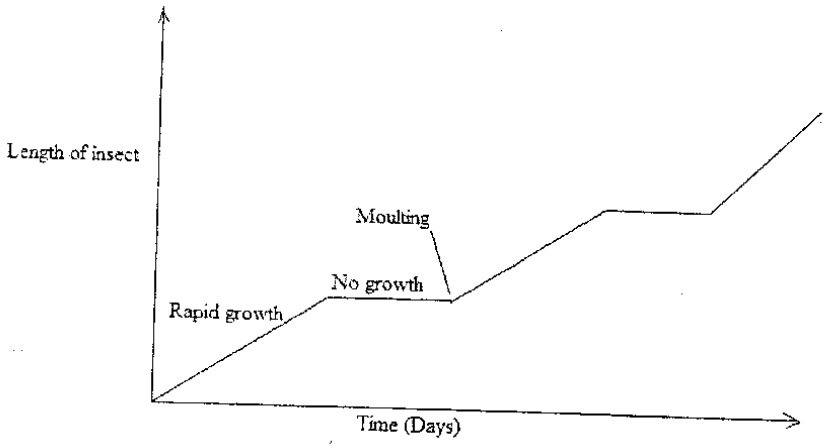
Arthropods shed their old exoskeleton and replace it with new larger one.

The process by which arthropods shed/remove old exoskeleton is called **moulting** or **ecdysis**. After moulting, the animal grows rapidly as the new exoskeleton is very soft. When the new exoskeleton becomes hard, growth stops until the time of next shedding.



Moulting also leaves an animal unprotected as such most animals hide after moulting until the new exoskeleton hardens.

GRAGH SHOWING GROWTH OF AN INSECT.



FLIGHT IN INSECTS.

Flight in insects is achieved by two pairs of muscles found at its thorax. These are:

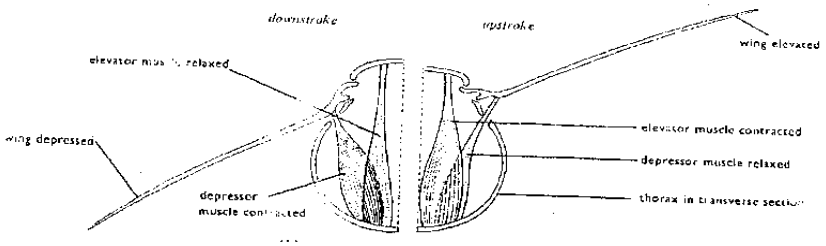
i. Depressor muscles.
ii. Elevator muscles.

Depressor muscles are joined to the base of a wing whereas elevator muscles are joined to the tergum (roof of the thorax)

When depressor muscles contract and elevator muscles relax, the wing is pulled downwards.

When elevator muscles contract and depressor muscles relax, the tergum is pulled downwards, which in turn pull the wing upwards. The upward and downward beat of the wing help an insect to fly.

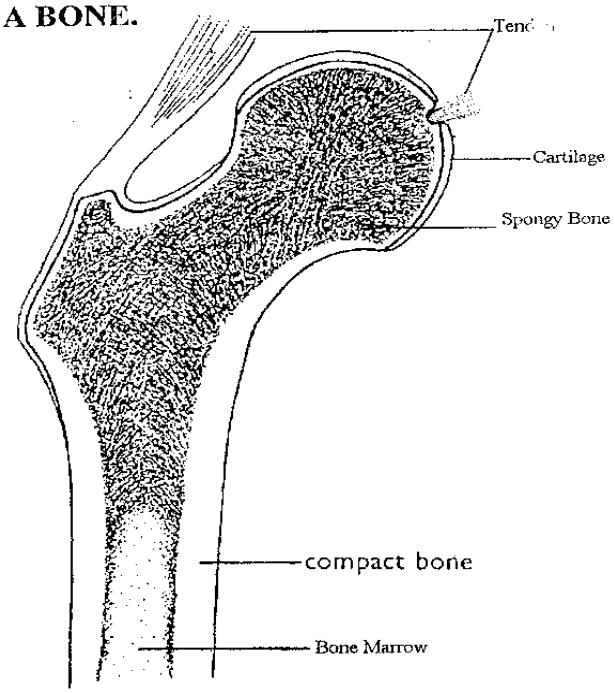
THE CROSS SECTION OF THE THORAX OF INSECT.



ENDOSKELETON.

It is a skeleton that forms an internal supporting unit of the body.
Endoskeleton is found in vertebrates such as mammal, fish, amphibians, reptiles and birds.
Endoskeleton consists of bones and cartilage. In endoskelcton, muscles are attached to the outer surface of the bone.

STRUCTURE OF A BONE.



PARTS OF A BONE AND THEIR FUNCTIONS.

CATILAGE.

It is the soft and smooth tissue that covers bone ends.
Cartilage reduces friction when bones move over each other.

SPONGY BONE.

It is part of the bone that has several air spaces.
Spongy bone makes the bone light for easy movement.

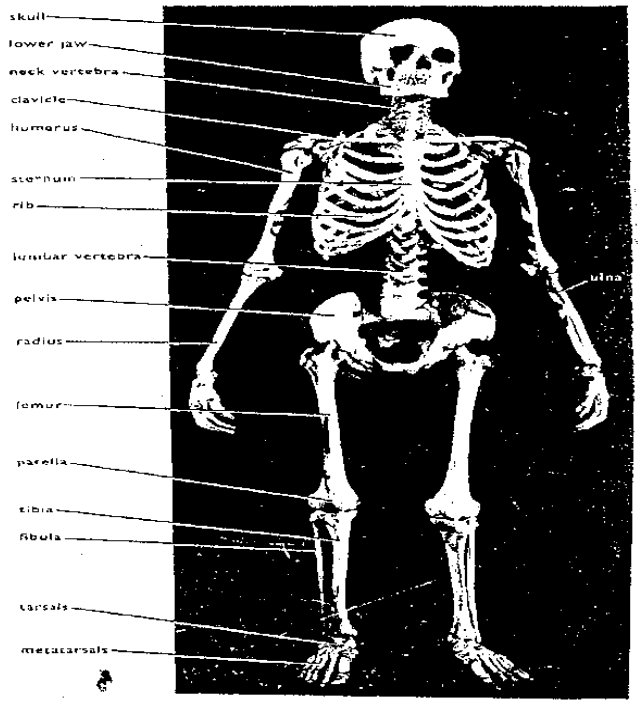
COMPACT BONE.
It is the hard part of the bone.
Compact bone gives strength to bone so that it should not break easily.

BONE MARROW.
It is the soft tissue found at the centre of the bone.
Bone marrow produces blood cells such as red blood cells, platelets and phagocytes.
Bone marrow also provides nutrients to bone cells.

TENDON.
It a soft but tough tissue that grows from compact bone.
Tendon joins a bone to a muscle.

COMPOSITON OF A BONE.
A bone contains both organic and inorganic substances.
Organic substance of a bone is a protein called **collagen**.
Collagen is flexible and elastic.
Inorganic substances of the bone are minerals such as calcium and phosphorous.
Inorganic substances make a bone hard and strong.
When a bone is dipped in dilute acid, it becomes flexible because acid dissolves mineral salts from the bone.

HUMAN SKELETON.



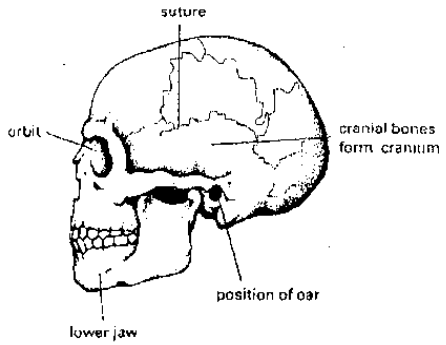
Human skeleton is divided into two main parts. These are:
Axial skeleton.
Appendicular skeleton.

AXIAL SKELETON.

It is part of human skeleton that forms the main axis (centre) of the body.
Axial skeleton consists of the following:

i. Skull.
ii. Rib cage.
iii. Vertebral column.

HUMAN SKULL.

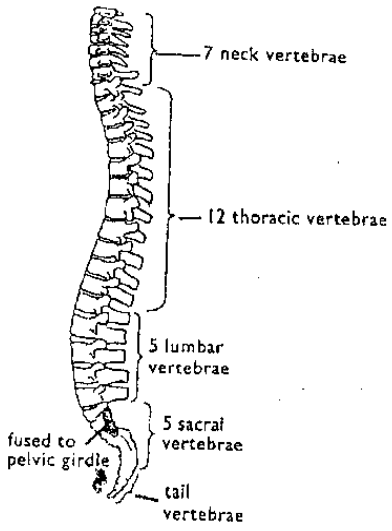


Human skull is made up of facial bones and cranium. Bones that form cranium are fused together by fixed joints or sutures.
Skull protects the brain, eye ball and inner parts of the ear.

RIB CAGE.

It consists of ribs, sternum and thoracic vertebrae.
Ribs are joined to sternum by costal cartilage that reduces friction between ribs and sternum during breathing.
Rib cage protects lungs, heart, liver and oesophagus.

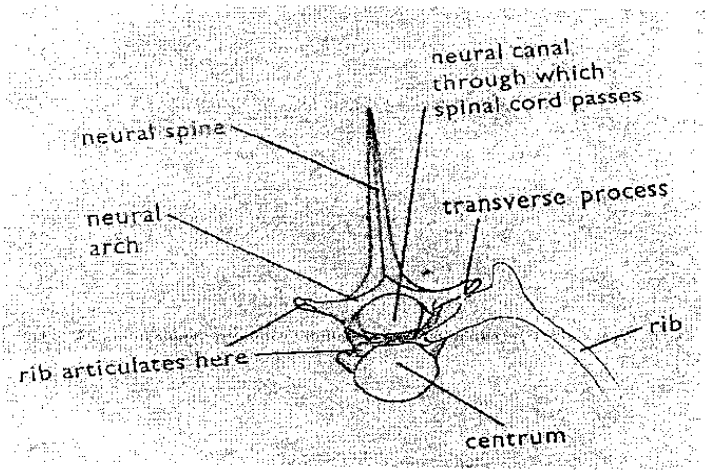
VERTEBRAL COLUMN.



DESCRIPTION OF VERTEBRAL COLUMN

It is a chain of bones that lie at the back.
Vertebral column forms the main axis of the body to which other bones get attached by muscles or ligaments.
Vertebral column consists of 33 individual bones called **vertebrae.**
Vertebrae are joined together by a disc of cartilage called **intervertebral disc.**
Intervetebral disc reduces friction between vertebrae and spread load between bones (shock absorber).
Vertebrae are held together by tough and elastic ligament.

STRUCTURE OF VERTEBRA.



PARTS OF VERTEBRA AND THEIR FUNCTIONS

i. Neural spine and transverse process
Used for muscle and ligament attachment.
ii. Neural canal.
It is the passage of spinal cord.
iii. Centrum.
It resists compression.
iv. Facets.
Used for articulating (joining) with neighboring bones.

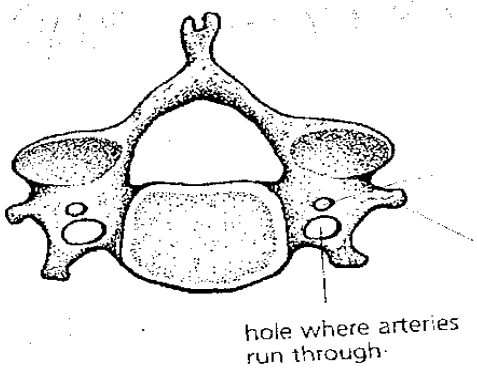
Groups of vertebrae.
Vertebrae are divided into five groups according to their position.
These are:

i. Cervical vertebrae.
ii. Thoracic vertebrae.
iii. Lumbar vertebrae.
iv. Sacral vertebrae.
v. Caudal vertebrae.

CERVICAL VERTEBRAE.

These are seven vertebrae that form a neck.
The top most cervical vertebra is called is called **atlas.**
The one next to atlas is called **axis**

Structure of cervical vertebra.



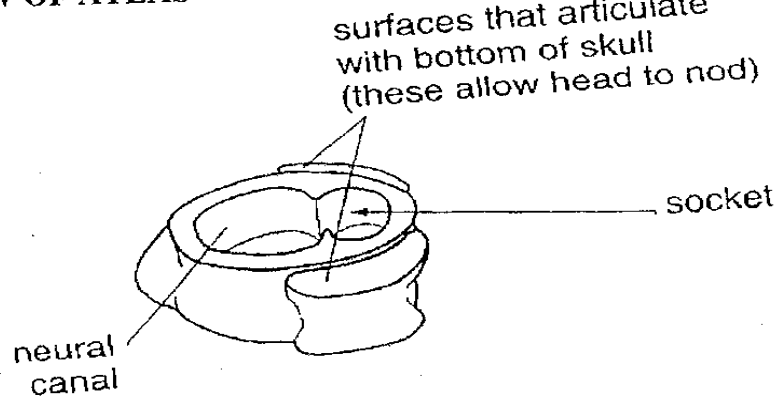
Characteristics of cervical vertebrae.

They have small neural spine, Centrum and transverse process.
They have wide neural canal to accommodate the size of the spinal cord.
They have facets.

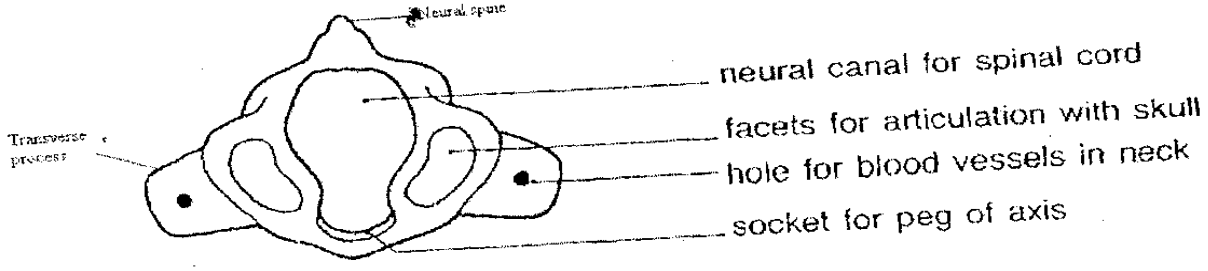
ATLAS.

It is the top most cervical vertebra.
Atlas has facets that articulate with the skull to allow nodding of the head.

SIDE VIEW OF ATLAS



TOP VIEW OF ATLAS



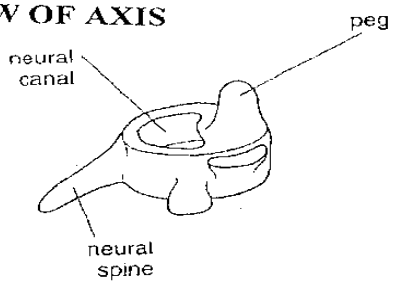
Characteristics of atlas.

i. It has broad and flat transverse process.
ii. It has wide neural canal that accommodates the size of spinal cord.
iii. It has small neural spine and no centrum.
iv. It has a socket that allows the peg of axis to fit into.

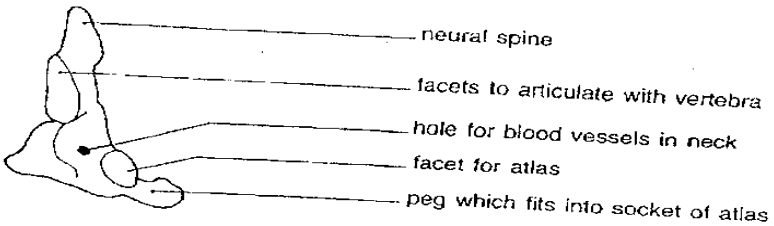
AXIS.

It is the second cervical vertebra.

TOP VIEW OF AXIS



SIDE VIEW OF AXIS



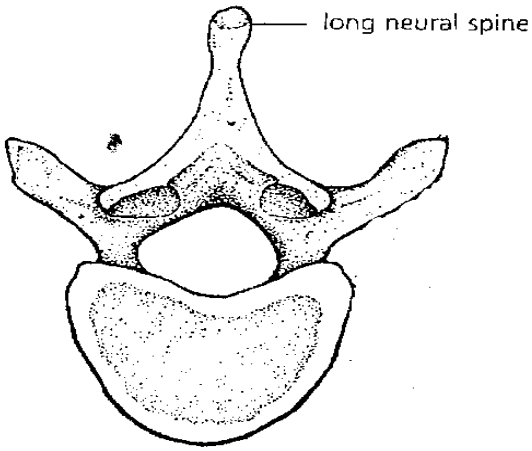
Characteristics of axis

It has broad centrum with a stout projection called **odontoid peg.**
Odontoid peg fits into a socket on atlas to form pivot joint.
Pivot joint allows rotation of the head.

THORACIC VERTEBRAE.

These are twelve vertebrae that form part of rib cage.

Structure of thoracic vertebra.



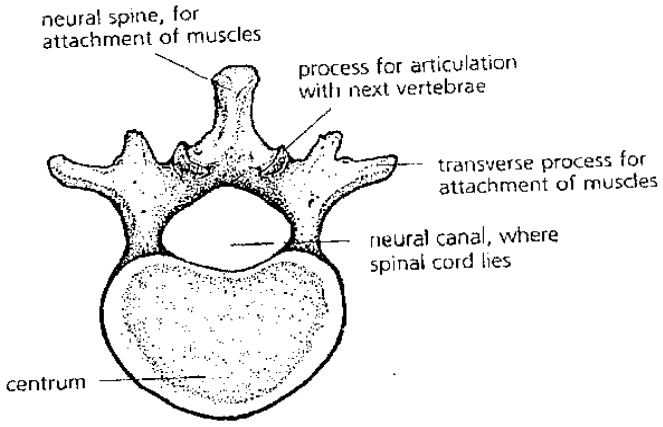
Characteristics of thoracic vertebra

i. It has long neural spine and transverse process.
ii. It has two pairs of facets on its side that articulate with a pair of ribs.

LUMBAR VERTEBRAE.

These are five vertebrae that form lumbar region (waist)

Structure of lumbar vertebra.



Description of lumbar vertebra.

It has large Centrum to resist compression by spreading force on large surface area.

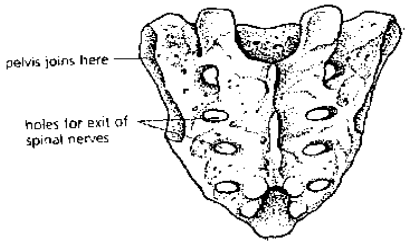
Functions of lumbar vertebrae.

i. They support heavy weight of the body as such they have large centra.
ii. They also protect delicate organs such as kidneys and intestine.
iii. They provide an area for powerful muscle attachment used during birth.

SACRAL VERTEBRAL

These are five vertebrae that are fused together to form a sacrum.
Sacrum is found at the base of the vertebral column.

Structure of sacrum



CAUDAL VERTEBRAE.

These are four vertebrae that are fused together to form a small piece of bone called coccyx (tail)
In humans, the tail is reduced to a very small piece of bone that hangs from sacrum.

FUNCTIONS OF VERTEBRAL COLUMN.

i. It protects spinal cord from external physical damage.
ii. It provides points of attachment for pelvis and rib cage.
iii. It supports weight of the body and keeps it upright.

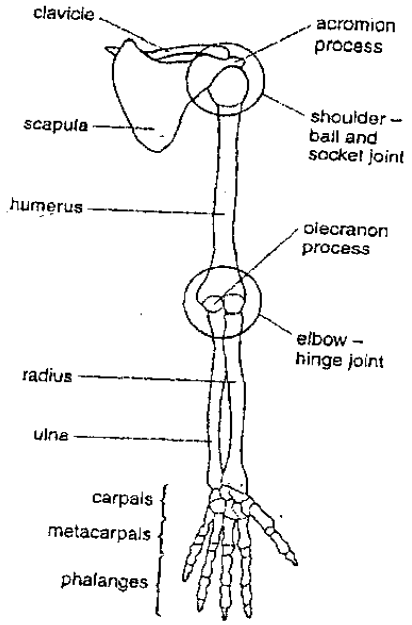
ADAPTATIONS OF VERTEBRAL COLUMN TO ITS FUNCTIONS.

i. It has hard centra that resist compression.
ii. It is S shaped, which makes it flexible and support heavy mass.

APPENDICULAR SKELETON

It is part of human skeleton that forms appendages/ limbs.
Limbs/ appendages are body structures used for movement.
Appendicular skeleton consists of pectoral girdle and pelvic girdle.
Girdles join limbs (arms and legs) to vertebral column.

FORE LIMB

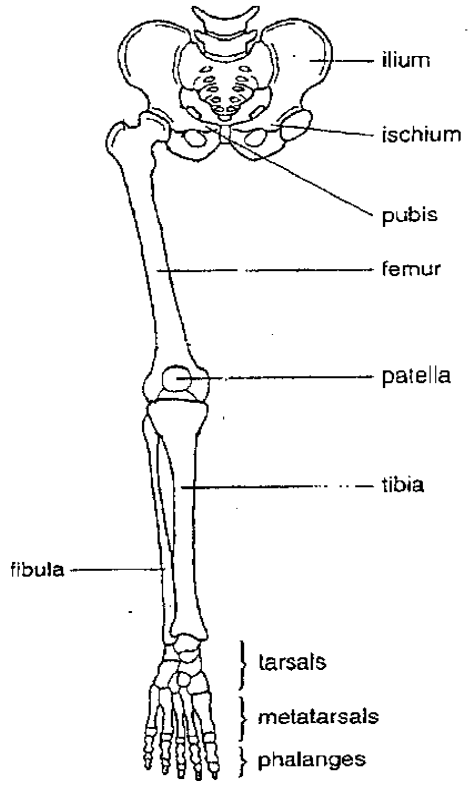


Description of fore limb.

It consists three arm bones and the hand. The fore limb is joined to pectoral girdle.
Pectoral girdle consists of scapula and clavicle.
Clavicle joins scapula to sternum.
Scapula is the triangular flat bone attached to vertebral column by muscles.
Scapula has a spine on its dorsal surface for muscle attachment.
At the end of scapula, there is a cavity called glenoid cavity where the ball of humerus fits into to form shoulder joint.
Pectoral girdle is able to move freely because it is joined to vertebral column by slings of muscles.
The arm of human being consists of three bones (humerus, ulna and radius)
Humerus forms the upper part of the human arm. The upper part of humerus has a ball that fits into glenoid cavity of scapula where as the lower end of humerus has a roller shaped surface called trochlea, which articulates with ulna and radius.
Radius and ulna form lower part of the arm. Ulna is larger than radius.

The upper end of ulna is broader and has a projection called olecranon process, which fits into a hollow at the back of the humerus when the arm is stretched.
The wrist has small bones called carpals where as the palm of the hand has metacarpals.
Fingers have phalanges.

The hind limb.



DESCRIPTION OF HIND LIMB

It consists of three leg bones and the foot. Hind limb is joined to pelvic girdle.
Pelvic girdle fuses into sacrum of the vertebral column as such its movement is restricted.
Pelvic girdle protects urinary bladder, rectum and female reproductive organs.
The three leg bones are femur, tibia and fibula.
Femur is the longest bone in the human body. The upper end of femur has rounded head that fits into a cavity on pelvic girdle to form hip joint.
The lower end of femur rests on tibia to form knee joint. In front of knee joint, there is patella that prevents over-stretching of knee joint.
Tibia and fibula form the lower leg. Tibia is larger than fibula
Foot bones consist of the following:

Tarsal -form ankle.
Metatarsal – form the foot.
Phalanges - form fingers.

ADAPATATIONS OF LONG BONES FOR MOVEMENT.

i. Long bones are hollow. This reduces weight of the bone.
ii. Bone marrow of long bones is surrounded by rings of bones that make bone strong.

JOINTS.

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

KINDS OF JOINTS.

i. Fixed joint.
ii. Sliding joint.
iii. Hinge joint.
iv. Ball and socket.
v. Pivot joint

FIXED JOINT.

It is a joint in which bones are fused together such that movement is limited.

Examples of fixed joints.

i. Sutures of the skull.
ii. Joints between pelvic girdle and sacrum.

SLIDING/GLIDING JOINT.

It is a joint in which flat surface of bones slide over each other.

Examples of sliding joints.

i. Joints between vertebrae.
ii. Wrist joint.
iii. Ankle joint

HINGE JOINT

It is a joint that allows movement in one plane only.
Hinge joint allows movement up to 180^0

Examples of hinge joint.

i. Elbow joint.
ii. Knee joint.

BALL AND SOCKET JOINT.

It is a joint in which the head of one bone fits into a cavity of another bone.
Ball and socket joint allows movement in all planes (360^0)

Examples of ball and socket joint.

i. Hip joint.
ii. Shoulder joint.

PIVOT JOINT.

It is a joint in which one bone rotates on the hole of the other bone.

Examples of pivot joint.

Joint between atlas an axis on the vertebral column.

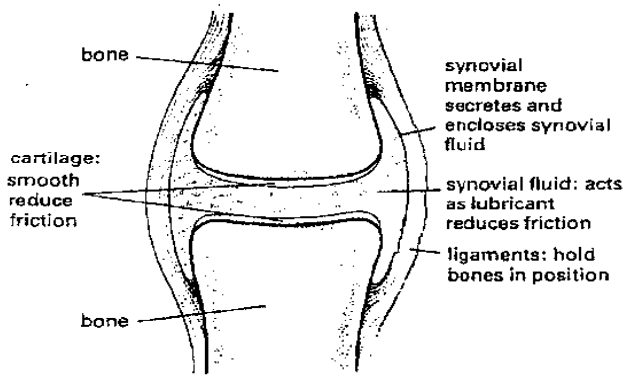
SYNOVIAL JOINTS.

These are joints that have synovial fluid, which reduces friction during movement.

Examples of synovial joints.

i. Ball and socket joint
ii. Hinge joint.

STRUCTURE OF SYNOVIAL JOINT.



Parts of synovial joint and their functions.

Ligament .

It binds bones together at a joint.

Cartilage.

It reduces friction when bones move over each other.

Synovial membrane.

It stores and secretes synovial fluid.

MUSCLES.

Muscles are flesh part of the body. There are made up of special tissues that have ability to contract and relax when working.

Muscles consist of muscle fibers. When muscles contract, fibers become short and thick whereas when muscles relax, fibers become long and thin.

KINDS OF MUSCLES.

i. Smooth muscles.
ii. Cardiac muscles.
iii. Skeletal muscles.

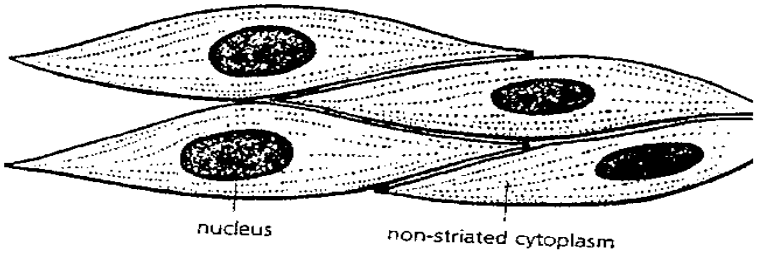
SMOOTH MUSCLES.

These are muscles that form wall of blood vessels and alimentary canal.

Smooth muscles have no cross striations in their fibers.

Smooth muscles are also called involuntary muscles because they work without the conscious control of the person.

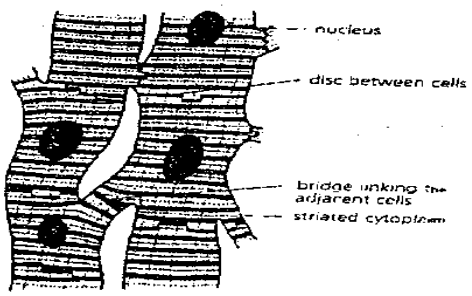
STRUCTURE OF SMOOTH MUSCLES.



CARDIAC MUSCLES.

These are muscles that form wall of the heart.
Cardiac muscles have faint cross striations in their fibers.
Fibers that form cardiac muscles are branched to increase strength of muscle fibers.
Cardiac muscles contract and relax rhythmically through out life time of the person without resting.

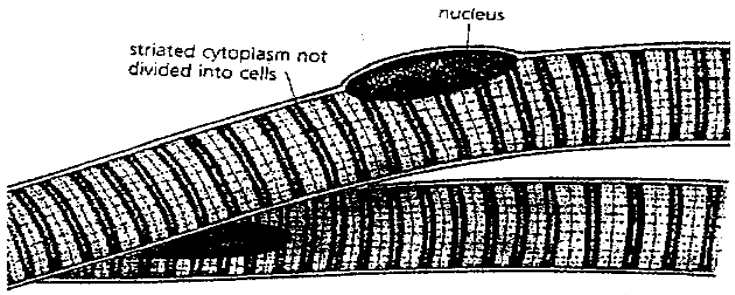
STRUCTURE OF CARDIAC MUSCLES.



SKELETAL MUSCLES.

These are muscles that move bones/skeletons in the body.
Skeletal muscles move bones by pulling them when they contract. These muscles have two ends; one end is attached to immovable bone thus **origin** where as the other end is attached to movable bone and thus **insertion**. When skeletal muscles contract, they become short and thick whereas when they relax, they become long and thin.
Skeletal muscles are called voluntary muscles become they work at will (working under conscious control of the person)
Skeletal muscles have cross striations in their fibers as such they are called **striated muscles**.

STRUCTURE OF SKELETAL MUSCLES.



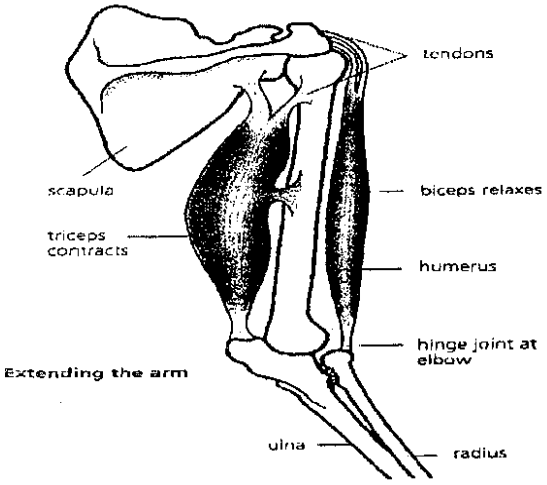
HOW SKELETAL MUSCLES WORK.

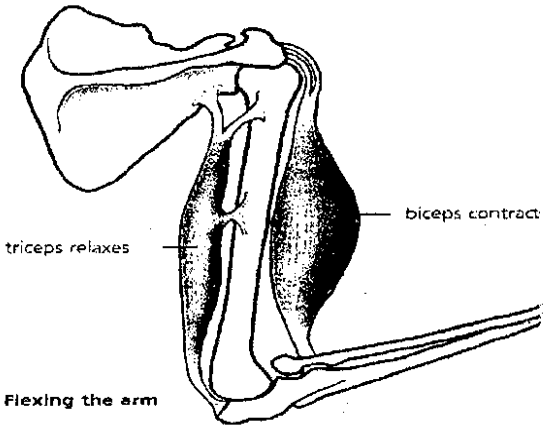
Skeletal muscles work in pairs. One set of muscles contract when the other set relaxes. A pair of muscles in which one contracts when the other muscles relax is called **antagonistic muscles**.

Examples of antagonistic muscles.

Biceps and triceps muscles.
Internal and external intercostal muscles.

Human arm showing biceps and triceps muscles.





LEVERS.

A lever is a bar that rotates on a fixed point.
A fixed point is called **fulcrum**.
When levers work, they lift objects called **load** and the force called **effort** is needed to lift a load.
In the body, bones, joints and muscles work as a lever. In this case, joints work as fulcrum; bones work as load and muscles work as effort.

KINDS OF LEVERS.

First order lever.

It is a lever in which the **fulcrum** is found between load and effort.

Examples.

Seesaw.
Nodding of the head.
Straightening an arm.

Second order lever.

It is a lever in which **load** lies between fulcrum and effort.

Examples.

Wheelbarrow.
Extending ankle joint.

Third order lever.

It is a lever in which **effort** lies between load and fulcrum.

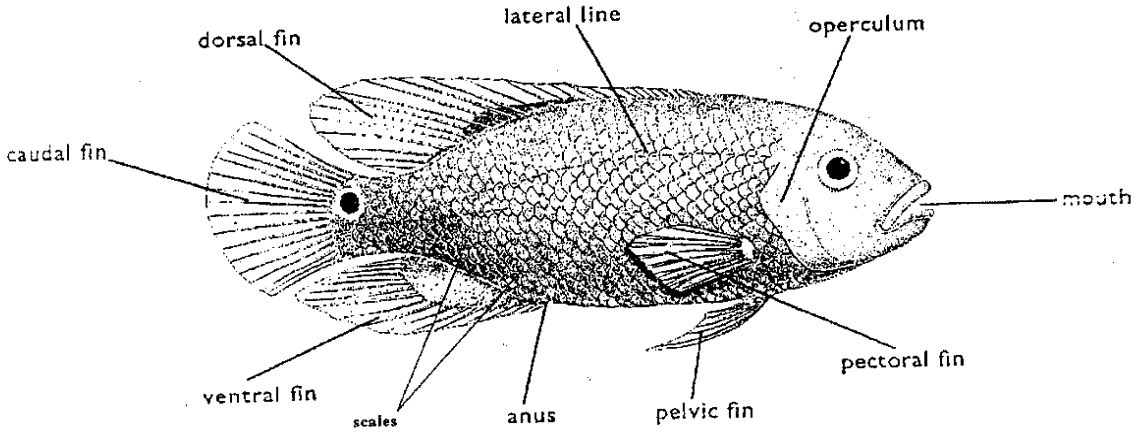
Examples.

Forceps.
Flexing elbow joint.
Flexing jaw joint.

LOCOMOTION IN FISH.

Fish moves in water using its fins. Parts of fish's body used for movement are called locomotory structures of fish.

LOCOMOTORY STRUCTURES OF FISH.



Tilapia

How fish moves.

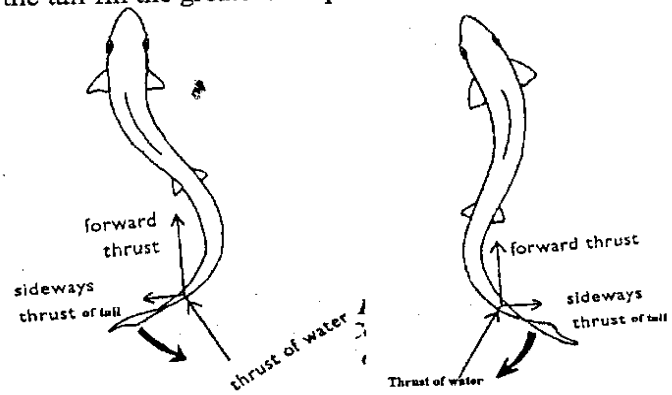
Movement of the fish is mainly brought about by the tail of the fish with the assistance from block muscles.

Block muscles are muscles that form the body of the fish. These muscles are zigzag in shape.

When block muscles contract alternately in series, they pull the body from side to side, which produces the wave like movement, which is transmitted backwards to the tail.

This wave makes the tail to flap from side to side and backwards causing water to produce equal and opposite force. The two sideways forces cancel each other leaving the forward thrust that propels the fish forward.

Note: The larger the tail fin the greater the speed of the fish.



Paired fins help the fish to adjust its speed or to change its direction.
When paired fins are held to side of fish's body, the fish becomes more streamlined and its speed increases whereas when paired fins are extended, the fish is slowed down.
When fish extends paired pectoral and pelvic fins on one side the fish turns towards the side where fins are extended as the movement of water on this side is slowed down.
Paired fins can also steer the fish forward when it is moving slowly.

ADAPTATIONS OF A FISH FOR SWIMMING.

i. Fish has streamlined body that reduces drag in water.
ii. It has a tail that propels the fish forward when it moves side to side.
iii. It has flexible vertebral column that allows side to side movement of the body.
iv. It has paired fins that steers the fish forward when moving slowly.
v. It has swim bladder that helps to adjust depth of the fish. When the bladder is filled with air the fish becomes less dense and it floats and when the bladder is empty, the fish becomes denser and it sinks.
vi. It has scales that overlap backwards and are covered with mucus that reduces drag.

LOCOMOTION IN BIRDS.

Birds are the most successful animals on earth because they can walk, fly and swim.

Flight in birds.

Birds can fly in two ways. These are:

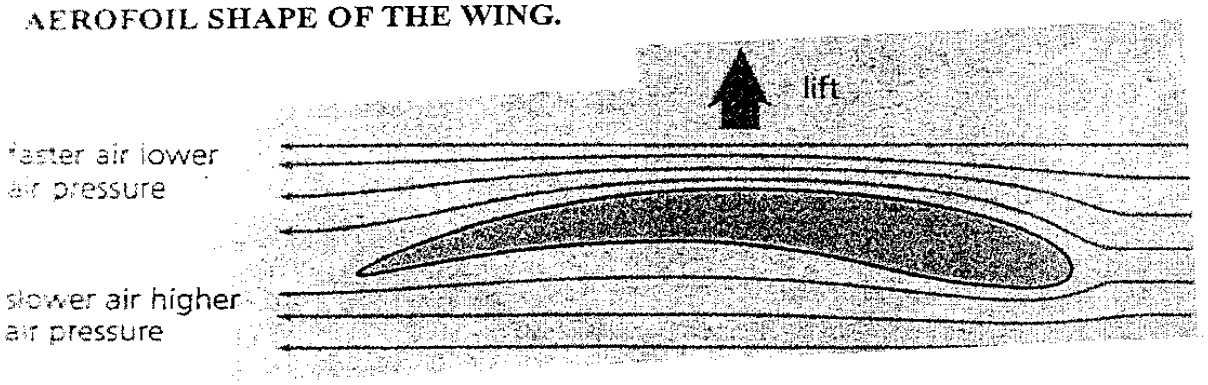
i. Gliding
ii. Flapping.

GLIDING.

(*a*) Wings and tail outspread. Uplift from air currents or by losing height.

Gliding is a flight in which a bird extends its wings and tail when flying.
Gliding is made possible because of the aerofoil shape of the wing (wing with curved upper surface)
Aerofoil makes air to move faster on the upper surface of the wing than its lower surface. This creates higher air resistance on the lower surface of the wing than its upper surface as a result the bird is lifted upwards.

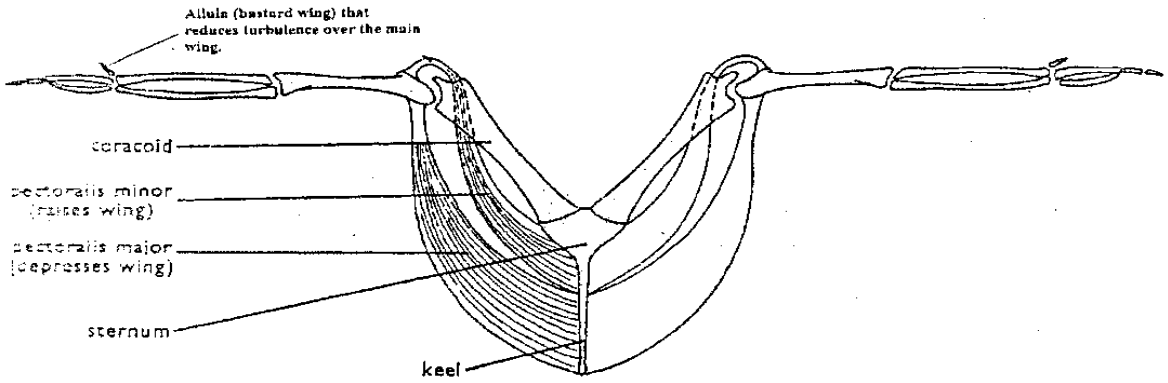
AEROFOIL SHAPE OF THE WING.



FLAPPING

It is a flight in which birds move their wings up and down during flight.
The lowering of the bird wing is called **down stroke** or **down ward beat.**
The raising of the wing is called **up stroke** or **upward beat.**
Flapping in birds is brought about by two pairs of chest muscles called **pectoris muscles**
Each wing has pectoris minor or elevator and pectoris major or depressor.
Pectoris major and pectoris minor are antagonistic muscles.

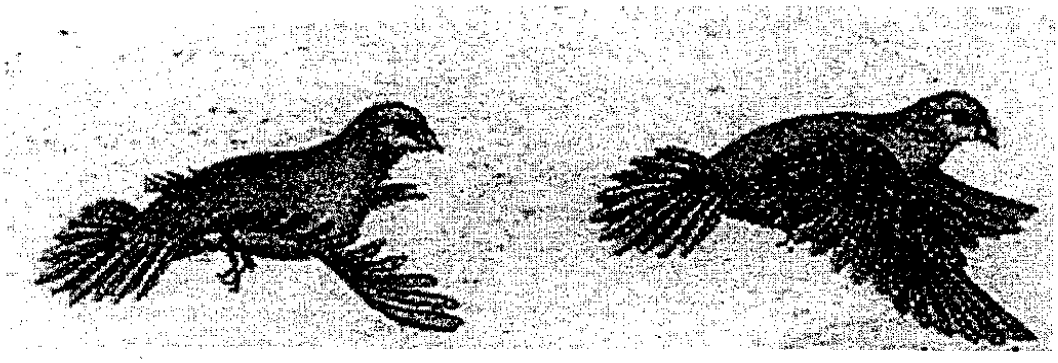
CROSS SECTION OF BIRD CHEST.



DOWN STROKE.

It is the lowering down of the wing.
Down stroke is also called power stroke as it provides power for lift and thrust (forward force)
During down stroke the wing beats downwards and forward.
This occurs because pectoris major muscles contract where as pectoris minor muscles relax and pull the wing downwards.

During down stroke wings extend to provide large surface area against air and feathers overlap so that air should not pass through the feathers. This creates higher air resistance below the wing than above the wing which brings up thrust force that lifts the bird upwards.



UPSTROKE. (RECOVERY STROKE)

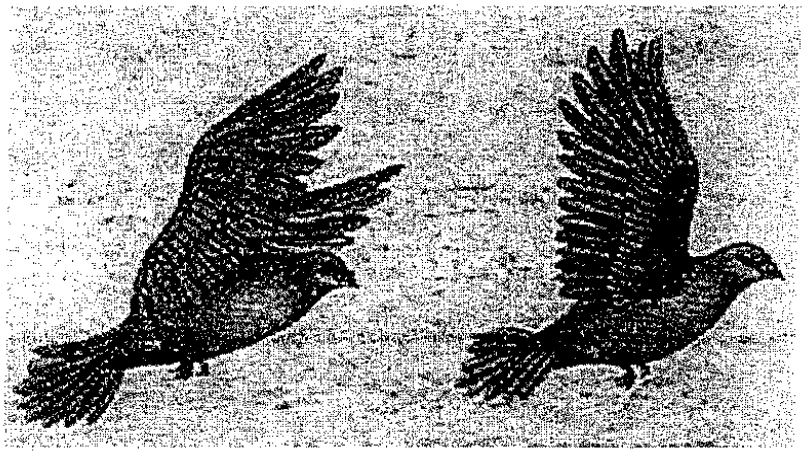
It is the raising up of the wing.

During upstroke the wing moves upwards and backwards.

This occurs because pectoris minor muscles contract where as pectoris major relax and pull the wing upwards.

During up stroke feathers become loose such that air passes through. This reduces air resistance below a wing as a result up thrust force disappears and the bird is pulled downwards by gravity.

Upstroke is also called recovery stroke because the wing appears to return to its starting position ready for next flap..



LOCOMOTORY STRUCTURES OF THE BIRD.

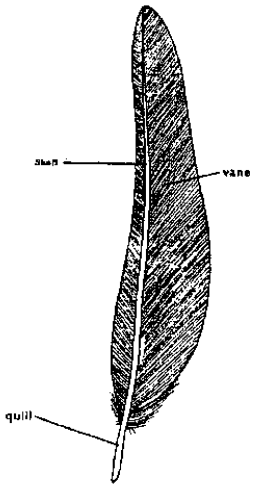
Birds use wings for flight.

Wings have feathers that increase surface area for flight.

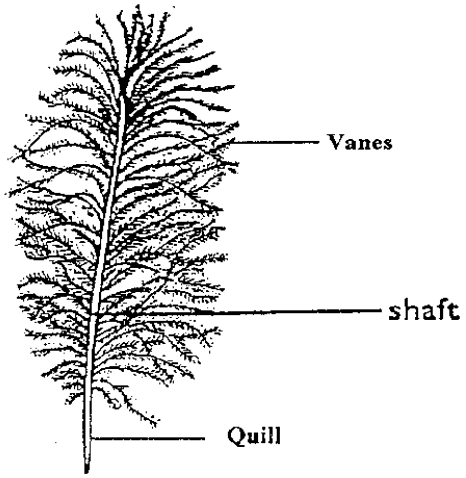
Feathers that are directly attached to the wings are called **flight feathers** as they are involved in flight of the bird.

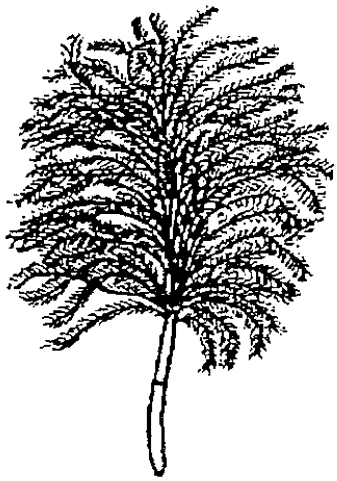
Feathers that cover the rest of the body are called **down feathers.**

FLIGHT FEATHER.



DOWN FEATHERS.





DIFFERENCES BETWEEN FLIGHT AND DOWN FEATHERS.

FLIGHT FEATHER	DOWN FEATHER.
Used for flight.	Insulate the body.
Has large quill	Has small quill.
Has tough vanes	Has soft vanes
Vanes are close together	Vanes are far apart
Has even margin.	Has uneven margin.

ADAPTATIONS OF FLIGHT FEATHER FOR FLIGHT.

i. Flight feather has large surface area that reduces density of the bird.
ii. It is hollow that reduces density of the bird.
iii. It has tough vanes that can withstand high air pressure.
iv. It is streamline in shape that creates aerofoil of the wing.

PROBLEMS FACED BY BIRDS DURING FLIGHT.

i. Drag (air resistance).
ii. Gravitation force.
iii. Low temperature at high altitude.

ADAPTATIONS OF BIRD FOR FLIGHT.

i. It is streamline in shape to reduce drag.
ii. The wing of the bird forms an aerofoil that creates a lift.
iii. Birds have powerful pectoris muscles that provide energy for flapping.
iv. The sternum of the bird has a keel that provides an area for breast muscle attachment.
v. Wing of the bird has feathers that increase surface area for flight.
vi. Its body temperature is slightly higher than the body temperature of mammals to overcome cold at high altitude.
vii. Feathers of the bird trap air for insulation when it is cold.
viii. Birds are light (less dense than air) to overcome gravitation force.

FACTORS THAT REDUCE THE DENSITY OF THE BIRD.

i. Hollow bones.
ii. Large surface area of the wing.
iii. Air sacs that protrude from lungs. These air sacs also provide more oxygen for respiration as flight needs more energy.

TOPIC 9: COORDINATION.

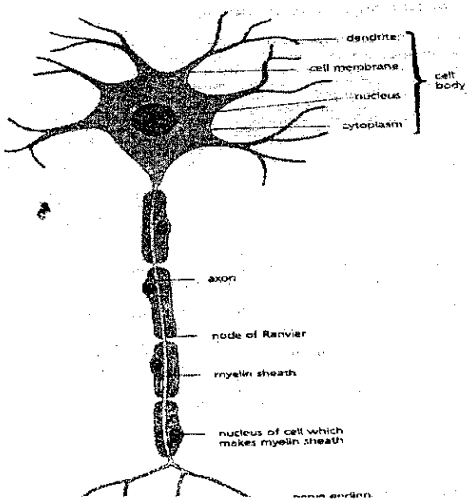
Coordination means the linking together of different processes in the body.
It is brought about by two body systems. These are:

Nervous system.
Endocrine system.

NERVOUS SYSTEM.

It is the system in which messages travel electrically in nerves.
A nerve consists of several nerve fibers that are grouped together. Nerve fiber is made up of a nerve cell called **neurone.**

STRUCTURE OF A NEURONE.



DESCRIPTION OF PARTS OF THE NEURONE.

Dendrites.
These are short fibres that project from the cell body of the neurone.
Dendrites conduct impulses from the neighboring neuron towards the cell body.

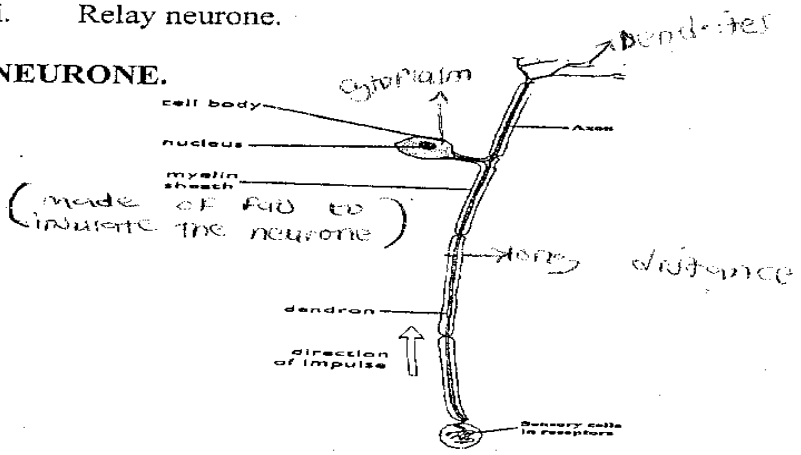
Axon.
It is the longest nerve fibre that project from the cell body.
Axon conducts impulses from the cell body towards the neighboring neurone.
Axon is wrapped in fatty layer called **myelin sheath.**
Myelin sheath insulates the axon so that impulses should travel faster.

Cell body.
It is part of the neurone that has a nucleus.
Cell body interprets sensory impulses and initiates response.

THREE KINDS OF NEURONES.

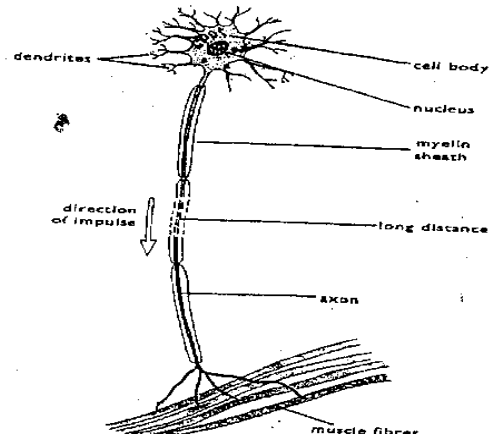
i. Sensory neurone.
ii. Motor neurone.
iii. Relay neurone.

SENSORY NEURONE.



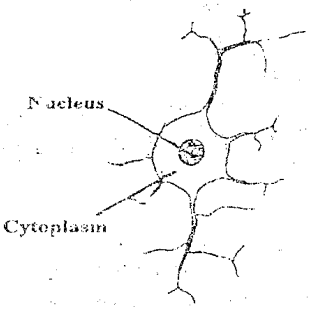
Description of sensory neurone.
It is a neurone that conducts impulses from receptors (sense organs) to the central nervous system
It has cell body along its axon.
It has dendrion

MOTOR NEURONE.



Description of motor neurone.
It is a neurone that conducts impulses from central nervous system to the effectors (Muscles and Glands)
It has cell body at the end of its axon.
Its dendrites are joined directly to its cell body.

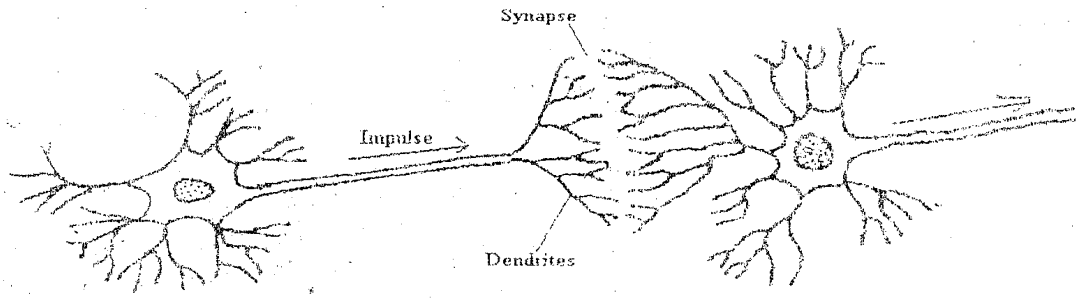
RELAY NEURONE.



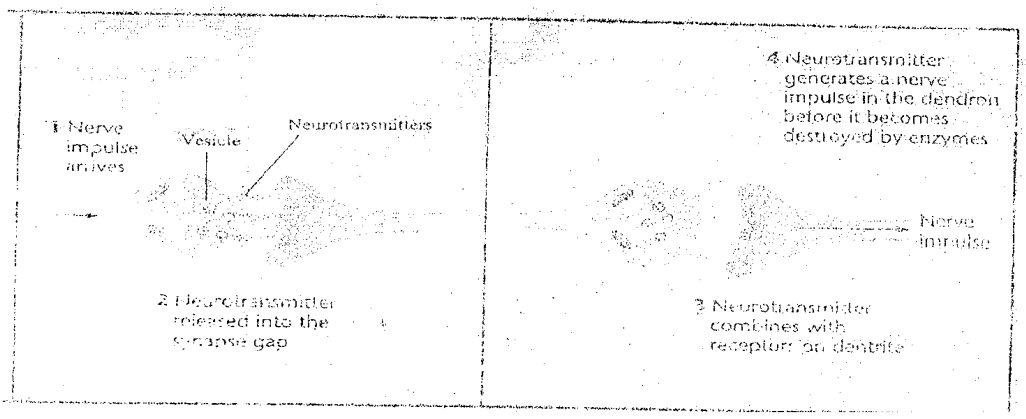
Description of relay neurone.
It is a neurone that conducts impulses from sensory neurone to the motor neurone.
It is found in the central nervous system.
It has cell body at middle of the neurone.
It has dendrites on both sides of the neurone.

SYNAPSES
These are microscopic gaps between dendrites of two neurons.
Synapses allow impulses to travel in one direction.
They also filter out weak and unwanted stimuli.

Diagram showing synapse

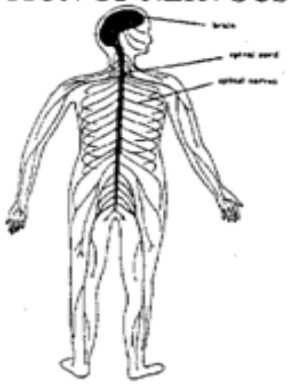


HOW IMPULSES TRAVEL ACROSS SYNAPSE.



Axon of the neurone has vesicles that contain chemicals called **neurotransmitters** such as **acetylcholine.**
When an impulse reaches the end of the axon, vesicles burst and release neurotransmitters into a synapse.
These neurotransmitters diffuse across synapse towards the membrane of the next neurone. When neurotransmitters touch the membrane of the next neurone, an impulse similar to the one in the previous neurone is produced and conducted away. The neurotransmitters are then destroyed by the enzymes.

DESCRIPTION OF NERVOUS SYSTEM.



THREE MAIN PARTS OF NERVOUS SYSTEM

Central nervous system (CNS)- consists of brain and spinal cord.

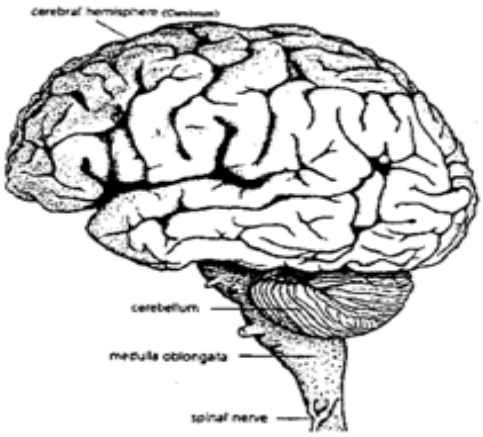
Peripheral nervous system- consists of nerves that conduct impulses from receptors to CNS and from CNS to effectors.

Autonomic nervous system- controls involuntary action such as breathing rate and heart rate

CENTRAL NERVOUS SYSTEM.

It is part of nervous system that consists of brain and spinal cord.
Central nervous system interprets sensory messages and initiates response.

STRUCTURE OF THE BRAIN.



DESCRIPTION OF THE BRAIN.

It is part of central nervous system that lies in the skull.
Brain is divided into three parts. These are:

i. Cerebrum.
ii. Cerebellum.
iii. Medulla oblongata.

CEREBRUM.

It is the largest and fore most part of the brain.
Cerebrum is divided into two halves which are called cerebral hemispheres.
Each hemisphere has three different parts of areas. These are:

Sensory area; that receives messages from sense organs such as eyes, skin and tongue.
Motor area; that sends messages to effectors such as muscles and glands.
Association area; that stores information from past experiences.

TWO LAYERS OF CEREBRUM.

Grey matter.
It is the outer layer of the brain.
Grey matter is concentrated with cell bodies of neurons.

White matter.
It is the inner layer of the brain.
White matter is concentrated with nerve fibers.

Functions of cerebrum.

The grey matter of the brain controls the following:

i. Speech.
ii. Emotions.
iii. Memory.
iv. Intelligence.
v. Smell.
vi. Vision.
vii. Taste.
viii. Touch.

Cerebrum is adapted to its functions as it is highly folded that increases surface area for the cell bodies.
The folding of the human brain also enables humans to carry out more complex activity that other animals can not do such writing, cycling, driving and digging.

CEREBELLUM.

It is the second largest part of the brain.
It has two layers like cerebrum. These are:

Grey matter. – Outer layer.
White matter. – Inner layer.

Functions of cerebellum.

It controls balance and posture by managing muscle tone.
It coordinates muscles during walking, cycling and running.

MEDULLA OBLONGATA.

It is part of the brain located at the base of the brain.
Medulla oblongata forms the brain stem

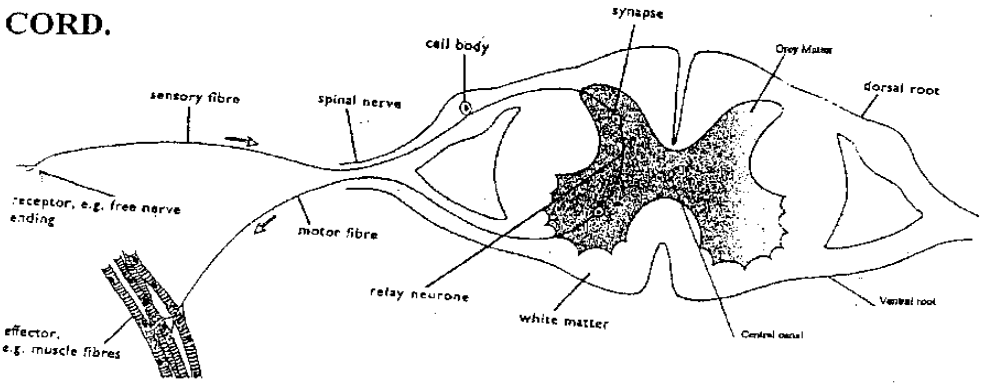
Functions of medulla oblongata.

It controls autonomic processes such as breathing rate, heart rate and blood pressure.
Medulla oblongata has hypothalamus that manages homeostasis (keeping internal environment constant).

How the brain is protected from injuries.

It is protected by cranium of the skull from external physical injuries.
It is surrounded by three membranes called **meninges** that are separated by cerebral spinal fluid which acts as shock absorber.

SPINAL CORD.



DESCRIPTION OF SPINAL CORD.

It is the cylindrical mass of nervous system that begins from medulla oblongata to the end of the vertebral column.
In the vertebral column, spinal cord passes through the neural canal of the vertebrae.
Vertebral column protects spinal cord from external physical damage.
Spinal cord has a hole at its centre **central canal,** which is filled with cerebral spinal fluid. This fluid acts as shock absorber. Cerebral spinal fluid also supplies nutrients to the nerve cells in the spinal cord.

Two layers of spinal cord.

White matter.
It is the outer layer of the spinal cord.
White layer is concentrated with nerve fibers.

Grey matter.
It is the inner layer of the spinal cord.
It is concentrated with cell bodies of the neurons.

SPINAL NERVES.

These are nerves that are joined directly to the spinal cord.
Human being has 31 pairs of spinal nerves.
Each pair has two groups of nerve fibers. These are:
Sensory nerve fibers.
Motor nerve fiber.

Sensory nerve fiber conducts impulses from receptor such as sense organs to the central nervous system (spinal cord)
Motor nerve fiber conducts impulses from central nervous system to effectors such as muscles and glands.
Sensory nerve fiber enters into a spinal cord through a dorsal root where as motor nerve fiber enters a spinal cord through ventral root.

FUNCTIONS OF SPINAL CORD.

i. It conducts sensory impulses from receptors to the brain for interpretation.
ii. It conducts motor impulses from the brain to effectors for response.
iii. It controls reflex actions below the neck e.g. withdrawing a hand from hot object and knee jerk.

REFLEX ACTION.

It is an automatic and immediate response to the stimuli.

Examples of reflex action.

i. Blinking of eyes when an insect fly over it.
ii. Salivation when you see food.
iii. Yawning when tired.
iv. Sneezing and coughing when trachea is irritated.
v. Knee jerk when area around knee is tapped.
vi. Withdrawing a hand from hot object.

KINDS OF REFLEX ACTION.

There are two kinds of reflex action. These are:
i. Simple reflex action.
ii. Conditioned reflex action.

SIMPLE REFLEX ACTION.

It is an inborn behaviour such as blinking of eyes, yawning and knee jerk.

Reflex arc.

It is the pathway of impulses that bring about simple reflex action.

Reflex arc of knee jerk.

i. When a skin around the knee is tapped with sharp object an impulse is produced, which is conducted by sensory neurone to the spinal cord.
ii. The spinal cord interprets the impulse and produces the impulse which is sent to muscles through motor neurone.
iii. When the leg muscles receive the impulse they contract and the leg straightens - thus knee jerk.

* The brain is made aware of each reflex action even if it is not directly involved. This occurs because there are nerve fibres that conduct impulses from sensory side of reflex arc in the spinal cord to the brain and from the brain to the motor side of reflex arc in spinal cord. This awareness enables the person to take proper action, which can't break valuable objects such as glass wares.

CONDITIONED REFLEX ACTION.

It is the reflex action acquired through training or past experience.

Examples of conditioned reflex action.

i. Salivation in dogs when a person touches its plate.
ii. Crying in babies when they see a nurse.
iii. Packing your note books when a knock off bell rings.

HOW CONDITIONED REFLEX DEVELOPS

(With reference to salivation in dogs when a bell rings)

i. Introduce **original stimulus** that brings response e.g. introducing food to dogs that will make it salivating.
ii. Introduce substitute stimulus together with original stimulus in order to induce response e.g. ringing a bell before giving food to the dog makes the dog salivating.
iii. When substitute stimulus and original stimulus are introduced continuously, substitute stimulus on its own brings response. When substitute stimulus only makes an organism to produce response, the organism is said to be conditioned.

DRUGS AND ALCOHOL ABUSE.

A drug is a chemical substance that changes the way body and mind work.
Drugs are usually taken for medical reasons. Some people take drugs for non medical reasons and this situation is called **drug abuse.**

Reasons for drug abuse.

i. To improve sporting performance.
ii. To create mood.
iii. To improve a feeling of well being.

HIDDEN PASSION

Groups of drugs.

Drugs are classified into several groups according to the way they work in the body. These groups are:

i. Pain killers.

These are drugs that suppress part of the brain that register pain. As a result the person does not feel pain when sick or injured. These drugs include; paracetamol, heroine and morphine.

ii. Stimulants.

These are drugs that speed up the action of the brain. These drugs make a person active and more alert. e.g. nicotine, cocaine and caffeine.

iii. Sedatives /depressants.
These are drugs that slow down the actions of the brain. These drugs make the person sleepy and dull e.g. valium and tranquilizer.

iv. Hallucinogens.
These are drugs that cause hallucinations and illusions.
Hallucination is a situation in which a person sees things and hears sounds that don't exist.
Illusion is a situation in which people believe in false impressions or ideas.
Examples of hallucinogens are Indian hemp, LSD and ecstay.

Dangers of drug and alcohol abuse.
i. Drugs lead to addiction. Addiction is a condition in which a person gets used to drugs such that he or she can't do without drugs.
ii. Some drugs disturb a person from sleeping and a person may lose appetite.
iii. Drugs may also increase heart rate and blood pressure.
iv. Drugs may impair judgement and make a person clumsy.
v. They prolong response to stimuli.
vi. They may kill tissues of the brain, liver and kidneys.
vii. They bring misery and distress to many people.

PROBLEMS ASSOCIATED WITH NERVOUS SYSTEM.
i. Stroke.
Stroke is the clot in the brain. It occurs when blood vessels around the brain burst due to high blood pressure.
When blood vessels burst, the spillage of blood accumulates in the brain and kills brain cells around the clot. This makes the organ controlled by the killed brain cells to become paralyzed.
High blood pressure is associated with stress, anxiety, worries, tension and overeating as such every person must avoid them in order to prevent stroke.

ii. Tetanus (lock jaw)
It is a disease in which there is uncontrollable contraction of skeletal muscles.
Tetanus is caused by a bacterium called clostridium tetanai. This bacterium lives naturally in the soil and a person becomes infected when he or she sustains a cut with dirty objects.
The bacteria grow rapidly on covered wounds that have no oxygen, where it releases the powerful toxin which is carried by blood to muscles. This toxin acts as an impulse that stimulates the muscles to contract and remain contracted.
Signs and symptoms of tetanus.
i. Uncontrollable contraction of the skeletal muscles.
ii. Difficult in breathing when intercostal muscles are attacked. This leads to death
iii. Jaws become locked.

Ways of preventing Tetanus
i. umbilical cord must be cut with clean and sterilized knife.
ii. Vaccinate children against tetanus.
iii. Avoid exposing the wound to soil.

iii. Leprosy.
It is a disease in which body parts lose their sensitivity such that a person does not feel pain, cold or hot.
Leprosy is caused by a bacterium called Mycobacterium reprae. This bacterium attacks sensory nerves of cooler parts of the body e.g. toes and fingers, which later lose their sensitivity.
The disease spread from one person to another through direct contact with affected parts of the patient.

Signs and symptoms of leprosy.
i. Blotches and lumps on the skin.
ii. Numbness, paralysis and deformation of affected parts due to thickening of nerves of the skin.
iii. Loss of sensation leading to loss of fingers and toes.

Ways of preventing leprosy.
i. Avoid direct contact with affected parts of the patient.
ii. Avoid any contact with objects used by infected person such as shoes, gloves and socks.
iii. Isolation.

iv. Poliomyelitus(polio)
It is a disease in which bones and muscles wither and shrink.
Polio is caused by a virus. This virus lives and multiplies in posterior parts of the spinal cord where it attacks motor neurone. When motor neurone is attacked, impulses from central nervous system fail to reach the muscles as the result muscles are unable to function and become withered and small. This in turn prevents proper development of bones since there is no muscular stress placed on them.

The disease spread from one person to another through direct contact with faeces, nose and throat secretion from infected person. The disease also spread through drinking water contaminated with faeces from infected person.
Signs and symptoms of the polio.
i. Withered legs or arm.
ii. Muscle pains.
iii. Flaccid paralysis.
iv. Fever and neck stiffness.

Ways of preventing polio.
i. Vaccinate children against polio.
ii. Personal hygiene.
iii. Proper disposal of faeces.
iv. Live in well ventilated house.
v. Control the houseflies.

v. Meningitis
It is a disease which attacks the brain and the membranes around the brain called **meninges.**

Meningitis is caused by a bacterium called Neseria meningitis.
This disease spreads from one person to another through direct contact with droplets from the nose and throat.

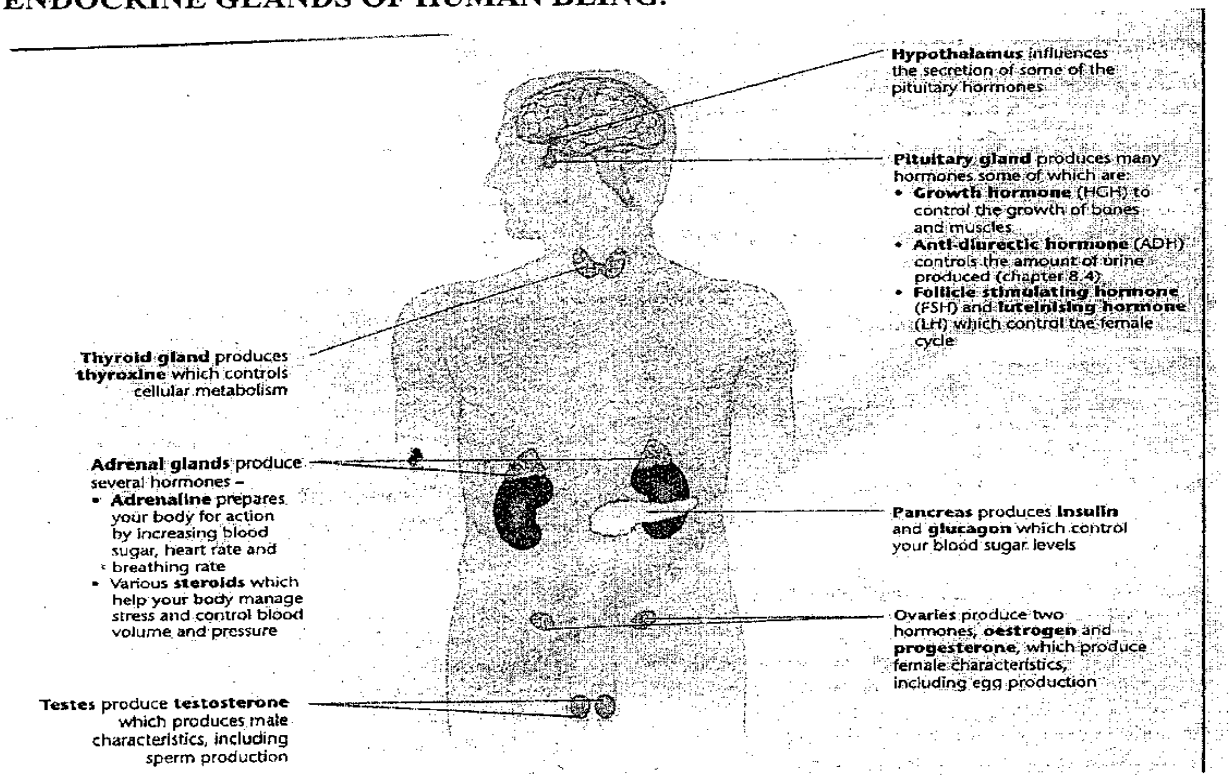
Signs and symptoms of meningitis.
i. Neck stiffness.
ii. Colvusions in children.
iii. Severe headache.
iv. Coughing and vomiting.
v. Fever.

Ways of preventing meningitis.
i. Vaccinate children against meningitis.
ii. Avoid overcrowding.
iii. Isolate the patient.

ENDOCRINE SYSTEM.

It is a system in which messages travel chemically in blood to the target organs.
Endocrine system consists of endocrine glands and hormones.
Endocrine glands are the ones that produce chemical messengers called **hormones**.
These glands are ductless (have no tubes that carry substances released by the glands) as such hormones are released into the blood, where they travel through out the body until they reach their target organs. Target organs have receptors for a specific hormone and are affected by the hormone e.g. liver is the target organ of the hormone called insulin.
Hormones may increase or slow down the rate of metabolic activities in the cells of target organs there by bringing change in the whole organism.

ENDOCRINE GLANDS OF HUMAN BEING.



PITUITARY GLAND.

It lies at the base of the brain. This gland is described to be master gland because it stimulates other glands to release their hormones.
Pituitary gland releases the following hormones:
i. Ant diuretic hormone (ADH)
ii. Follicle stimulating hormone (FSH)
iii. Luteinizing hormone (LH)
iv. Oxytocin
v. Growth hormone.

Anti diuretic hormone (ADH)

It is released when the level of water in the blood is very low. This hormone is carried by the blood to the kidneys, where it stimulates collecting duct to be more permeable to water as such more water is reabsorbed from filtrate. This in turn reduces the volume of urine output.

Follicle stimulating hormone (FSH)

It is released when ova (eggs) start maturing in the ovaries of the woman. This hormone stimulates the development of **follicle cells** that surround the mature ova. These follicle cells develop into **graffian follicle** that burst to release the ovum during **ovulation.**

Luteinizing hormone (LH)

This hormone is secreted when the ovum is about to be released into fallopian tubes. This hormone triggers/causes ovulation in women. The hormone is also responsible for the development of **corpus luteum** from graffian follicle

Oxytocin.

This hormone is secreted when the woman is about to give birth. This hormone induces labour in pregnant women. Oxytocin is also responsible for the secretion of milk in mammary glands.

Growth hormone.

It is a hormone that is responsible for the growth and development of a person. Growth hormone controls the growth of bones and muscles.
Too much production of growth hormone leads to **giantism** in human beings, whereas little production of growth hormone results into **dwarfism** (retarded growth)

THYROID GLAND.

It is a butter fly shaped gland that lies at the neck in front of trachea. Thyroid gland secretes a hormone called **Thyroxine**. The production of thyroxine requires iodine as such thyroid gland swells up to form goiter when the body is lacking iodine.
Thyroxine controls rate of metabolic activities in the body such as respiration.
Excess production of thyroxine increases rate of metabolic activities as such a person becomes thin, overexcited and mentally unstable. Too little production of thyroxine decreases rate of metabolic activities as a result a person becomes fat and sluggish.
In children, thyroxine deficiency causes stunted growth and cretinism (mentally retarded)

PANCREAS.
It is an organ that acts as both endocrine gland and exocrine gland (digestive gland)
Pancreas has hormone producing cells called **islets of langerhans.** These cells produce two kinds of hormones: **insulin** and **glucagons.**
Insulin and glucagons regulate the level of blood sugar (glucose) in the body.

Insulin.
This hormone is secreted when the level of blood sugar is very high especially soon after a meal. Insulin reduces the level of blood sugar by:
i. Stimulating liver cells to convert excess glucose to glycogen (animal starch), which is stored in the liver and muscles for future use.
ii. Promoting the conversion of carbohydrates to lipids, which are stored under the skin and around internal organs such as kidneys.
iii. Stopping the conversion of proteins to carbohydrates.

Too little production of insulin result into diabetes (sugar disease). A person who is suffering from diabetes excretes a lot of glucose in the urine.

Test for diabetes.
i. Benedict's solution turns brick red when heated together with urine.
ii. White ants rush to the urine and drink it.

Signs and symptoms of diabetes
i. Weight loss as lipids and proteins are used by cells for energy instead of glucose.
ii. Heart attack as the amount fats in the blood increases.
iii. A person produces a breath that smells of pear drops as blood pH is altered by the toxic substances released during the use of fatty acids by the cells.
iv. Unconsciousness which occurs because the brain is affected by the low pH of the blood.
v. Dehydration and thirsty as more water is used in excretion of glucose in kidneys.
vi. Blindness, kidney failure and peripheral vascular disease as blood vessels become damaged by high levels of blood sugar.

Treatment of diabetes
i. The patient is injected by insulin regularly. This insulin is extracted from pigs.
ii. Eat food stuffs that raise the blood sugar level slowly.

Glucagon.
This hormone is released when the level of blood sugar is very low in the body especially during fasting.
Glucagon raises blood sugar by:
i. Stimulating liver cells to convert glycogen to glucose for immediate use.
ii. Promoting the conversion of lipids to carbohydrates.
iii. Promoting the conversion of proteins to carbohydrates.

ADRENAL GLAND

This gland is located above the kidneys. Adrenal gland secretes a hormone called adrenaline.

Adrenaline prepares the body for fight or flight as such this hormone is also called fight or flight hormone.

Adrenaline is released when a person is angry, excited, afraid or under stress and anxiety.

How adrenaline prepares the body for fight or flight (effects of adrenaline)

i. It increases heart beat by making heart muscles to contract and relax rapidly. This ensures that more blood is sent to the muscles to supply food nutrients and oxygen for the respiration of muscle cells.

ii. It increases breathing rate by making the breathing muscles to contract and relax rapidly so that more oxygen is supplied for respiration and more carbondioxide is removed from the blood.

iii. It makes the arterioles of the skin and alimentary canal to constrict so that more blood is diverted to muscles where it supplies nutrients.

iv. It stimulates liver cells to convert glycogen to glucose for muscle respiration.

v. It dilates the pupil so that more light should enter into the eye for proper vision.

Adrenaline is quickly broken down in the body after it has being released so that its effects should not prolong in the body.

Differences between nervous system and endocrine system

Nervous system	**Endocrine system**
Messages travel faster	Messages travel slowly
Impulse is delivered in the precise area	Impulse is delivered over large area.
It brings quick response	Response is very slowly
Few chemicals are used	More chemicals are used
Response is short lived	Response is long lived

TOPIC 10: REPRODUCTION.

Reproduction is the formation of new organism from already existing organisms. This process maintains the existence of species of organisms on earth.

Types of reproduction.

i. Asexual reproduction.

ii. Sexual reproduction.

Asexual reproduction.

It is the formation of new organisms from a single parent. This process is usually practiced by simple organisms such as bacteria, protozoa, fungi, viruses and coelentrates.

Examples of asexual reproduction.

a. Binary fission in amoeba.

b. Budding in hydra.

c. Regeneration in earthworms and cuttings.

Advantages of asexual reproduction.
i. It is fast.
ii. No transmission of STIs.
iii. It maintains genetic uniformity.

Disadvantages of asexual reproduction.
i. No crop or animal improvement.
ii. Transmission of diseases from parents to offspring is very high.
iii. No variations among offspring as such they may be wiped out by a disease out break.

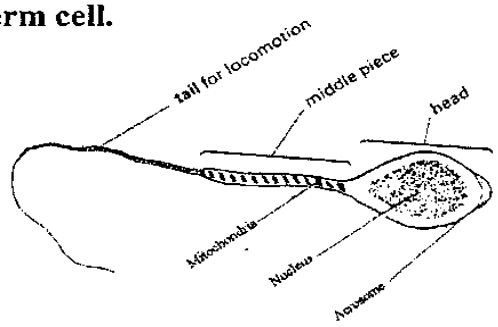
Sexual reproduction.
It is the formation of new organisms from male and female parents.
This process is usually practiced by higher organism such as vertebrates.

Advantages of sexual reproduction.
i. It brings about variation that increases chances of survival in the environment.
ii. Crops or animals can easily be improved.

SEXUAL REPRODUCTION IN HUMAN BEINGS.

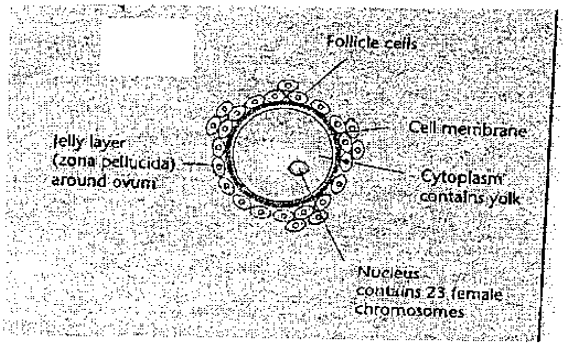
Men and women produce sex cells called **gametes,** which carry information about a particular person. The gametes are produced in special organs called **gonads or genitals.** The genitals of the man are the testes, which are found in the scrotum that hangs outside the body between two legs. Testis produces gametes called spermatozoa (sperms). The production of sperms require a temperature slightly below body temperature (32^0C-33^0C) thus why testes lie outside the body.
The genitals of the woman are the ovaries that produce gametes called **ova/eggs.**

Structure of a sperm cell.



Adaptation of a sperm for movement.
i. It has a tail that flaps side to side thereby propelling the sperm forward.
ii. It has a lot of mitochondria on its middle piece that provide more energy required for movement.
iii. It has streamlined shape that reduces drag during movement.
*Acrosome of the sperm contains enzymes that digest the wall of the ovum so that the head of the sperm should easily penetrate the ovum.

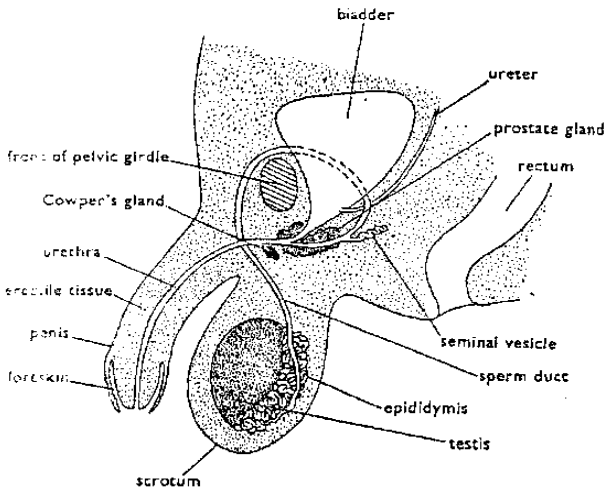
Structure of ovum.



Differences between sperm cell and ovum.

Sperm cell	Ovum
Streamlined shape	Oval shape
Has tail	No tail
Has head	No head
No york	Has york

Reproductive system of the man.



Parts of the male reproductive system.

1. Testes.
These are oval shaped organs that lie in the scrotum.
Testes produce sperms and hormones called **testosterone.**

2. Epididymis.
It is a coil of tubules that lie outside testes.
Epididymis stores sperms and eject (release) them during ejaculation.

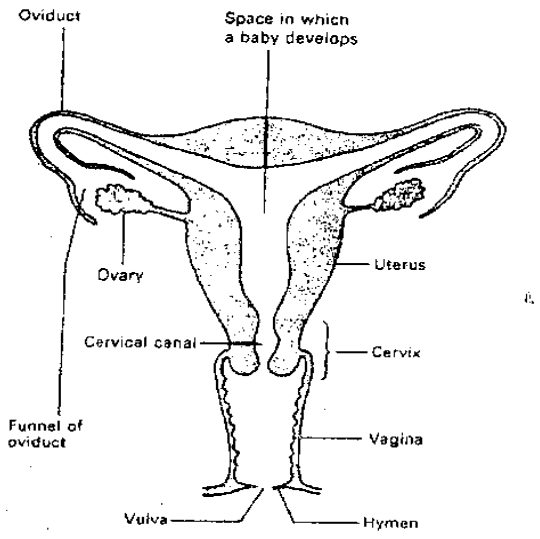
3. Sperm duct.
It is a tubule that connects epididymis to urethra.
This tubule provides the passage of sperms to urethra during ejaculation.

4. Prostate gland, Cowper's gland and Seminal Vesicles.
These are glands that add fluids to sperms during ejaculation. The mixture of sperms and fluids is called semen.

Functions of fluids added to sperms.
i. They stimulate swimming movement in sperms.
ii. They neutralize acid in the vagina that may kill sperms.
iii. They provide nutrients to sperms.

5. Penis.
It is a special organ that has erectile tissues with numerous blood spaces. When the man is sexually aroused blood is pumped into penis faster than it can return to venous blood stream. This blood fills the blood spaces in the penis and the penis becomes erect and hard.
The function of the penis is to inject/deposit sperms into the vagina during intercourse.

Reproductive system of the woman.



Parts of the female reproductive system:
1. Ovaries.
These are oval shaped organs that lie in the lower part of the abdomen.
Ovaries produce ova (eggs) and hormones called **Oestrogen and progesterone.**

2. Oviduct.
It is a muscular tube that lies between ovary and uterus.
Oviduct provides the passage of ovum (egg) from ovary to the uterus. It is also the site for fertilization.
Ovum moves in oviduct by action of cilia and peristaltic movement of the oviduct's wall.

3. Uterus.
It is a wide muscular tube that lies in the lower part of abdomen. Uterus is that site for implantation and embryo development.

4. Vagina.

It is a hollow muscular tube that joins uterus to outside of the body.

Vagina provides the passage of penis and sperms that swim towards the uterus. It is also the birth canal.

OVA PRODUCTION

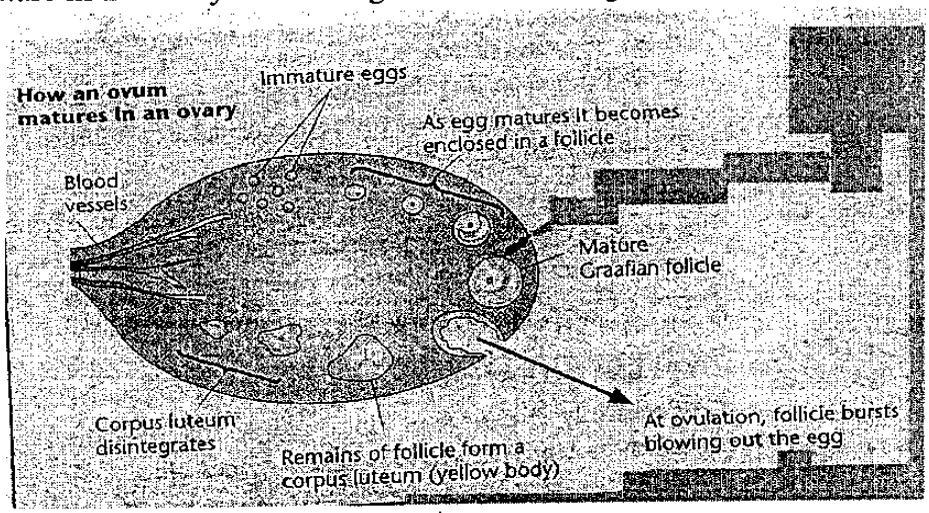
Biologically a baby girl is born with over 75, 000 potential eggs. These eggs start maturing when the girl reaches puberty and are released at interval monthly.

In the ovary, each ovum is surrounded by follicle cells. When the ovum matures, follicle cells divide rapidly to form a liquid filled sac called **Graffian follicle**. Graffian follicle begins producing a hormone called oestrogen. Oestrogen stimulates the thickening of uterine wall in readiness for implantation of the foetus.

When graffian follicle matures, it protrudes from ovary and burst to release the ovum into oviduct. The release of the ovum from ovary is called **ovulation**. After ovulation, the remains of graffian follicle develop into yellow body called Corpus luteum.

Corpus luteum starts producing a hormone called progesterone and little amount of oestrogen. These two hormones further thicken the uterine wall.

In the oviduct, the ovum is pushed towards uterus by action of cilia and peristaltic movement of uterine wall. If the ovum is not fertilized within 24-36 hours from the time it was released, it dies upon reaching uterus. When the ovum dies, corpus luteum degenerates as a result the production of progesterone and oestrogen stops. This makes the new uterine lining to disintegrate/break apart since there is no hormone to maintain its thickness. When uterine wall disintegrate, some blood and dead ovum pass out of the body through vagina. This is called **menstruation**. After menstruation, another ovum begins to mature in the ovary and undergoes the same stages mentioned above.



HORMONES INVOLVED IN MENSTRUAL CYCLE.

1. Follicle stimulating hormone (FSH)

It is secreted by pituitary gland of the brain.

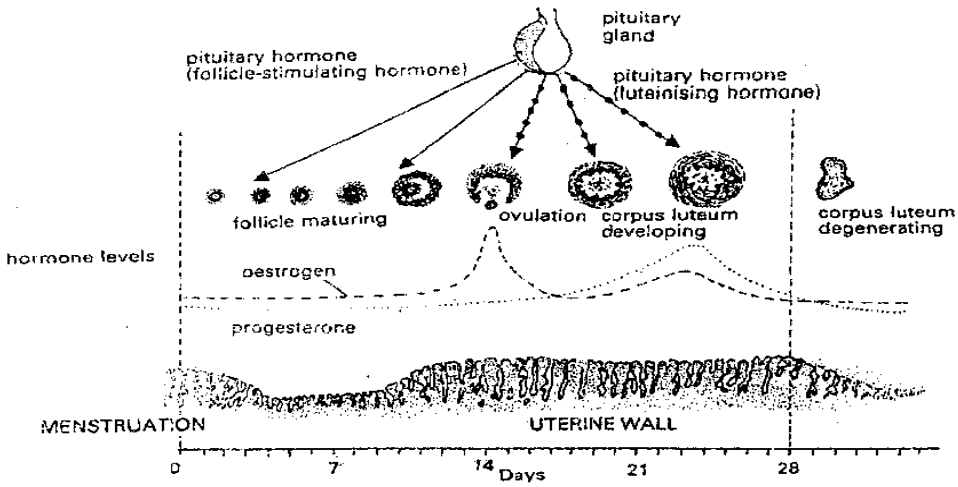
FSH initiates the development of graffian follicle in the ovary that release ovum when burst.

2. Luteinising hormone (LH)
It is secreted by pituitary gland of the brain.
LH Initiates the development of corpus luteum. It also triggers ovulation.

3. Oestrogen
It is secreted by graffian follicle in the ovary.
Functions of oestrogen.
i. It initiates the thickening of uterine wall.
ii. It initiates the development of blood capillaries in the uterine wall.
iii. It initiates the development of secondary sex characteristics such as pubic hair, breast development and soft voice in girls.

4. Progesterone.
It is secreted by corpus luteum in the ovary.
Functions of progesterone.
i. It thickens uterine wall in readiness for implantation.
ii. It causes the development of blood capillaries in the uterine wall.

DIAGRAM SHOWING MENSTRUAL CYCLE.

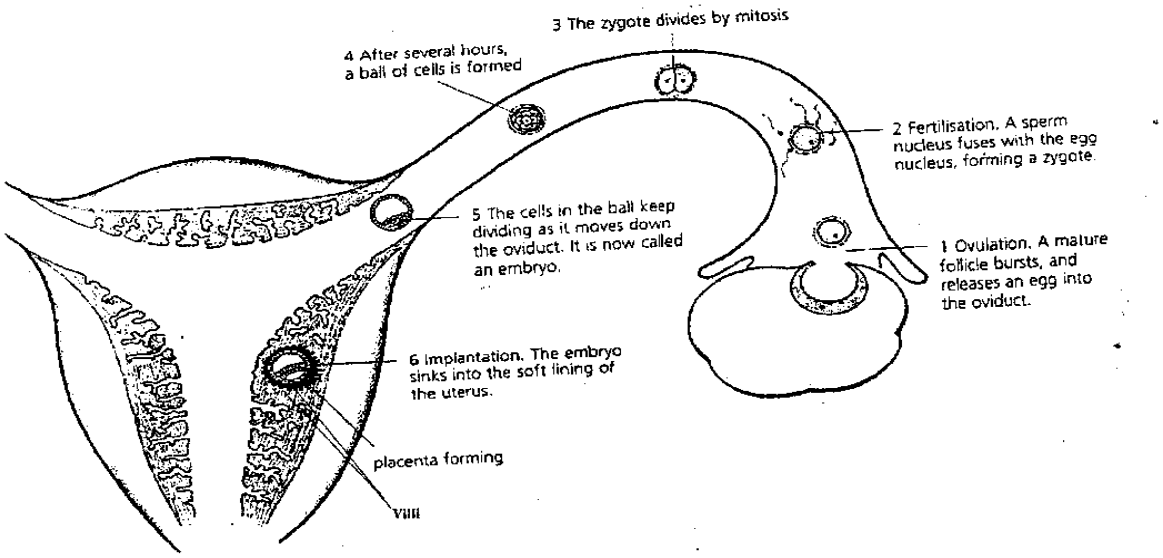


THE PROCESS OF FERTILIZATION
During sexual intercourse, semen from the man is released into the vagina through the penis. Some of the semen is drawn towards the uterus by the contraction of the vaginal wall. In the uterus, sperms from semen swim towards ovaries. When a sperm meets an ovum along the oviduct, its acrosome releases enzymes that digest the wall of vagina and the head of the sperm penetrates into the ovum. For sperm to penetrate into the ovum more sperms are needed to remove follicle cells that surround the ovum. When one sperm penetrates into the ovum, an extra membrane is formed around the ovum to prevent the entry of other sperms into the same ovum. In the ovum, the nucleus of the sperm and ovum fuse to form a single cell called **zygote**. The process in which the nucleus of the sperm and ovum fuse to form zygote is called **fertilization**.

THE PROCESS OF IMPLANTATION.

After fertilization, zygote divides rapidly into a ball of cells called **blastula.** This ball of cells then develops into an embryo. When embryo reaches uterus, it releases enzymes that digest uterine wall and it becomes embedded /buried in the uterine wall. The process in which the embryo becomes embedded in uterine wall is called **implantation.**

Diagram showing fertilization and implantation.



THE DEVELOPMENT OF EMBRYO.

After implantation, the embryo develops some villi that absorb nutrients from the uterine wall. The region bearing villi later develops into **placenta**

Functions of placenta.

1. It forms barrier that separates the blood system of the mother and the foetus. This has the following importance:

i. It prevents the entry of harmful substances from the mother to the embryo.

ii. It prevents high blood pressure of the mother from damaging delicate blood vessels of the foetus.

iii. It prevents agglutination of the blood if the blood group of the mother and foetus are incompatible.

2. Placenta also produces a hormone called progesterone. This hormone has the following functions:

i. It prevents ovulation during pregnancy by stopping the release of the FSH and LH.

ii. It maintains pregnancy by thickening the uterine wall.

3. Placenta provides an area for exchange of materials between the mother and embryo. These materials are exchanged by diffusion.

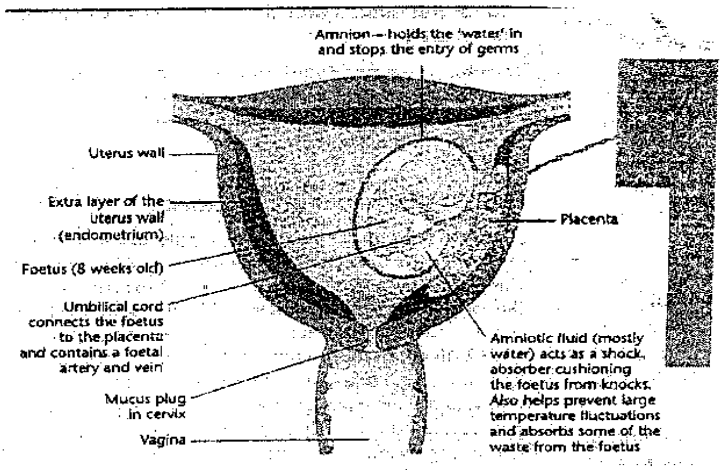
Materials that move from mother to embryo are food nutrients, oxygen and antibodies where as materials that move from embryo to mother are urea and carbondioxide.

Adaptations of placenta for exchange of materials.
i. It has villi that increase surface area for diffusion of materials.
ii. It is highly folded, which increases surface area for diffusion of materials.
iii. It has thin wall for easy diffusion of materials.
iv. It is in close contact with the blood capillaries for fast diffusion of materials.
v. It has blood sinuses, where blood is collected for efficient diffusion of materials.

THE DEVELOPMENT OF FOETUS.

Cells forming embryo continue dividing to form tissues. A tissue is a group of cells performing similar functions. These tissues then form organs. One of the first organs to be formed is the heart that starts pumping blood of the embryo. When all organs of the embryo have been formed, the embryo becomes the **foetus.**
In the uterus, the foetus is surrounded by a membrane called **amnion** and is connected t placenta by **umbilical cord.**
Amnion contains the fluid called **amniotic fluid.**

Foetus in the uterus.



Functions of amniotic fluid.
i. It acts as shock absorber thereby protecting the foetus from external physical force.
ii. It acts as insulator that prevents the exchange of heat energy between the foetus and the mother
iii. It lubricates the vagina during birth so that the baby should easily pass through it.

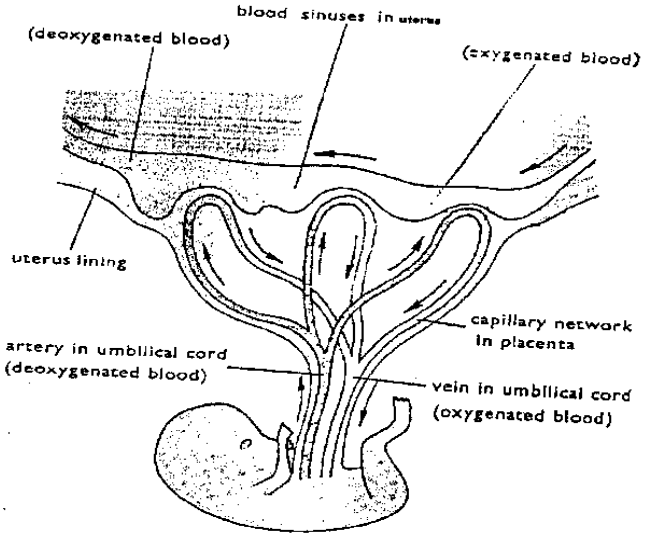
Umbilical cord.
It is a cord of blood vessels that join the foetus to the placenta. Umbilical cord has artery and vein.

Blood in umbilical artery.
It moves from foetus to the placenta.
This blood has more waste matters such as carbondioxide and urea produced by the foetus during metabolic processes of its cells.

Blood in umbilical artery has less oxygen and food nutrients as they have been used by the cells of the foetus. As such this blood is dark red in colour due to absence of **oxyhaemoglobin.**

Blood in umbilical vein.
It moves from placenta to the foetus.
This blood has more oxygen and food nutrients to be used by cells of foetus. As such this blood is bright red in colour due to presence of oxyhaemoglobin.
Blood in umbilical vein has little/ no urea and carbondioxide.

Movement of blood in umbilical cord



PREGNANCY.
It is a period between implantation and birth. In human pregnancy takes about 38 weeks (9 months)

Care during pregnancy.
i. Pregnant woman should eat balanced diet rich in:
a. proteins for the proper development of the foetus.
b. calcium for the formation bones of the foetus.
c. iron for formation of blood of both the mother and foetus.

ii. Pregnant woman should visit antenatal clinic regularly so that doctor should check the progress of the pregnancy.
iii. Pregnant woman should avoid alcohol and smoking as these substances may harm the baby. Smoking makes the baby to be under weight whereas alcohol damages the brain of the baby.
iv. Pregnant woman must avoid STIs that may harm unborn baby.

BIRTH.
It is a period when the baby moves out of the mother's body to the outside world. At this time the baby begins the process of becoming independent organism.

PREPARATION FOR BIRTH.
i. Uterine wall develops tough muscles to be used for expelling the baby out of uterus.
ii. The baby turns within the uterus until its head lies on the cervix so that it can come out easily.

BIRTH PROCESS.
Birth is induced by a hormone called **oxytocin**, which is secreted by pituitary gland of the brain. Oxytocin stimulates rhythmic contraction of uterine wall. Rhythmic contraction begins gently and later becomes steady and more powerful. This is called **labour**.
Powerful contraction of uterine wall results into bursting of amnion and amniotic fluid flows out through vagina. The cervix also dilates/widens to the size of baby's head. When cervix dilates, the baby is pushed out by the contraction of uterine wall and abdominal muscles. This baby comes out head first and he or she is received by the doctors who cut umbilical cord. Umbilical cord returns into the uterus and it is later delivered together with placenta. This is called **after birth.**
When the baby comes out, he or she starts crying as she experiences change in temperature. Crying helps the baby to draw air from atmosphere into the lungs through the nostrils and breathing begins.

Stages of birth.

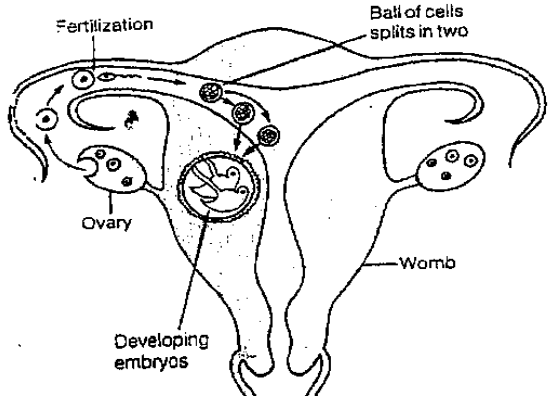
a. Stage one.
i. Rhythmic contraction of uterine wall.
ii. Bursting of amnion.
iii. Dilation of cervix.

b. Stage two.
i. Coming out of the baby.

c. Stage three.
i. Coming out the umbilical cord and placenta.

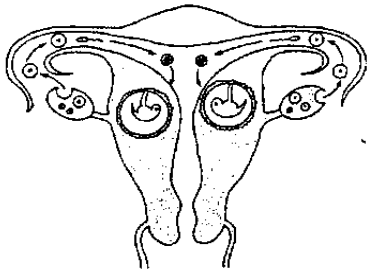
TWINS.
These are two embryos that develop in the uterus at the same time.
There are two kinds of twins. These are:
i. Identical twins.
ii. Non identical twins (fraternal twins)

IDENTICAL TWINS.



Identical twins are formed when fertilized ovum splits into two zygotes that develop into two separate embryos.
Identical twins resemble each other because they carry similar genetic materials as they arise from same gametes (one sperm and one ovum).
When fertilized ovum fails to split completely, Siamese twins are produced. These twins are born whilst they are attached to each other at a certain part of the body.
Siamese twins and identical twins share the same placenta but different umbilical cord.
They are always of the same sex.

FRATERNAL TWINS



Fraternal twins arise when two ova released by a woman at a same time are fertilized by two different sperms. Each fertilized ovum develops into its own embryo.
Fraternal twins use different placenta and umbilical cord. These twins don't resemble each other because they carry different genetic materials as they arise from different gametes. Fraternal twins may be of the same sex or different sex.

BREAST FEEDING.
It is a process in which a baby sucks milk from mammary glands of his or her mother.
The production of milk in mammary glands is controlled by the hormone called **prolactin** but the release of milk from mammary glands is controlled by **oxytocin.**
Prolactin and oxytocin are secreted by pituitary gland of the brain.
Suckling stimulates the secretion of oxytocin as such mothers are advised to breast feed their babies soon after birth.

Importance of breast feeding.
i. It provides all necessary food nutrients for the proper development of the baby.
ii. It provides antibodies that fight against early infections in the baby
iii. It acts as birth control as some hormones are released when the mother is breast feeding that stop ovulation.

Advantages of breast milk over bottled milk.
i. It contains colostrum that is rich in food nutrients and antibodies.
ii. It is easily digested by the baby.
iii. It is cheap and instantly available.
iv. It is pure and fresh.
iv. It is at the right temperature for the baby.
v. The contents of breast milk changes with the stage of development of the baby.
vi. Breast milk increases the bond between the mother and the baby.

PROBLEMS ASSOCIATED WITH REPRODUCTION.

i. Maternal mortality.
ii. Sterility/infertility.
iii. Sexually transmitted infections (STIs)

MATERNAL MORTALITY.

It is the death of the woman due to pregnant related illness.

Causes of maternal mortality.

i. Too much loss of blood during delivery that leads to anaemia.
ii. High blood pressure that cause heart failure.
iii. Breech birth (coming out of the baby bottom first instead of head first) that leads to too much loss of blood.
iv. Abortion at advance stage of pregnancy that lead to too much loss of blood.
v. Pregnancy at tender or old age that damage uterus.
vi. Delay in visiting maternity that brings about complications during birth.
vii. Visiting traditional birth attendance who can not handle complications.

STERILITY.

It is the failure of the person to reproduce.

Causes of sterility.

i. Low sperm count in semen.
ii. Blockage of sperm ducts and oviducts by infection or abnormality.
iii. Failure of the woman to ovulate due to hormone inbalance.
iv. Hostile vagina (too acidic) that kills sperms.
v. STIs that damage genitals.
vi. Male impotence.

Solutions to problems that cause sterility.

i. Surgery to clear blocked sperm ducts and oviducts.
ii. Drugs to clear infections.
iii. Hormone treatment to correct hormone inbalance.
iv. Artificial insemination to get past cervix.
v. Invitro fertilization followed by implantation (test tube baby)

SEXUALLY TRANSMITTED INFECTIONS.

These are diseases that people get infected through sexual intercourse.

Examples of sexually transmitted infections.

i. Gonorrhea
ii. Syphilis
iii. HIV/ AIDS
iv. Candidiasis.
v. Genital warts and herpes.

These diseases spread from one person to another through sexual intercourse, blood transfusion, kissing, mother to baby transmission and sharing piercing materials.

STIs cause death, infertility and blindness in un born child

CONTRACEPTIVE METHODS.

These are methods that prevent pregnancy by stopping ovulation, fertilization and implantation.

Examples of contraceptive methods.

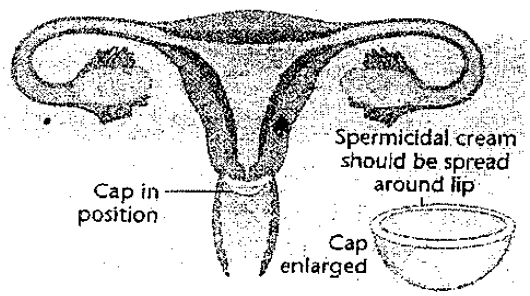
i. Pills
ii. Vasectomy.
iii. Norplant
iv. Tubal legation
v. Loop
vi. Condom use.
vii. Diaphragm
viii. Spermicides.
ix. Rhythm
x. Withdrawal

Contraceptive methods are divided into four groups.
These are:
i. Mechanical methods e.g. condom use, diaphragm and loop.
ii. Chemical methods e.g. pills, norplant and spermicides.
iii. Surgical methods e.g. vasectomy and tubal legation.
iv. Natural methods eg rhythm and withdrawal

condom use.

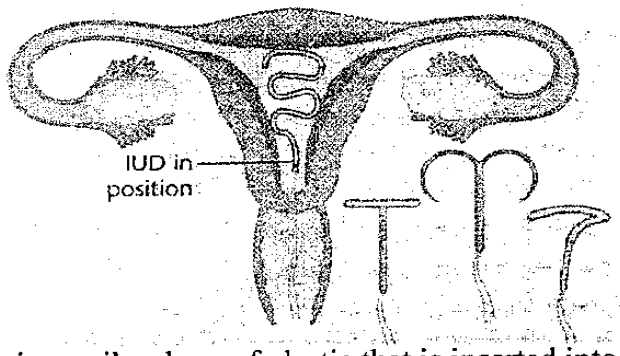
A condom is a thin rubber sheath that covers erect penis before sexual intercourse. It has a teat at the end that collects semen during ejaculation such that semen is not released into the vagina.
Condom use prevents fertilization as sperms are blocked from entering into vagina.

Diaphragm.



A diaphragm is a domed rubber cap with elastic rim, which is inserted into vagina where it covers cervix.
Diaphragm prevents fertilization by blocking sperms from reaching uterus

Intrauterine device (IUD)/ loop.



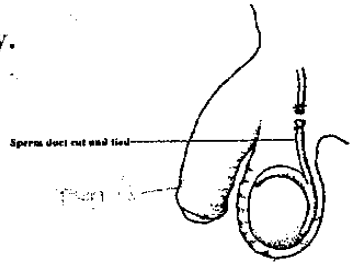
Loop is a coil or loop of plastic that is inserted into the uterus through vagina. Loop prevents implantation of embryo in the uterus.

Contraceptive pills.
These are drugs that contain female sex hormones (oestrogen and progesterone like hormones). These drugs prevent ovulation by inhibiting the release of FSH and LH. Some contraceptive pills may prevent fertilization and implantation.

Norplant
It is a capsule that is inserted on the upper part of the woman through surgery.
This capsule contains female sex hormones that stop ovulation.

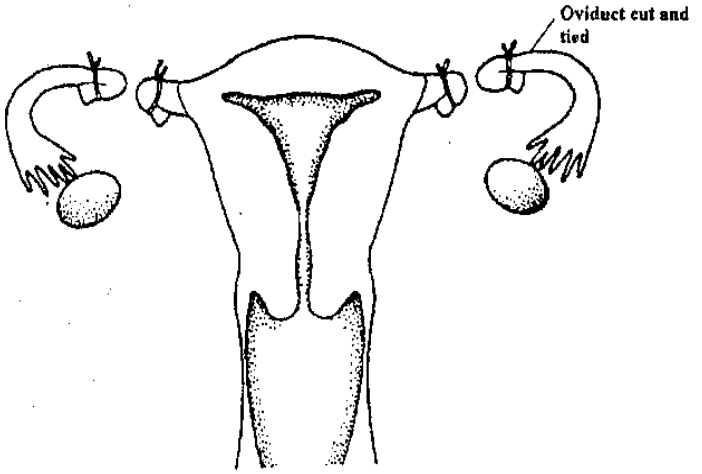
Spermicide.
These are chemicals which are in form of jelly, foam or cream that are applied in the vagina. Spermicidal creams kill sperms in the vagina thereby preventing fertilization. Spermicidal creams are usually coated to the rim of the diaphragm for effective use of the diaphragm.

Vasectomy.



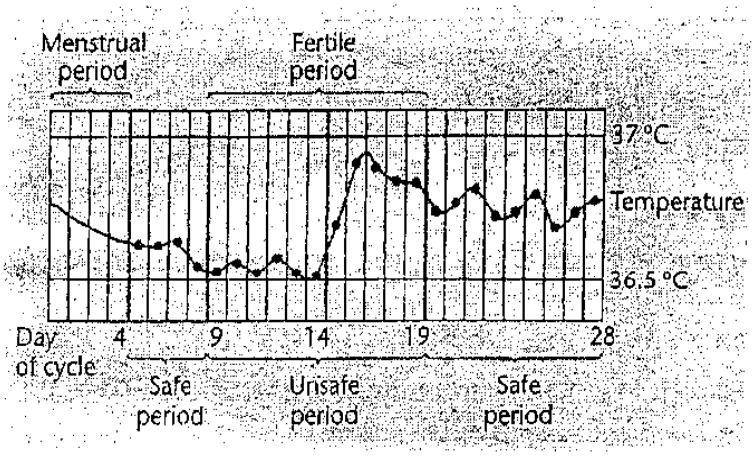
Vasectomy is a method in which a sperm duct is cut and tied in an operation (surgery). Vasectomy prevents fertilization by stopping sperms from being released during ejaculation. A man whose sperm duct is cut, release fluids without sperms during ejaculation as such it is hard for a woman to know whether her husband has been vasectomised. Vasectomy is not suitable to young men as it can not be reversed.

Tubal legation



Tubal is a method in which fallopian tubes are cut and tied in a surgery. Tubal legation prevents fertilization by blocking sperms from reaching ovum. This method is not suitable to young women as it can not be reversed.

Rhythm method. (Safe period method)



Rhythm is a method in which women avoid sexual intercourse during the period when ovulation is most likely to occur (fertile period). In this method women keep records of their menstrual cycle so that they should know when they are most likely to ovulate. Rhythm prevents fertilization by preventing sperm from meeting a live ovum. This method is unreliable as menstrual cycle may be affected by illness and emotional stress.

Withdrawal method.

It is a method in which a man removes his penis from vagina when he is about to ejaculate. This method prevents fertilization as sperms are not released into the vagina. Withdrawal method is not reliable as some sperms may be released unnoticed.