BIOLOGY

COMBINED SCIENCE NOTES

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FORM 3 & 4

BIOLOGY

TOPICS

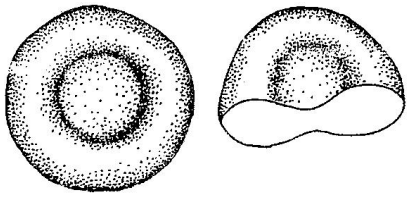
- **CELLS AND LEVELS OF ORGANISATION**
- **NUTRITION**
- **RESPIRATORY SYSTEMS**
- **TRANSPORT SYSTEM**
- **REPRODUCTION**
- **HEALTH AND DISEASE**

CELLS AND LEVEL OF ORGANISATIONS

SPECIALISED CELLS

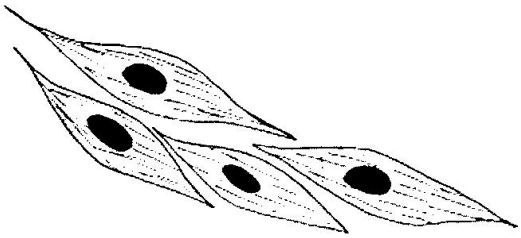
- Different types of cells carry out specific functions and when all cells combine their functions, they can share out the processes of life.
- Each cell is dependent on the other and all of them function collaboratively to support the diverse processes in an organism
- When cells are specialised they carry particular job and develop a distinct shape. The changes in shape enable the cell to carry out its special function.

Red blood cell (erythrocytes)



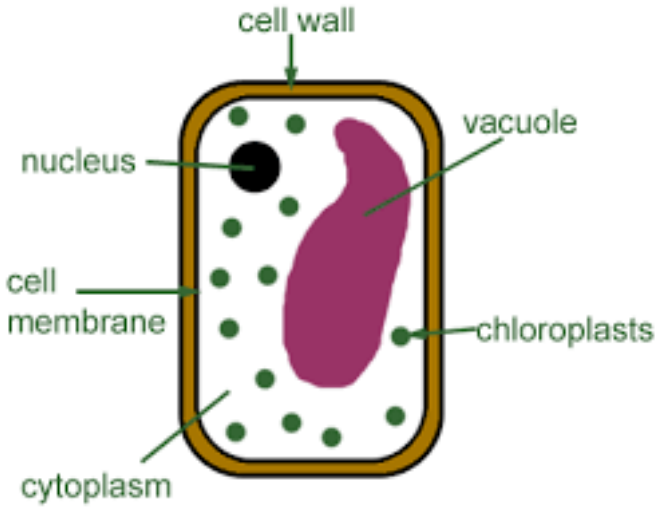
- Its function is to transport oxygen from lungs to body tissues and carbon dioxide from body tissue to the lungs.
- Lacks a nucleus to increases surface area for absorption of oxygen.
- Their bi-concave shape and flexibility allow them to pass along small capillaries.
- Contains haemoglobin (red pigment) which carries oxygen needed for cell respiration to produce energy.

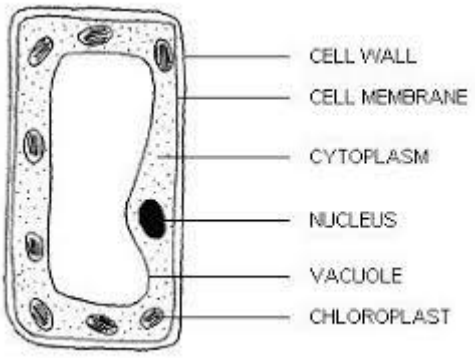
Muscle cell



- It is responsible for contraction when stimulated by a nerve so that movement occurs.
- They are long and thin and have the ability to change their shape when they contract.
- Have large numbers of mitochondria to provide energy for muscle contraction.

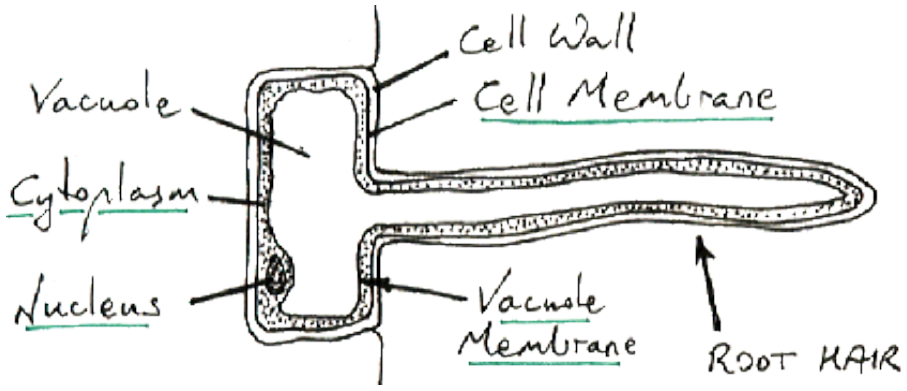
Palisade cell





- Its function is to make food by photosynthesis.
- Packed with chloroplasts that contain chlorophyll for absorption of light.
- They are columnar and closely packed to increase surface area for absorption of sunlight and carbon dioxide.

Root hair cell



- Responsible for absorption of water and salts from the soil.
- Have thin cell walls to allow water and nutrients to pass easily from the soil
- They are numerous to increase surface area for absorption of water and mineral salts as they are in close contact with the soil.
- The hair like projection on each cell penetrates between the soil particles and offers a large absorbing surface area.
- Large vacuole facilitates water absorption and storage.

ECOSYSTEMS

- ***An ecosystem*** is a self contained system of interdependent organisms and their physical environment.

Components of an Ecosystem

- An ecosystem consists of two components i.e.
    - *Physical (abiotic) components* which include all the non-living factors like humidity, temperature, air, soil, water, light e.t.c.
    - *Biological (biotic) components* which include all living organisms i.e. fungi, plants and animals, bacteria.

NATURAL ECOSYSTEM

- Describes the influence of the environment in determining which organisms survive.
- In a natural ecosystem there is close interaction between the plants and animals. There is a natural balance of nature. Better adapted organisms survive to reach maturity and produce offspring
- Nutrients are naturally recycled by decomposers
- Pests and disease are part of the natural ecosystem and no control measures are taken to limit them

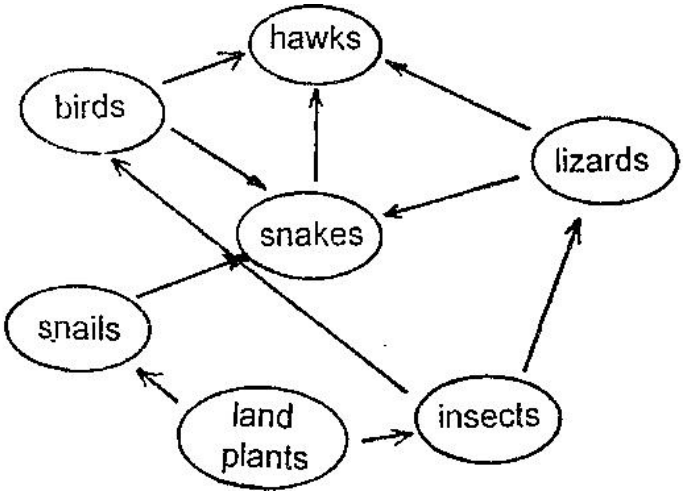
Food chain

- It is a nutritional sequence which involves a series of organisms existing as part of an ecosystem through which energy is transferred.
- Each organism feeds on, and therefore derives energy from the preceding one.
- It usually originates from producers i.e. green plants. The arrow shows the direction of energy flow

$$grass \rightarrow insects \rightarrow dragon\ fly \rightarrow frog \rightarrow snake \rightarrow eagle$$

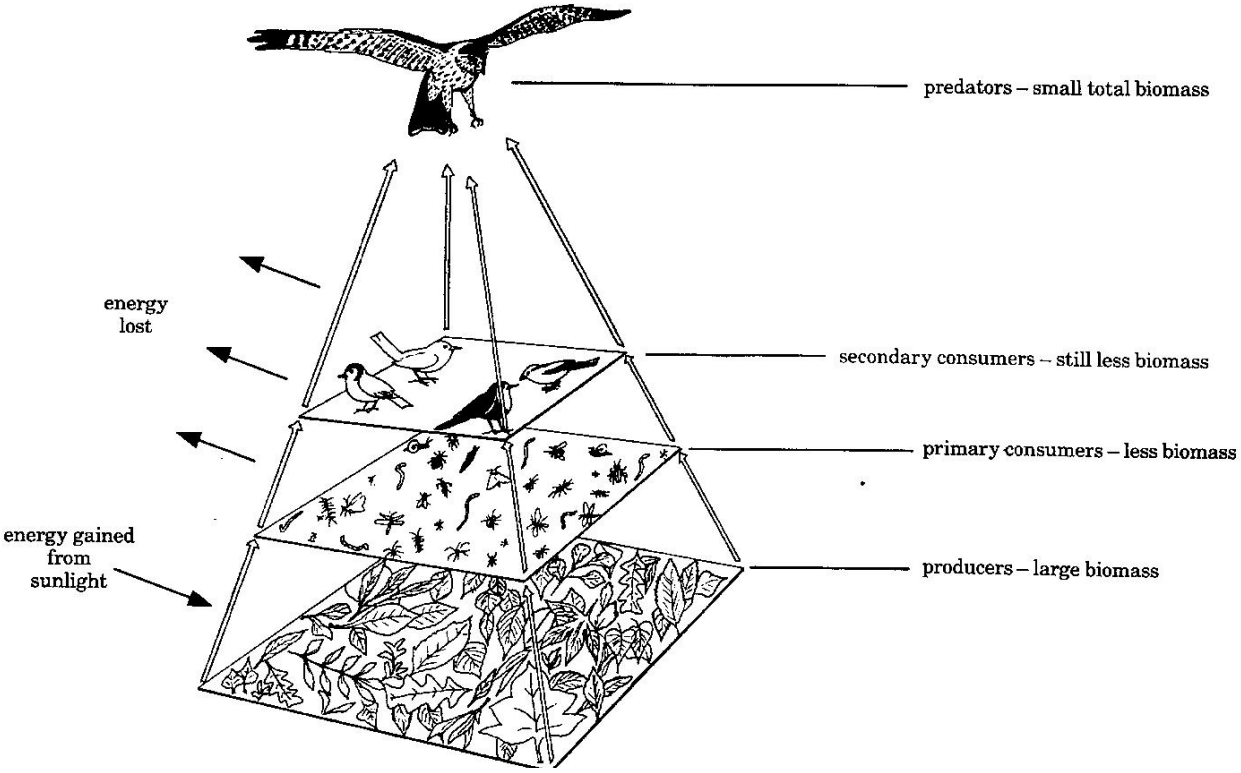
Food web

- A food web is made up of plants and animals which are closely linked by their feeding relationships.
- An organism may feed on more than one organism and in turn it may be source of food for more than one organism



Pyramid of biomass

- Biomass is the amount of living material.
- In a balanced ecosystem, the biomass of producers should be greater than that of herbivores whose biomass in turn should be greater than that of carnivores.
- The amount of energy available for next trophic (feeding) level keeps on decreasing as you go up the pyramid.



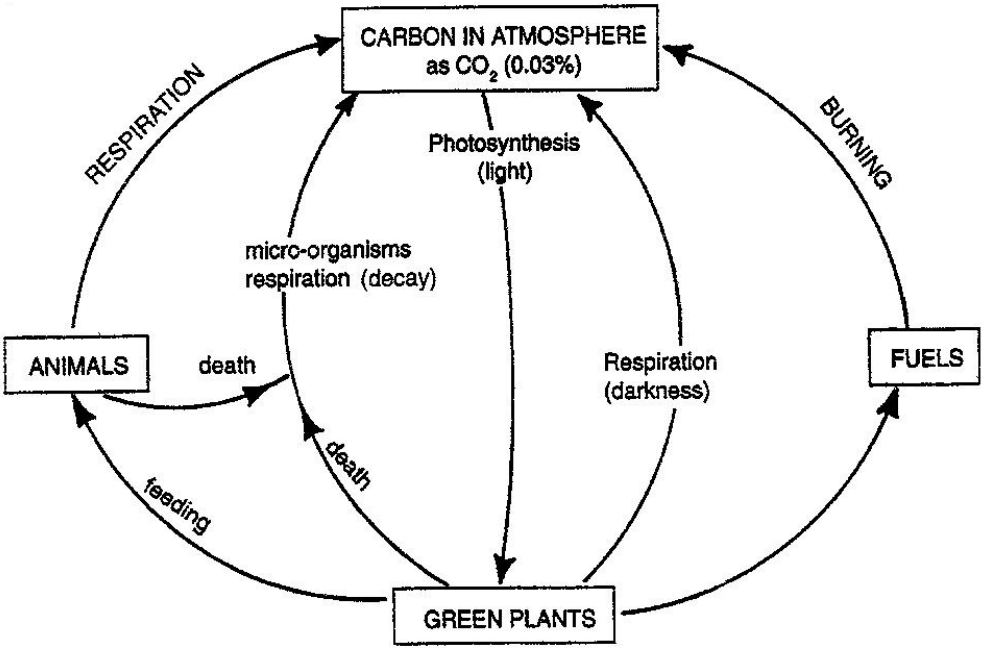
Energy loss in food chains and food webs

- The sun is the primary source of energy. Produce at the first trophic level, trap energy by photosynthesis i.e. 100% energy.

- Consumers lose a lot of energy to the environment as heat and due to life processes such as respiration, movement and excretion at each trophic level.
- On average, about 90% of the energy is lost at each level in a food chain i.e. about 10% of the energy of a trophic level is transferred to next trophic level.
- Whatever is not used or eaten by predators at high trophic level is eaten by decomposers like fungi & bacteria.
- The number of organisms decreases from one trophic level to another because there is less and less energy available for the next trophic level since energy is lost at each trophic level.

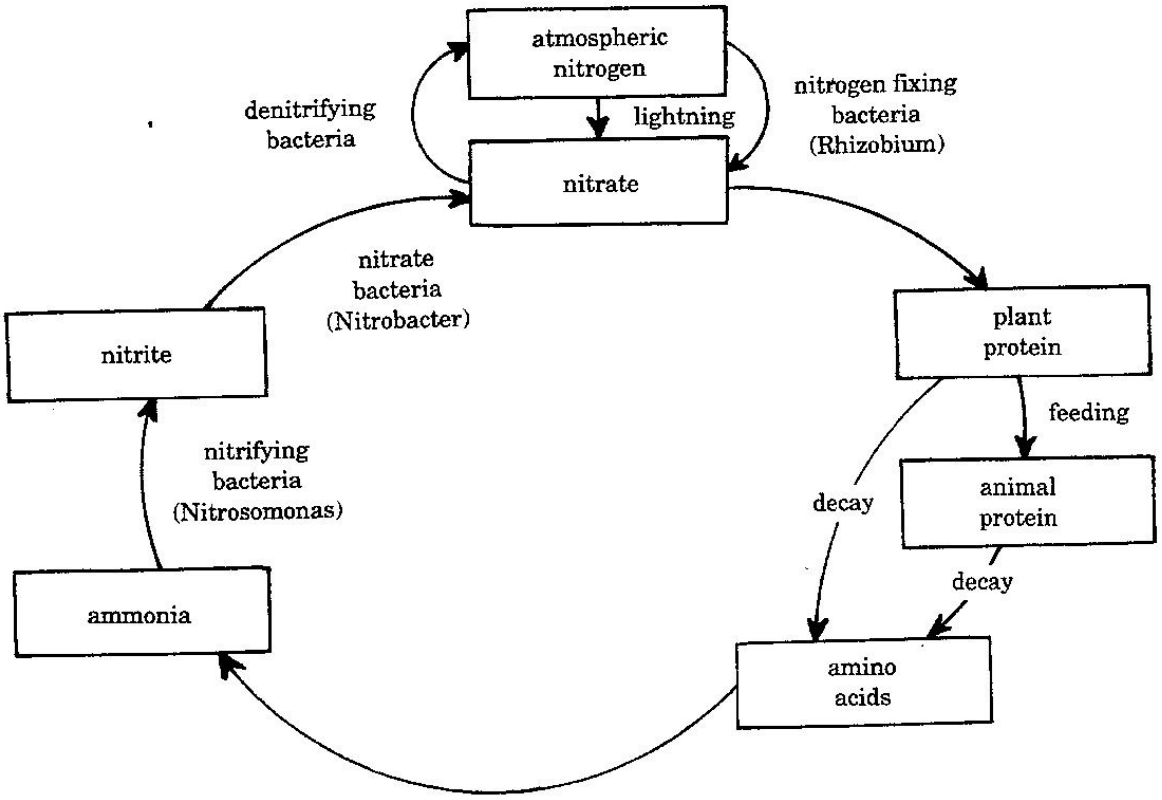
NUTRIENT CYCLE

The Carbon Cycle



- Carbon is recycled in the form of carbon dioxide and it is present in all organic compounds.
- Plants remove carbon dioxide from the air during photosynthesis and use it to build carbon containing organic compounds.
- Animals obtain the carbon by eating organic compounds from plants.
- Carbon dioxide is released back into the atmosphere by animals, plants and microorganisms when they respire and decay.
- It is also released back into the atmosphere by human activities such as burning fossil fuels

The Nitrogen Cycle



- Nitrogen is present in all proteins of both plants and animals
- When animals or plants die the proteins are decomposed by fungus and bacteria. The nitrates produced are reabsorbed by plants and then transferred to animals through ingestion.
- All plants and animal wastes reaching the ground are acted upon by a number of soil organisms i.e. worms, millipedes, bacteria and fungi which change the materials to ammonium compounds.
- These are further decomposed by nitrifying bacteria i.e. *Nitrosomonas* which convert the ammonium compounds into nitrites and *Nitrobacter* which converts nitrites to nitrates. It is in this form that nitrogen is mainly absorbed by plants
- About 79% of air is Nitrogen. A small portion of this is changed into ammonia by lightning then to ammonium compounds which can be absorbed by plants.
- A small fraction of the Nitrogen in air is converted into nitrates directly by nitrogen fixing bacteria called *Rhizobium* which lives in nodules of some leguminous plants.
- If aeration is poor, certain bacteria use the oxygen in the nitrates and in the process release nitrogenous gas to the air in a process called de-nitrification.

ARTIFICIAL ECOSYSTEMS

- An artificial ecosystem is one that is heavily influenced by human beings e.g. monoculture, crop production and animal rearing.
- Farming activities destroy equilibrium since the same types of plants are grown over an area.
- Strict control measures are taken to control pests and diseases.
- Nutrients are often added to the soil in the form of artificial fertilizers
- Grazing is controlled by use of paddocks to avoid overgrazing

BIODIVERSITY

- Biodiversity is the variability within species, between species and between organisms
- It is a measure of the variety of organisms present in different ecosystems.

Problems caused by limited bio-diversity

- Pests problem and disease outbreaks
- Ecosystem becomes unstable and unbalanced
- Little or no recycling of nutrients back into the soil
- Soil infertility
- Overgrazing and deterioration of the natural ecosystem
- Production meant for human consumption
- Pollution

Advantages of biodiversity

- Wide variety of food source
- Self sustenance of an ecosystem
- Interdependence
- Less spread of disease
- It provide shelter, medicine and resources to mankind

NUTRITION

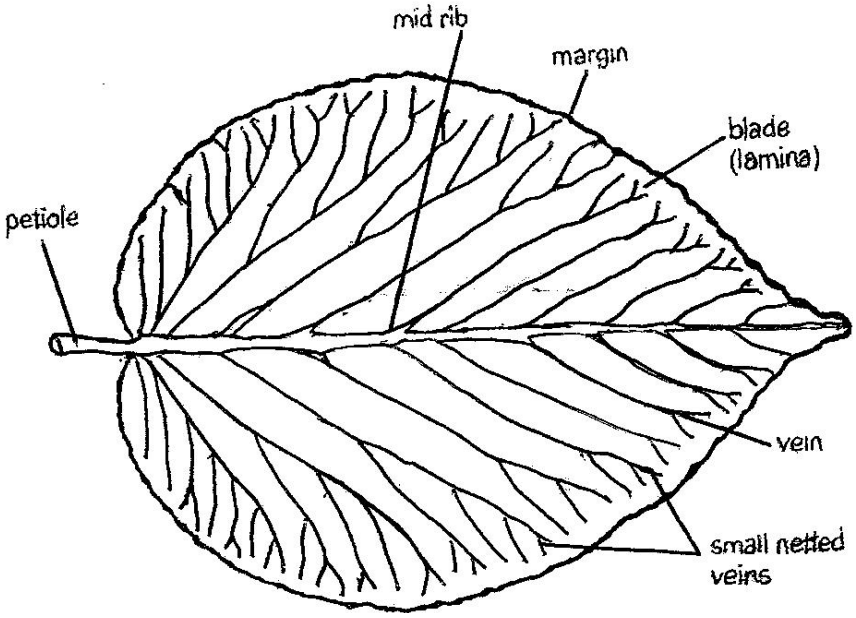
PLANT NUTRITION

PHOTOSYNTHESIS

Leaf structure

External structure

- Most leaves are covered by a waxy cuticle on the outside which is waterproof and prevents the plant from losing too much water through leaves. It also protects the leaf.
- On the surface of most leaves there are veins which transport substances to and from the leaf.



- Leaves are attached to the stem by a petiole that can change position of the leaf so that it always receives as much sunlight as possible for photosynthesis.
- Most leaves are thin and flat with a large surface area(lamina) and the edge is called the margin

Internal structure

Cuticle made of wax, waterproofing the leaf. It is secreted by cells of the upper epidermis

Epidermis thin and transparent to allow light to pass through. No chloroplasts except for guard cells. Acts as a protective layer i.e. prevents bacteria and fungi from

getting in. Stomata are present for gaseous exchange. The epidermis helps to keep the leaf's shape. The closely fitting cells reduce evaporation from the leaf

Palisade cells main region for photosynthesis. Cells are columnar and packed with chloroplasts to trap light.

Spongy cells cells are more spherical and loosely packed. They contain chloroplasts, but not as many as in the spongy mesophyll. Air spaces between cells allowing gaseous exchange

Vascular bundle This is a leaf vein made up of xylem and phloem vessels. Xylem brings water and minerals to the leaf while phloem transport sugars and amino acids away (translocation)

Stomata Each stoma is surrounded by a pair of guard cells which control the opening and closing of the stomata. Stomata allow for gaseous exchange during photosynthesis, transpiration and respiration

Leaf adaptation for photosynthesis

- ✓ Their broad, flat shape offers a large surface area for absorption of sunlight and carbon dioxide.
- ✓ Most leaves are thin and the carbon dioxide and light energy has to diffuse across short distances to reach the inner cells.
- ✓ There are many chloroplasts in the palisade cells than spongy cells to receive most sunlight and this will reach the chloroplasts without being absorbed by too many cell walls
- ✓ The large spaces between spongy cells inside the leaf provide an easy passage through which carbon dioxide can diffuse
- ✓ There are many stomata to allow for the exchange of carbon dioxide and oxygen with the air outside
- ✓ Palisade cells closely packed and elongated to increase surface area for absorption of sunlight
- ✓ The branching network of veins provides a good water and mineral ions from the roots to the leaves during photosynthesis

Factors affecting rate of photosynthesis

Light intensity

- Place a moveable light source at varying distances and count the number of bubbles of oxygen produced per minute. These reflect the rate of photosynthesis
- The rate of bubbling should decrease as the lamp is moved further away from the plant. Assuming that the bubbles contain oxygen produced by photosynthesis, as the light intensity is increased the rate of photosynthesis (as indicated by the rate of oxygen bubble production) increases. This is because the plant uses the light energy to photosynthesise and oxygen is produced as a waste product.
- As light intensity increases, so does the rate of photosynthesis.

Carbon dioxide concentration

- Add varying amounts of sodium hydrogen carbonate, each time recording the number of bubbles produced per minute at each level. Sodium hydrogen carbonate which releases carbon dioxide into the water. More carbon dioxide becomes available to the plant as more sodium hydrogen carbonate is added to the water.
- As the concentration of available carbon dioxide is increased, the number of bubbles released also increases. So an increase in carbon dioxide increases the rate of photosynthesis.

Effect of water on photosynthesis

- Water is necessary for the chemical reaction to take place. Plants need water to be turgid. If a plant does not have enough water the stomata will close hence the plant will not absorb carbon dioxide which is needed for photosynthesis.

Effect of chlorophyll on photosynthesis

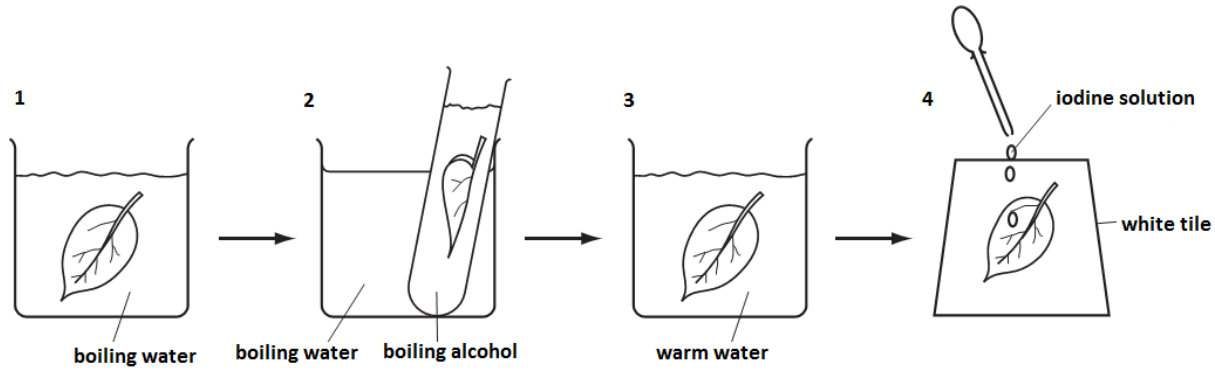
- The chloroplasts contain the green pigment chlorophyll. The chlorophyll traps light energy and converts the light to chemical energy in form of carbohydrates. Without chlorophyll to trap light energy photosynthesis cannot take place.

Effect of temperature on photosynthesis

- As temperature increases so does the rate of photosynthesis
- A rise in temperature will increase the rate at which carbon dioxide is combined with hydrogen to make carbohydrate.

Products of photosynthesis

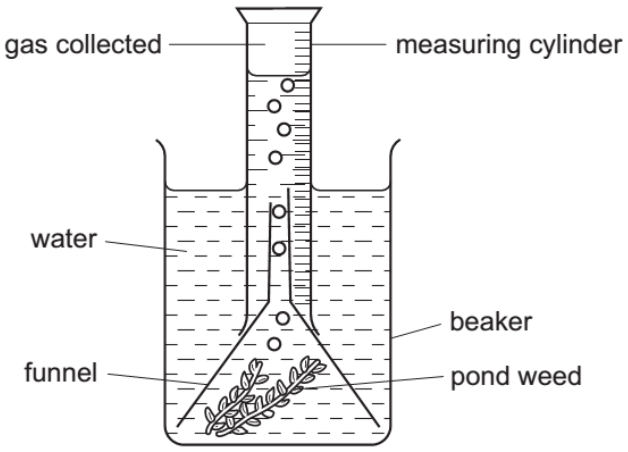
Testing a leaf for starch



- Boil the leaf in hot water to kill the cells and stop all chemical reactions and make the leaf permeable to iodine solution
- Boil the leaf in alcohol to decolorize it.
- Precaution: extinguish all flames because alcohol is highly flammable.
- Dip the leaf in hot water to soften it and wash away the methylated spirit.
- Place the leaf on a white tile and add iodine solution.
- Blue black colour shows the presence of starch.

Test for oxygen

- Place a pond weed in water and invert a short stemmed funnel over it
- Fill a test tube with water and invert it over the stem of the funnel without letting any water to escape.
- Place the apparatus in sunlight for about 4-6 hours and observe what happens.
- Remove the test tube by lifting it upwards so that the gas remains in it



- Test the gas in the test tube with a glowing wooden splint.

- The glowing splint bursts into flames or glows brighter. Relighting of the splint indicated presence of oxygen in higher concentration than in ordinary air.

Fate of end products of photosynthesis

Glucose

- Glucose is converted to starch in leaf cells for temporary storage to prevent osmotic effects on leaf cells during the day.
- At night starch is converted to sucrose in leaves. Sucrose is translocated through phloem vessels to storage organs e.g. roots, stem tubers or fruits.
- Some carbohydrates are converted to
    1 amino acids which are used to make proteins to make enzymes and for structural purpose e.g. cell
    2 Cellulose for cell wall formation.
    3 Lipids for cell membranes

Oxygen

- Oxygen released into the atmosphere as a by-product and is used for respiration by plants and animals.

HUMAN NUTRITION

BALANCED DIET

- A balanced diet is a diet that contains all the essential nutrients in their correct proportions.

Components of a balanced diet

Carbohydrates

- Carbohydrates are energy rich foods that are largely made up of starch and sugars.
- They are easily broken down to glucose which helps the body generate energy through cellular respiration.
- Supplies dietary fibre.
- Starch is abundant in potatoes, bread, maize, rice and other cereals. Sugar appears in our diet mainly as **sucrose** (table sugar) which is added to drinks and many prepared

foods such as jam, biscuits and cakes. Glucose and fructose are sugars that occur naturally in many fruits and some

Lipids (fats and oils)

- Supplies energy and heat. They contain higher energy values per gram than carbohydrates.
- Help the body to absorb certain vitamins
- Form structural components of cell membranes
- Help in blood clotting
- Stored fats help to cushion internal organs and protect the body from extreme cold
- Animal fats are found in meat, milk, cheese, butter and egg-yolk. Plant fats occur as oils in fruits (e.g. palm oil) and seeds (e.g. sunflower seed oil), and are used for cooking and making margarine.

Proteins

- Promotes growth and repair of body tissues
- Builds antibodies to fight infection
- Supplies energy in the absence of carbohydrates
- Speed up chemical reactions and serve as chemical messengers in the body
- Lean meat, fish, eggs, milk and cheese are important sources of animal protein. All plants contain some protein, but soybeans, seeds such as pumpkin, and nuts are the best sources.

Vitamins

- Allow the body to grow and develop
- Play important roles in metabolism, immunity i.e. they help to fight infections and digestion and are required in minute quantities in order for metabolism to occur
    - *Vitamin A (retinol)* – Needed for growth and reproduction. Promote good sight and vision especially in dim light. Maintain the health of skin and membranes. Helps develop bones and teeth. Helps fight infection. Sources include green vegetables, spinach, liver, egg, palm oil
    - *Vitamin C (ascorbic acid)* – maintains healthy teeth and gums. Helps wound healing and helps the body to use iron. It acts as an anti-oxidant that protects the body from harmful free radicals. It forms part of an enzyme needed for protein

metabolism and maintaining healthy immune system. Sources include oranges, lemons, tomatoes, guava, pawpaw, mango, green vegetables

- *Vitamin D (calciferol)* – for bone formation and maintain teeth. Helps the body to use calcium and phosphorus. When exposed to sunlight, the skin produces vitamin D. Sources include liver, milk, egg yolk, fish-liver oils.

Mineral salts

- Essential for the chemical activities (enzyme action) in the body and for construction of certain tissues.
    - *Iodine* – for the formation of hormone thyroxin in the thyroid gland which help to control many processes in the body like growth and development.
    - *Calcium* - for the formation of strong bones and teeth. It is also needed for proper muscle contraction and relaxation. Promotes proper functioning of nerves, regulating blood pressure and normal blood clotting. The richest sources of calcium are milk (liquid, skimmed or dried) and cheese, but calcium is present in most foods in small quantities and also in 'hard' water
    - *Iron* – for the formation of haemoglobin in the red blood cells and transport oxygen in the body. Red meat, especially liver and kidney, is the richest source of iron in the diet, but eggs, groundnuts, whole grains such as brown rice, spinach and other

Dietary Fibre

- It is made up of cellulose (plant fibre) and it aid digestion process by helping bowl movement through the digestive tract.
- The fibre itself and the bacteria, which multiply from feeding on it, add bulk to the contents of the colon and help it to retain water. This softens the faeces and reduces the time needed for the undigested residues to pass out of the body. Both effects help to prevent constipation and keep the colon healthy.
- Fibre binds with cholesterol to reduce cholesterol levels in the blood
- Good sources of dietary fibre are vegetables, fruits and whole wheat bread.

Water

- About 70% of most tissue consists of water; it is an essential part of cytoplasm. The body fluids, blood, lymph and tissue fluid are composed mainly of water.

- Water acts as a solvent and as a transport medium for digested foods, salts, vitamins and urea.
- Digestion is a process that uses water in a chemical reaction to break down insoluble substances to soluble ones. These products then pass, in solution, into the bloodstream.
- In all cells there are many reactions in which water plays an essential part as a reactant and a solvent.
- Regulates body temperature through sweating and evaporation

Balanced meal for different groups of people

Toddler

- Breast feeding can continue until two years and even beyond
- The child needs extra protein for making new tissues as the child grow.
- Large amounts of starchy foods such as cassava, potatoes or rice should be avoided because the child soon feels full up yet may not have taken in sufficient protein.
- The child should be given protein rich food such as meat, chicken, fish or eggs every day. These will help build strong muscles.
- Give a variety of fruits everyday these provide vitamin and healthy fibre
- Give dark green and yellow vegetables , as they are rich in vitamins for protection against diseases
- They need extra Calcium for growing bones, iron for their RBC
- Encourage the toddler to drink clean, fresh water throughout the day

Adolescent

- Vigorously active, playful and growing. Needs a balanced diet with increased protein, calcium, vitamin D and phosphates for rapid growth, bone and teeth development.
- They need high quality of body building foods and starchy foods to provide energy and dietary fibre.
- Drink clean safe water

Manual worker

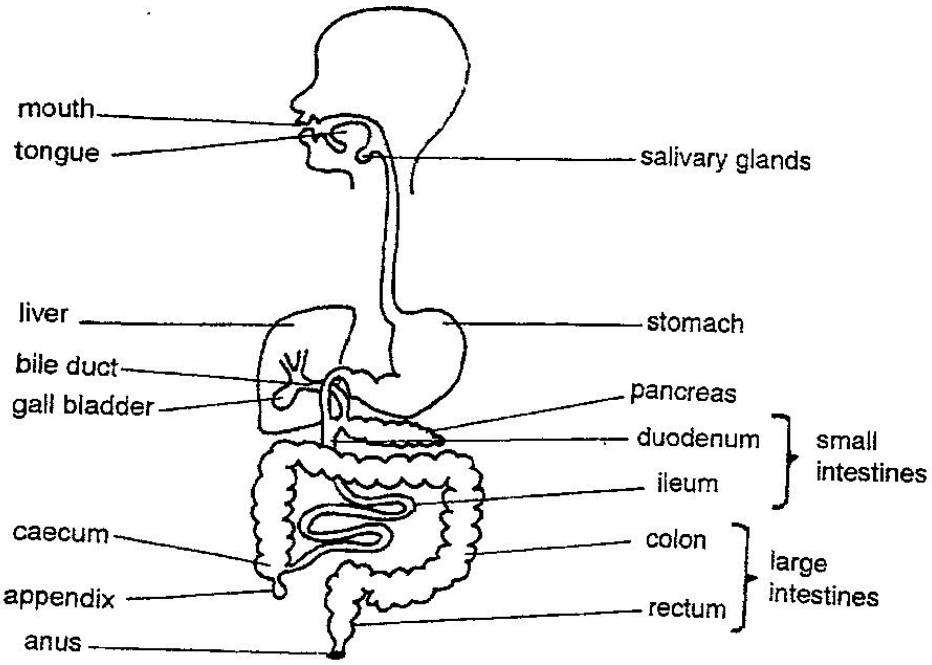
- Is a person who does physical work for most of the day e.g. builder, road worker
- Uses a lot of energy and sweats a lot therefore need a balanced diet with higher energy giving foods, more salts and water to replace lost energy, water and salts.

- Increase the amount of proteins eaten to provide for strong muscles
- Sugary foods can be eaten in moderation, as they will provide quick energy.
- Drink lots clean safe water if working in hot sun
- Eat plenty of vegetables and fruits everyday

Sedentary worker (office worker)

- Usually office workers do not move around a lot at work. Needs a balanced diet with less energy giving foods to avoid overweight.
- Avoid sugary and high fat foods as this can cause obesity.
- Eat plenty of different varieties of vegetables, fruits, legumes and small portions of protein
- Nutrients are needed for normal functioning of the body

ALIMENTARY CANAL



FUNCTIONS OF PARTS OF THE ALIMENTARY CANAL

Ingestion

- It is the intake of complex organic food into the body through the mouth (eating) and chewing it into smaller pieces.
- The mouth, tongue and teeth are involved with ingestion. The teeth chop and grind food into smaller pieces, increasing surface are of the food on which enzymes can act.

Saliva, produced by salivary glands also moisten food, allowing us to taste it and make it easier to swallow

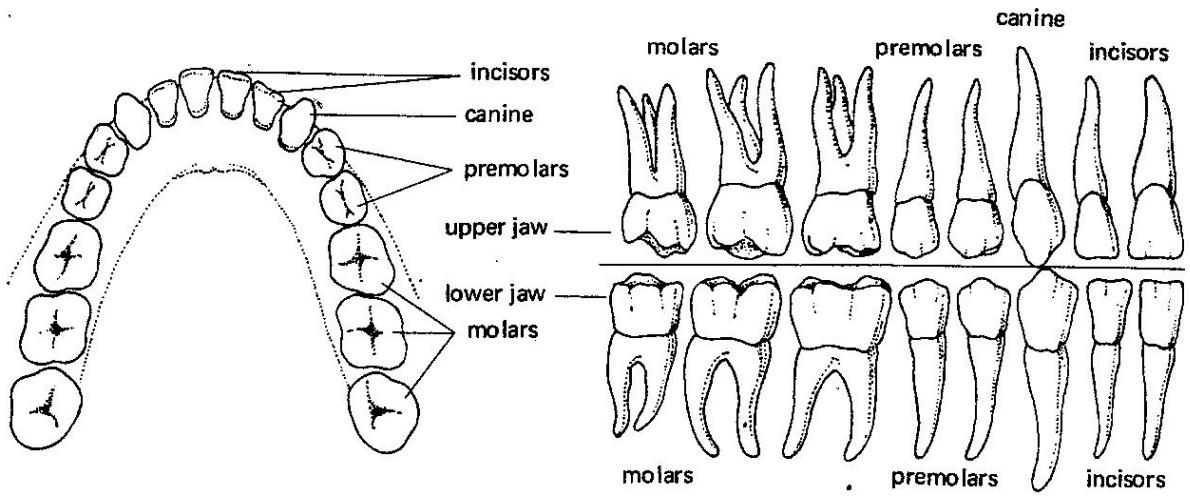
- The food bolus is rolled into bolus and pushed to the back of the mouth ready to be swallowed

Human Teeth

- Teeth chop and grind the food into smaller pieces, increasing the surface area of the food on which enzymes can act.

Types of teeth and their functions

- Each type of tooth is specialised to perform a particular function.
- From the centre of each jaw outwards, one half of each jaw contains two incisors, one canine, two premolars and three molars.
- There are normally 32 permanent teeth in an adult human.



Incisor

- Are eight teeth in front center of the mouth (4 on top and 4 on bottom jaw)
- They are chisel shaped teeth (flat teeth with flat edges) to provide a cutting surface.
- They are used for biting and cutting food.
- They have a single root to support the tooth in the jaw.

Canines

- They are pointed teeth found on either side of incisors.
- They are used for gripping and tearing food.
- They have a single root for supporting the tooth in the jaw.

Premolars

- Have a flat surface with cusps suitable for crushing and grinding.
- They are used for crushing and grinding (chewing) food. Small ridges on the surface also helps with grinding
- They have two roots for support.

Molars

- Are the largest teeth with a large flat biting surface
- Their function is similar to that of the premolars, to grind and crush food

Digestion

- Is the breakdown of food into simpler soluble inside the organism.
- Digestion takes place in the mouth, stomach and small intestines.
- There are two types of digestion i.e.
    a) *Mechanical (physical) digestion* – Involves the physical break down of food into smaller particles, increasing surface area over digestive enzymes can act. This is achieved by the chewing actions of the teeth in the mouth and churning food in the stomach and intestine. Bile physically digests fats by emulsifying them – turning them into small droplets with a large surface area
    b) *Chemical digestion* – Is the use of enzymes to break down large, insoluble molecules into small, simpler molecules that can easily be absorbed through the lining of the gut to the blood vessels. It starts in the mouth, continues in the stomach and is completed in the small intestines.

Digestion in the mouth

- The food is chewed by the teeth in the mouth (mechanical digestion) and broken down into smaller molecules. The food is mixed with saliva.
- Saliva helps to moisten and lubricate the food making it slippery and allowing it to move down the alimentary canal easily.
- Saliva contains also contains an enzyme called *salivary amylase* which starts the chemical digestion of cooked starch and converts it to maltose The food is rolled into bolus and pushed to the back of the mouth ready to be swallowed.

Swallowing

- The beginning of swallowing action is voluntary, but once the food reaches the back of the mouth, swallowing becomes automatic.
- The food bolus is forced into and down the oesophagus by peristalsis.
- Peristalsis involve the involuntary rhythmic contraction and relaxation of the muscles through-out the alimentary canal.
- The walls of the oesophagus contains two layers of muscle i.e. the circular and the longitudinal muscles. Circular muscles behind the food bolus contracts, constricting the oesophagus or intestines pushing the bolus forward while longitudinal muscles ahead of the bolus contracts, widening the oesophagus to allowing the bolus to move along the gut.

Digestion in the stomach

- The muscles in the walls of the stomach alternately contract and relax churning and squeezing the food and mixing food with gastric juice to form *chyme.* This action gives the food a greater surface area so that it can be digested more efficiently.
- Glands in the lining of the stomach produce gastric juice which contains mucus, enzymes (rennin & pepsin) and hydrochloric acid.
    - ✓ Hydrochloric acid kills any bacteria that the stomach with food. It provides the proper medium of action of pepsin (buffer). Hydrochloric acid dissolves insoluble minerals (hydrolysis)
    - ✓ Rennin assist in the coagulation of milk protein thus preventing it from passing too rapidly through the alimentary canal before it can be digested.
    - ✓ Pepsin to breakdown proteins into polypeptides.
    - ✓ Mucus lines the stomach to protect the stomach tissues from hydrochloric acid

Digestion in the small intestines

Duodenum

- Pancreatic juice from the pancreas and bile from liver are poured into the duodenum.
- The food from the stomach is acted upon by several enzymes found in the pancreatic juice. These enzymes chemically break down the food making it smaller and more soluble and so more easily absorbed by the body.
    - ✓ Pancreatic amylase acts on starch that were not digested in the mouth converting it to maltose

- ✓ Trypsin acts on proteins breaking them to peptides and then amino acids which are more soluble
- ✓ Pancreatic lipase hydrolyses fats into fatty acids and glycerol. The digestion of fats is aided by bile. Bile emulsifies fats, splitting their large molecules into a smaller milky colloid called an emulsion so that lipase can act on fats more readily. Bile also neutralise the acidic chyme

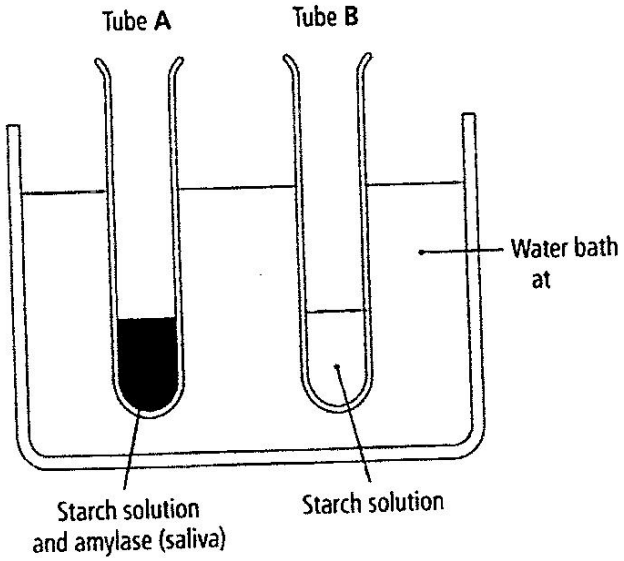
Ileum

- All digestion is completed here. The walls of the ileum secrete several digestive juices with various enzymes to complete digestion of food produce intestinal juice which contains enzymes that will complete the digestion of all food substances.
  - ✓ Maltase breaks down maltose to glucose
  - ✓ Sucrose breaks down sucrose to glucose and fructose
  - ✓ Lipase breaks fats into fatty acids and glycerol
  - ✓ Trypsin breaks polypeptides to amino acids

The importance of digestion

- Digestion reduces molecule size and improves solubility so that food can be absorbed and transported to all parts of the body.

The action of amylase on starch



- Half fill a beaker with water and warm it to about 40^{o}C.

- Place equal quantities of starch solution in to each test tube. To one test tube add $10cm^3$ of 1% salivary amylase and mix.
- Remove a small amount of starch solution from both test tubes after intrevals of five minutes. Test the samples for the presence of starch.
- The iodine test showed increasingly negative results when testing for starch in the test tube that contained saliva. The test tube that contained only starch solution continued to give the same positive results for starch. This is because the amylase enzyme present in saliva gradually digested the starch to a reducing sugar.
- Since iodine tests only for starch, it would detect the products of starch digestion and therefore would result in a negative test.

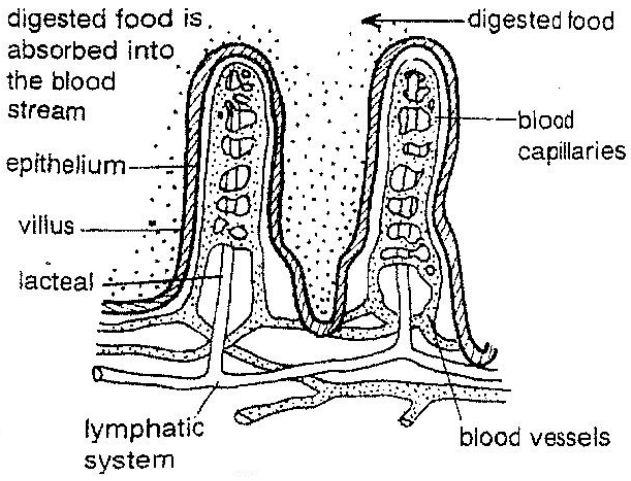
The end products of digestion

- End products are simple molecules that are soluble in water i.e. can diffuse through tissues and can be absorbed and used for metabolic functions.
    - ✓ Carbohydrates – glucose, fructose, galactose (simple sugars)
    - ✓ Proteins – amino acids
    - ✓ Fats – fatty acids and glycerol

Absorption

- It is the process of taking in of soluble food substances through the epithelium of ileum into the bloodstream.

Absorption in the ileum



- The end products of digestion are absorbed into the blood stream in the ileum while fatty acids and glycerol pass into the lacteals connected to the lymphatic system.

- The ileum has certain characteristics that make it efficient in the absorption of digested food i.e.
    - ✓ The ileum is usually fairly long and presents a large absorbing surface to the digested food.
    - ✓ The internal surface is greatly increased by circular folds bearing thousands of tiny finger-like projections called *villi.* This gives a larger surface area for absorption of nutrients
    - ✓ The lining epithelium is very thin and the fluids can pass rapidly through it to reach the blood capillaries and lacteals
    - ✓ There is a dense network of blood capillaries in each villus. Most digested food enters the capillaries directly except for fatty acids which enter a tube in the middle of the villus called lacteal.
- The small molecules of digested food molecules pass through the epithelial cells and then through the wall of the capillaries in the villus and into the blood plasma by diffusion.
- They are then carried away in the capillaries which join to form the hepatic portal vein. This carries all the blood from the intestines to the liver, which may retain or alter any of the digestion products. The digested food then reaches the general circulation.
- Digested fats , enter the blood capillaries of the villi but a large proportion may be recombined in the intestinal lining to form fats and then these fats pass into the lacteals
- Some molecules pass in the same direction by active uptake e.g. salts. Energy is required to absorb these molecules

Absorption in large intestines

- The material passing into the large intestines consists of water with undigested matter, largely cellulose and fibres, mucus and dead cells from the lining of the alimentary canal
- The bacteria in the colon digest part of the fibre to produce vitamin B. The colon absorbs most of the water and vitamin B from the undigested residues.

Assimilation

- It is the utilization of absorbed nutrients by body cells in metabolic processes. The products of digestion are carried round the body in the plasma. From the blood, most living cells are able to absorb and metabolise glucose, fats and amino acids

Glucose

- During respiration in the cells, glucose is oxidised to carbon dioxide and water. This reaction provides energy to drive the many chemical processes in the cells, which result in, for example, the building-up of proteins, contraction of muscles or electrical changes in nerves.

Fats

- These are built into cell membranes and other cell structures. Fats also form an important source of energy for cell metabolism. Fatty acids produced from stored fats or taken in with the food, are oxidised in the cells to carbon dioxide and water. This releases energy for processes such as muscle contraction. Fats can provide twice as much energy as sugars.

Amino acids

- These are absorbed by the cells and built up, with the aid of enzymes, into proteins. Some of the proteins will become plasma proteins in the blood. Others may form structures such as cell membranes or they may become enzymes that control the chemical activity within the cell. Amino acids not needed for making cell proteins are converted by the liver into glycogen, which can then be used for energy. Excess is deaminated in the liver to form glycogen and urea

Egestion

- It is the elimination from the body of the undigested food substances and wastes through the anus.
- The semi-solid wastes (faeces) are passed into the rectum by peristalsis and is expelled at intervals through the anus.

MALNUTRITION

- It is undernourishment or over-nourishment i.e. lack of balanced diet either because of shortage of a particular nutrient or an excess
- It is a disorder of nutrition resulting from unbalanced diet.

Effects of malnutrition

Obesity

- Is caused by high intake of carbohydrates which results in excess being stored as fat under the skin. The person may gain weight and become obese

Effects

- Increased risk of developing heart diseases, type 2 diabetes and bone and joint diseases

Anorexia nervosa

- Involves self-starved and excessive weight loss
- The body is denied the essential nutrients it needs to function normally, so it is forced to slow down all its processes to conserve energy

Effects

- Heart failure as heart rate and blood pressure becomes lower
- Muscle loss and weakness
- Severe dehydration which can result in kidney failure
- Fatigue

Diabetes mellitus 2

- Occurs as a result of obesity and not enough exercise

Effects

- Risk of cardiovascular diseases/heart diseases
- Stroke
- Blindness
- Kidney failure

DEFICIENCY DISEASES

- A ***deficiency disease*** is a disease caused by the lack of an element in the diet, usually a particular protein, vitamin or mineral salts possibly stemming from insufficient intake, absorption or utilization of a nutrient.

Kwarshiorkor Is caused by lack of proteins in a diet. Children with kwarshiorkor are under weight but have an enlarged abdomen caused by a swollen liver. The children

are inactive and irritable. To recover, the child is fed a high protein diet in the form of dried skimmed milk.

Goitre Goitre is a swelling or large mass on the throat which results from abnormal growth of the thyroid gland. Goitre is caused by lack of iodine in the diet lack iodine can lead to stunted growth, deafness and mental retardation. Use of iodised salt prevents the development of goitre

Scurvy Is caused by lack of vitamin C in a diet. A person with scurvy bruises and has joint and muscles pains. It is also causes dry skin and tooth loss. Scurvy is treated by taking tablets containing vitamin C and eating fresh citrus fruits and yellow vegetables

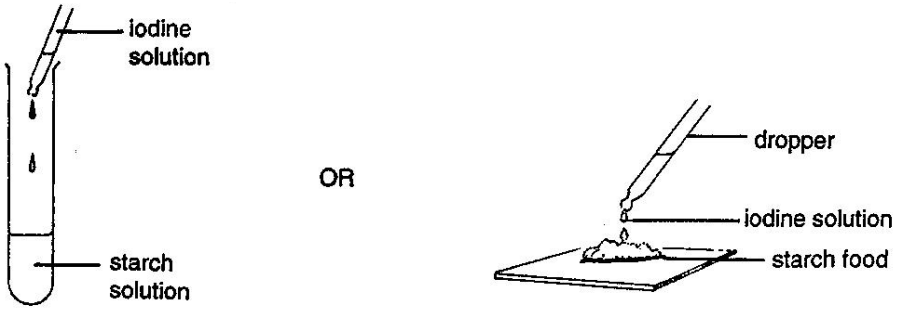
Anaemia Is caused by lack of iron. Without iron the body is unable to make enough haemoglobin so that the blood so that the blood cannot carry enough oxygen to body cells hence less energy is made available in cells leading to tiredness and weakness, a condition known as anaemia. It can be corrected by eating foods rich in iron

Night blindness Is caused by lack of vitamin A in the diet.

Beriberi Is caused by lack of vitamin B_1

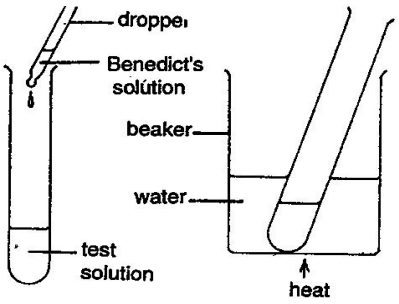
FOOD TESTS

Test for starch



- A little starch powder is shaken in a test tube with some cold water and then boiled to make a clear solution.
- Add a few drops of iodine solution
- Iodine solution turns blue-black if starch is present

Test for reducing sugar



- Add Benedict's solution to about 5cm^3 of food solution and heat gently in a water bath.
- The Benedict's solution changes from green/orange to red/brown/brick red precipitate

Test for proteins

- Add 5cm^3 of sodium hydroxide to the food sample

  Care; sodium hydroxide is caustic, do not allow it on the skin
- Add 5cm^3 of 1% copper sulphate solution.
- A purple colour indicates the presence of proteins

Test for fats

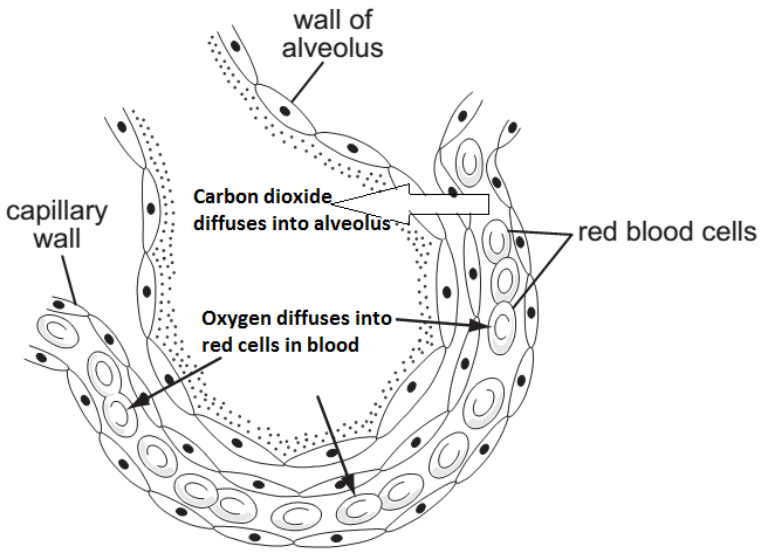
- Place about 5cm^3 of food solution in a test tube.
- Add 5cm^3 of ethanol and shake thoroughly until the fat dissolves
- Add 5cm^3 of water
- A cloud white emulsion forms if fat is present

RESPIRATORY SYSTEM

GASEOUS EXCHANGE

Gaseous exchange in the alveoli

- The alveoli are respiratory surfaces where gaseous exchange take place



- Air in alveoli has more oxygen than the surrounding blood capillaries therefore oxygen diffuses into the blood capillaries.
- There is more carbon dioxide proportion in the blood than in the alveoli therefore carbon dioxide diffuses from blood into the alveoli.

Adaptations of the alveoli for gaseous exchange

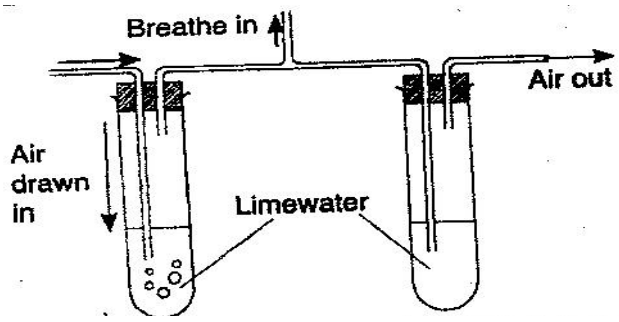
1. Globular/pocket/sac-like in shape to provide a large surface area for gaseous exchange.
2. Moist epithelial surfaces to dissolve carbon dioxide and oxygen for easy diffusion.
3. Thin walled epithelial (one cell thick) to allow gases to diffuse easily into capillaries.
4. Extensive network of blood capillaries to carry away oxygen and to bring carbon dioxide to increase concentration gradient and facilitate diffusion.
5. Numerous alveoli to increase surface area to maximise diffusion.

INHALED AND EXHALED AIR

Difference between inhaled and exhaled air

- Inhaled air has more oxygen (21%) than exhaled air (16%) since oxygen is used during respiration.
- Inhaled air has less carbon dioxide (0.03%) than exhaled air (4%) since carbon dioxide is produced in the process of respiration.
- Inhaled air has variable moisture while exhaled air is saturated since water is produced during respiration.
- Inhaled air is cool while exhaled air is warm since heat energy is also produced during respiration

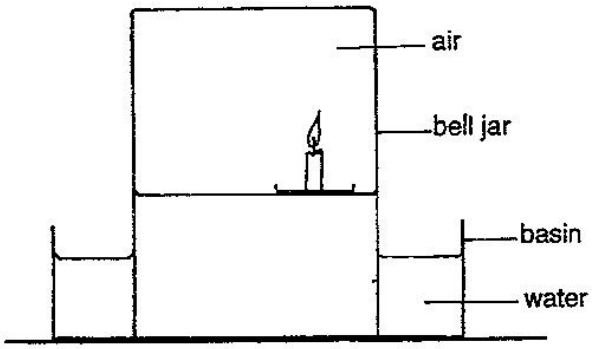
Experiment to show the change in proportion of carbon dioxide in inhaled and exhaled air



- Half fill two test tubes with lime water or bicarbonate indicator and connect with tubing or straw.
- Breathe in and out through the mouth piece, blocking the outlet tube when breathing in and blocking the inlet tube when breathing out, allowing inspired air to pass through the limewater or bicarbonate indicator tube in B.
- Air bubbles are seen A when you breathe in and in B when breathing out.
- Lime water in B turns milky or bicarbonate indicator in B turns yellow, while in A it remained clear.
- Therefore there is much more carbon dioxide in exhaled air.

Experiment to show the change in proportion of oxygen in inhaled and exhaled air

- Place a candle inside a container with inhaled and exhaled air and measure the water displacement.
- Water displacement in inhaled air is greater and the candle burns for a longer time than in exhaled air. This is because inhaled air contains more oxygen and less carbon dioxide when compared to exhaled air which contains less oxygen and more carbon dioxide.



RESPIRATION

Aerobic respiration

- Involves the use of oxygen in the breakdown of carbohydrates or fats which are eventually oxidized completely to carbon dioxide, water and energy

$$glucose + oxygen \rightarrow carbon\ dioxide + water + energy$$

- During respiration the energy is transferred to the special energy carrier molecules, Adenosine Trios phosphate (ATP). The ATP spontaneously release energy when it is required in the cell.

Anaerobic respiration

- Is the breakdown of carbohydrates to release energy without the use of oxygen
- Glucose is broken down incompletely and only some (less) of the energy is released. The intermedial compounds such as lactic acid or alcohol are produced.

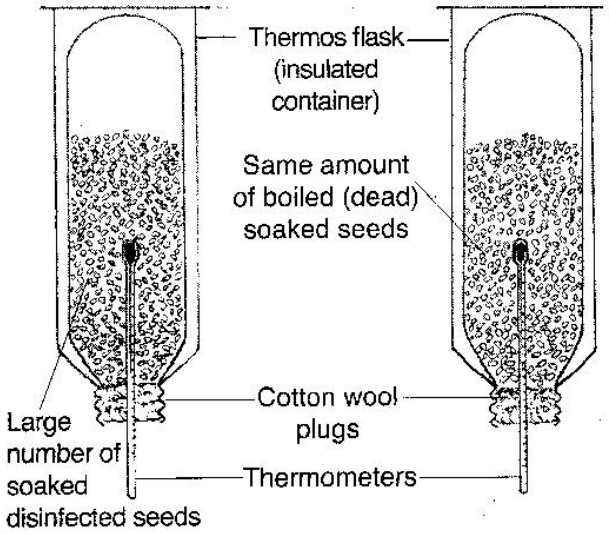
$$\text{glucose} \rightarrow \text{lactic acid} + \text{little energy}$$

$$\text{glucose} \rightarrow \text{carbon dioxide} + \text{alcohol} + \text{energy}$$

Experiments to show release of energy from germinating seeds

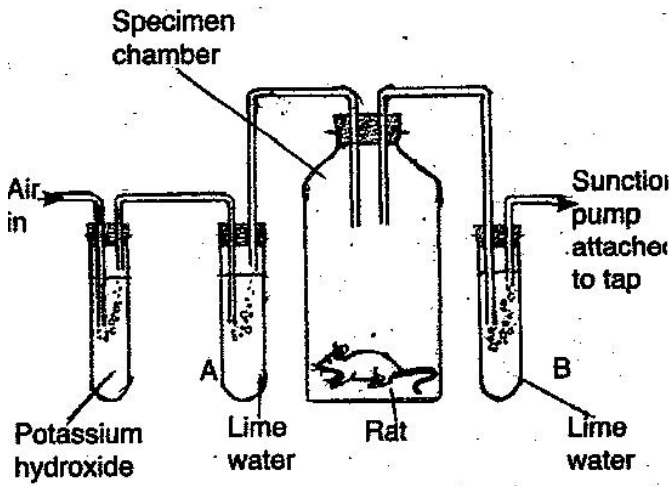
- Soak the seeds overnight so as to soften the coat and boil half of the soaked seeds for 15minutes
- Rinse them in a mild disinfectant e.g. sodium hydrochlorite to prevent the seeds from rotting as a result of bacterial of fungal activity.
- Place each set of seeds in thermos flasks and insert a thermometer. Plug cotton wool and clearly label A and B. Flasks are insulated with a cotton lagging to prevent heat loss by conduction
- Flasks are inverted so that the bulb of each thermometer is surrounded by seeds allowing the reading of the thermometers to be taken more easily.

- Record the temperature of each flask and leave for a week. Record the temperature daily



- Temperature rise was high in A than B
- Rise in temperature in flask A is caused by heat produced by respiring germinating seeds while in B seeds did not germinate hence no heat was produced because boiling killed the seeds

Experiments to show release of carbon dioxide from animals

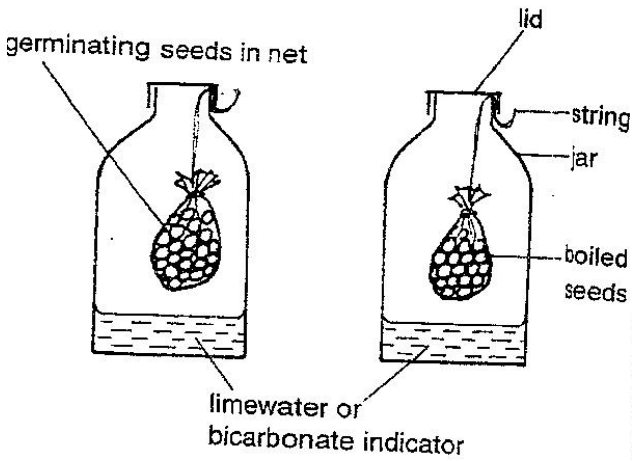


- Set up apparatus as shown in the diagram. Using rubber tubing at joints allow flexibility
- Describe observations after 30 minutes
- NaOH or KOH was used for absorption of carbon dioxide in the incoming air.

- Limewater in test tube B is for testing the incoming air to confirm that it is free from carbon dioxide by remaining clear.
- Air without carbon dioxide enters the bell jar with the animal.
- Limewater in B remained clear and that of D turned milky. This is because of high carbon dioxide concentration in the air exhaled by respiring animal

Experiments to show release of carbon dioxide from germinating seeds

- Soak seeds overnight so as to soften the coats.
- Boil half of the soaked seeds for 15 minutes to kill them.
- Wash both sets of seeds in a disinfectant and put them into each of the two net bag
- Add equal volume of limewater or bicarbonate indicator into each of the jars.
- Hang the nets filled with dead seeds and germinating seeds in the jam jars using strings.
- Close the jars tightly using lids and leave the jars for about 24 hours



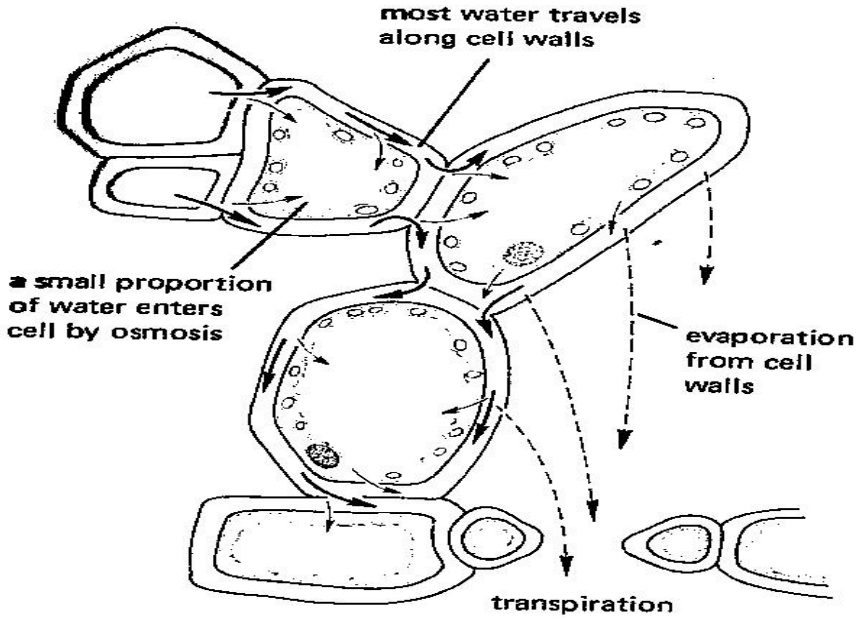
- Lime water in A turns milky while in B it remained clear.
- This is because as seeds germinate, they respire releasing carbon dioxide. Boiled seeds were killed hence did not respire and no carbon dioxide produced

TRANSPORT SYSTEM

TRANSPORT IN PLANTS

TRANSPIRATION

- Transpiration is the process by which plants lose water as vapour into the atmosphere.
- Turgor pressure in mesophyll cells force outwards through the cell walls. From the outer surface of the cell walls, the water evaporates into the air spaces and diffuses out of the stomata into the atmosphere.



Factors affecting the rate of transpiration

Temperature	High temperature provides latent heat of evaporation and therefore encourages evaporation of water from the mesophyll cells thus increasing the rate of transpiration.
Relative humidity	The lower the relative humidity of the surrounding atmosphere the greater the saturation deficit and the faster the water vapour escapes through the stomata. When humidity is high transpiration will be high.
Air movement	Air movement blows away saturated water vapour from leaf surfaces and so increases the rate of evapo-transpiration.
Light intensity	If light intensity is increased the rate of evaporation from a plant increases. Light causes stomata to open thereby increasing water loss from the plant.

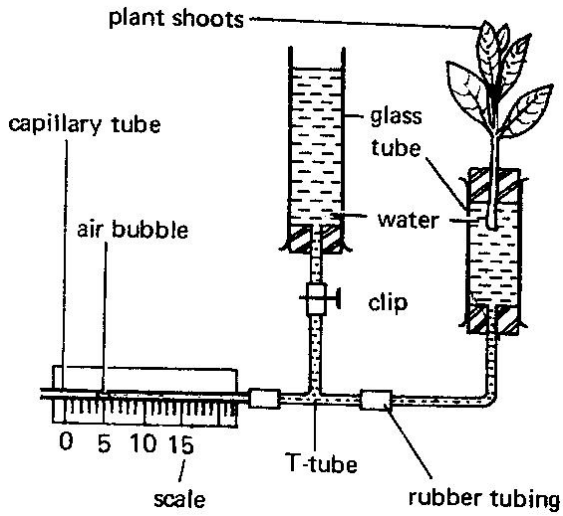
Surface area Large surface area of leaves allow evaporation of more water vapour thus causing high transpiration.

Number of stomata The more the stomata present the higher the rate of transpiration. More stomata are found on the lower surface of leaves, away from sunlight and wind.

Measuring transpiration in a plant

The Potometer

- It is an instrument used to measure the rate of water uptake by a plant or rate of water loss by a plant.
- As the plant leaves transpire, the plant uses water from the Potometer. The air bubble in the water moves along the capillary tube, showing the amount of water the plant uses. The water level in the beaker drops as a result.
- The tap below the reservoir is opened to add water to the glass capillary so that air bubble can be pushed back to its starting point.
- Precautions taken include;
    - Make sure that the stem fits tightly into the rubber tubing. Seal with Vaseline.
    - The shoot must be cut under water and inserted under water to avoid any air bubbles that can block the xylem preventing further water uptake.
    - Leaves must be dry



- To investigate factors influencing the rate of transpiration, a Potometer is placed under is placed under different atmospheric conditions such as placing it in a humid atmosphere, warm or sunny spots or wind (in front of a fan).

- The speed that the bubble moves with along the capillary tube under these different atmospheric conditions will indicate the rate of transpiration.

$$rate\ of\ transpiration = \frac{distance\ moved\ by\ air\ bubble}{time\ in\ seconds}$$

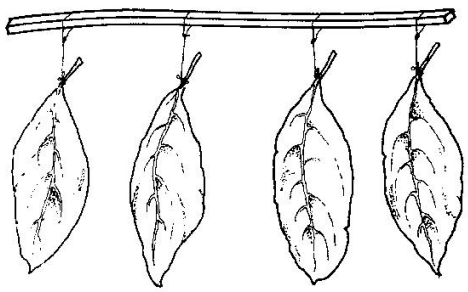
Importance of transpiration

- Cooling the plant
- Uptake of water
- Uptake of salts

Adaptations of plant leaves to reduce transpiration

- Leaf surfaces may have sunken stomata covered with hairs. The hairs slow down air movement and trap water vapour. This decrease concentration gradient hence slowing rate of transpiration.
- May have thick cuticle making the leaf more waterproof
- Reduced leaf size in some plant species to reduce transpiration. Smaller leaves have a smaller surface area than large leaves. The smaller leaves will lose less water.
- Some grass curl up (fold/roll) their leaves inwards to reduce the surface area exposed to air and water vapour
- Fewer stomata per unit surface area will result in less water being lost by the leaf.
- More stomata are found on the lower surface of leaves to prevent them from being exposed to the sun and wind to reduce transpiration rate.

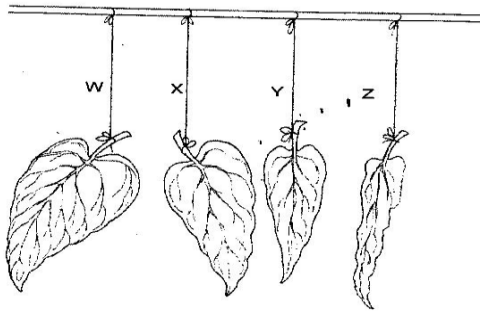
Experiment to demonstrate the distribution of stomata in water loss



- Take four similar leaves from a plant and label them as follows
    - W – put Vaseline on both surfaces of the leaf
    - X – put Vaseline on the lower leaf surface only
    - Y – put Vaseline on the upper leaf surface only

- Z – no Vaseline

- Tie the leaves with threads and hang them on a retort stand in the sun for about 6 hours and observe the leaves.



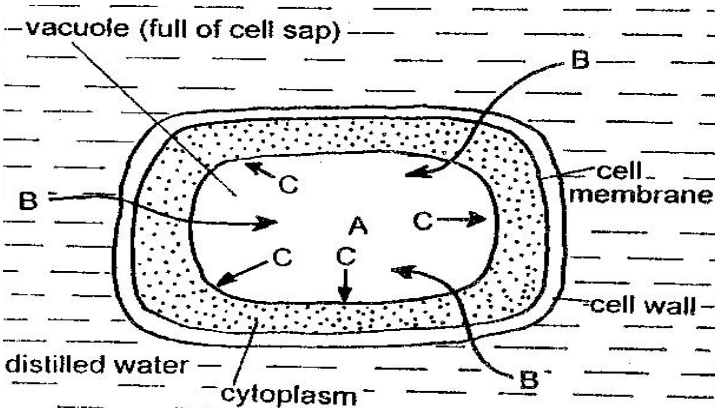
- W loses almost no water
- X loses only little water
- Y loses much water
- Z dries out

- This experiment shows that the lower surface of leaf loses much more water vapour than the upper side because there are more stomata on lower surface.
- The top is covered by a waxy cuticle that reduces water loss. Water is lost from plants through the stomata

TURGITY AND PLASMOLYSIS

Turgidity

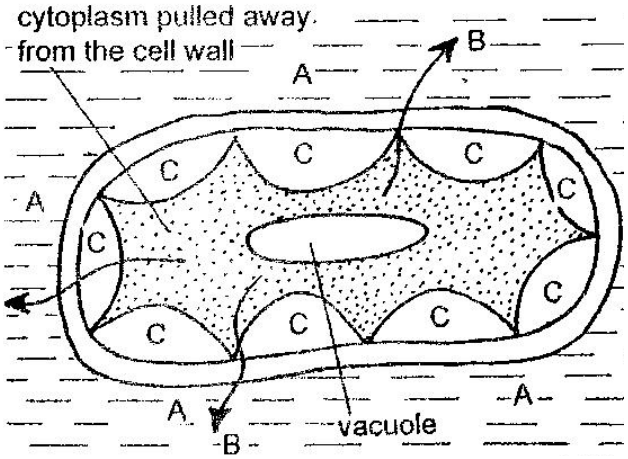
- Is when a cell is fully expanded due to the absorption of water.



- When a plant has enough water available water enters the cell forcing the vacuole to expand.
- The vacuole pushes the cytoplasm against the cell wall causing the cell to become turgid (stiff) thus builds up an internal pressure called Turgor pressure.
- Turgid cells are firm and support the plant to maintain its shape, resilient and strength

Plasmolysis

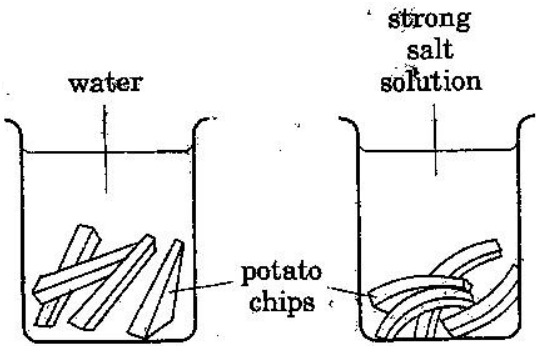
- Is the shrinking of protoplasm away from the cell wall of a plant due to loss of water by osmosis. In so doing leading to the cell membrane pull away from the cell wall



- When a plant cell is immersed into highly concentrated solution, water diffuses out of the cell, and Turgor pressure of the cell is lost. The cell becomes flaccid and the cell membrane is pulled away from the cell wall. Additional loss of water will lead to Plasmolysis, and finally the cell wall totally collapses.
- Further water loss results in wilting of the plant

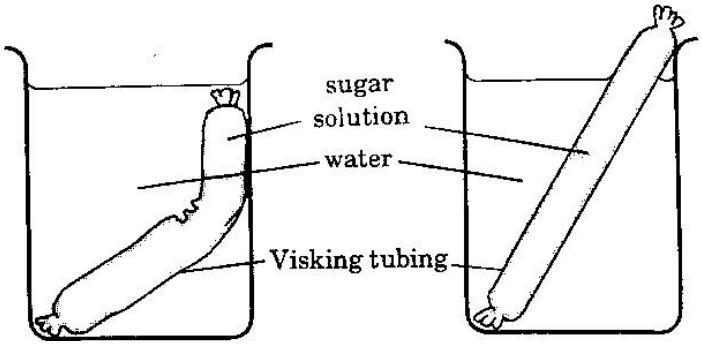
Experiment to demonstrate Plasmolysis and turgidity using potato strips

- Use potato strips obtained from a fresh potato, of same diameter and length.
- Add one piece of potato strips to each solution i.e. distilled water and 10% salt solution.



- Strip in distilled water increased in length and diameter while that one in sugar solution decreased.
- Strip in distilled gained water by osmosis and become turgid.
- Strip in salt solution lose water by osmosis and become flaccid.

Experiment to demonstrate Plasmolysis and turgidity using visking tubing

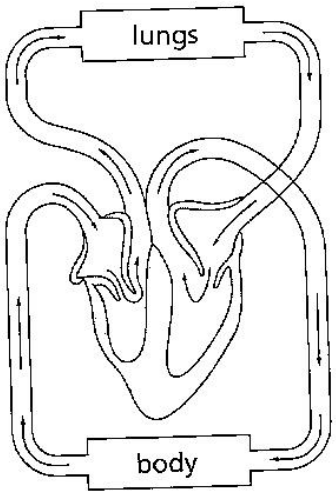


TRANSPORT IN HUMANS

BLOOD CIRCULATION

The double circulatory system

- Blood flows through the heart twice. Blood flows from the heart through a continuous system of blood vessels to different parts of the body and then returns to the heart and proceeds to the lungs.



- The circulatory system consists of pulmonary and systemic circulation systems.
    - Pulmonary circulation carries deoxygenated blood to lungs and oxygenated blood back to the heart. When the right ventricle contracts, deoxygenated blood is forced through the semi-lunar valve in the pulmonary artery towards the lungs for oxygenation. From the lungs oxygenated blood returns to the heart through the pulmonary veins and into the left atrium.
    - Systemic circulation carries oxygenated blood to the body parts and deoxygenated blood back to the heart. The left ventricle pumps oxygenated

blood into the aorta to all body parts. Blood returns to the heart through the inferior and superior vena cava

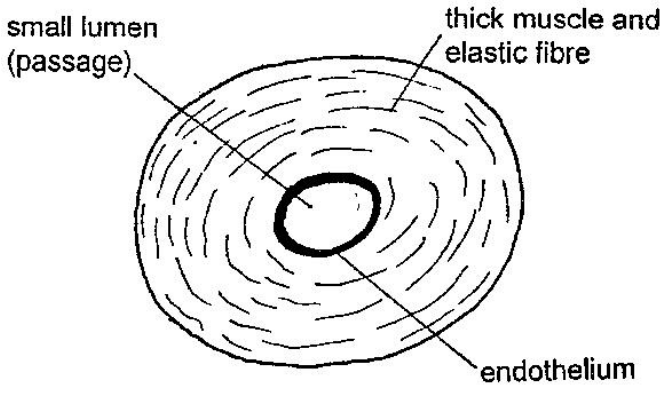
Functions of blood

1. Transport i.e.
    - Carbon dioxide from respiring cells to lungs
    - Oxygen from lungs to cells
    - Products of digestion from ileum to cells
    - Excreta from all metabolizing cells to liver
    - Hormones from endocrine glands to the target organs e.g. liver
    - Heat from main heat producing organs (liver and muscles) to all body parts
2. Homeostasis i.e.
    - Maintenance of a constant internal environment i.e. water, glucose, temperature
3. Defence i.e.
    - Carry white blood cells to site of infection to destroy pathogens
    - Carry platelets to site of infection for blood clotting to stop infection.

Blood vessels

Artery

- The function of the artery is to carry oxygenated blood away from the heart.

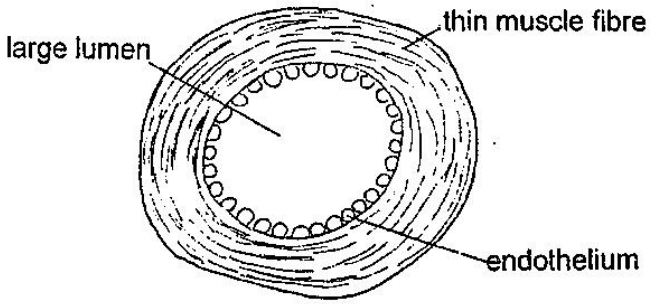


- Arteries have thick tough wall with muscles, elastic fibres and fibrous tissue. This prevents bursting since they carry at high pressure and help maintains pressure wave. Elastic fibres allow them to withstand the surges of high pressure caused by heart beat.
- The lumen is quite narrow. This helps to maintain blood pressure

- Valves are absent. High pressure prevents backflow of blood

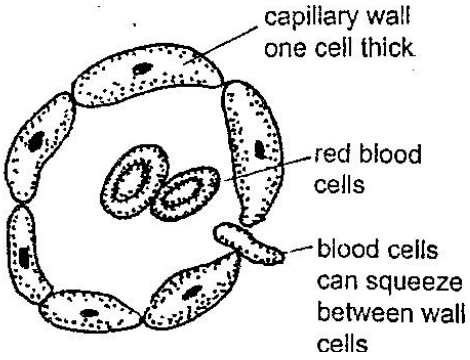
Vein

- The function of the vein is to carry deoxygenated blood to the heart.



- Veins are thin walled – mainly fibrous tissue, with little muscle or elastic fibre. This is because they carry blood at low pressure.
- They have large lumens to reduce resistance to blood flow
- Valves are present to prevent backflow of blood. Contraction of body muscles compresses the veins assisting the return of oxygenated blood to the heart.

Capillary

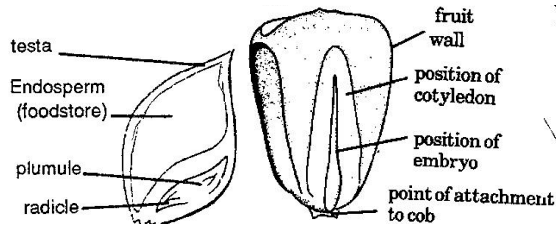
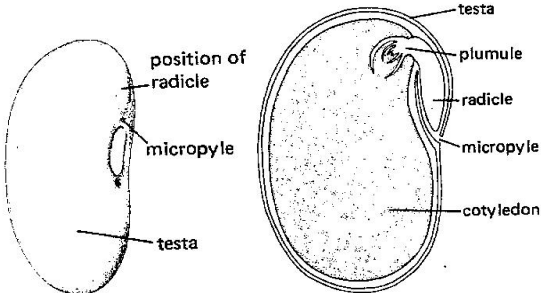


- Capillaries allow oxygen and food molecules to diffuse into cells and wastes out of the cell.
- Capillaries have permeable walls which are one cell thick, with no muscle or elastic tissue to allow diffusion of materials between capillary and surrounding tissues.
- The lumen is very small to allow blood cells to squeeze through. Blood cells pass through slowly to allow diffusion of materials and tissue fluid.
- Valves are absent as blood is still under pressure though the pressure is lower than in arteries.
-

REPRODUCTIVE SYSTEMS

REPRODUCTION IN PLANTS

STRUCTURE OF SEEDS

Maize (monocotyledon)	Bean (dicotyledon)
 - One cotyledon - Endosperm as food store - Has pericap	 - Two cotyledons - Cotyledon as food store - Has testa

Functions of parts of seeds

- Testa – tough, hard coat which protect the seeds from fungi, bacteria and insects.
- Radicle – is the embryonic root which grows and develops into the root system of the plant.
- Plumule – is the leafy part of the embryonic shoot which grows and develops into the leafy system of the plant.
- Endosperm – food store
- Cotyledon – food store
- Micropyle – is a tiny pore in the testa that allows water to the embryo before germination.

GERMINATION

- Germination is the process by which an embryo starts to grow to form a seedling
- Germination starts when a seed absorbs water through the micropyle which causes the seed to swell and the seed coat (testa) breaks.

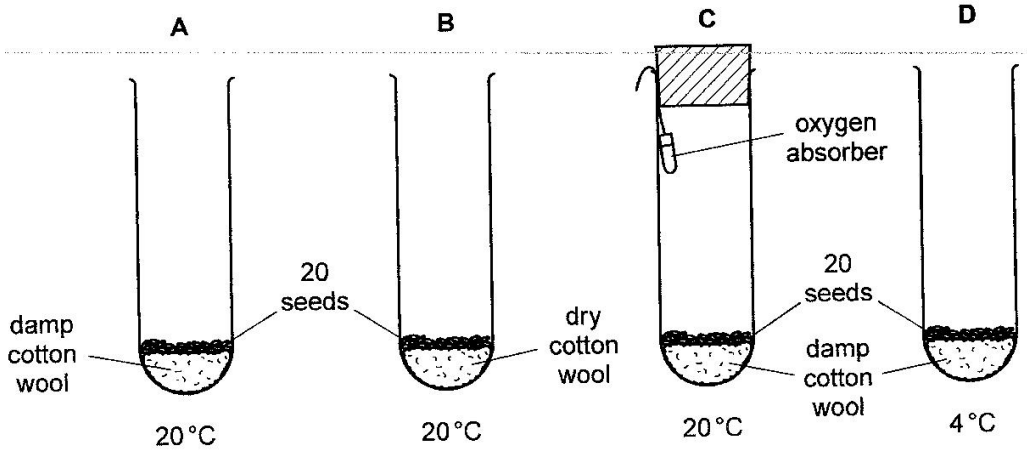
- Enzymes are activated and the process of respiration begins. Enzymes start to break down the food store in endosperm or cotyledon. Once the food source becomes soluble it diffuses into the seed embryo which starts to grow into a seedling.
- In some dicotyledonous plants, the cotyledons are brought out of the testa and above the ground, where they become green and make food by photosynthesis during early stages of germination (*epigeal germination).*
- In monocotyledonous plants the cotyledon remains below the ground (hypogeal germination)

Conditions necessary for germination

- Water/ moisture Water is necessary for chemical reactions to occur. It acts as the medium for dissolving food substance so that enzymes can digest the food.
- Suitable temperature of about– germination occurs more rapidly at high temperature from20^{o}C up to about 40^{o}C which is the optimum temperature for enzyme activity. This speeds up biological reactions and growth and development of the embryo. Low temperature slow down enzyme activity while high temperatures denature enzymes
- Oxygen is used in aerobic respiration, which provide energy for the chemical change involved in mobilising the food reserves and making the new cytoplasm and cell walls of the growing seedling

Experiments on conditions necessary for germination

- Set up four test tubes A, B, C and D as shown in the diagram. All containers had same number of seeds soaked placed in damp cotton wool and left at different conditions for a few days.



- In B, there is no water resulting in no germination. Moisture was absorbed by the calcium hydroxide granules.

- In C, Alkaline pyrogallol absorb oxygen from air therefore no germination in C due to absence of oxygen.
- In A seeds will germinate because all conditions needed are available
- No germination in D because the temperature was not favourable for enzyme activity to occur.

Germination Success

- This refers to how well a sample of seeds germinates when all the necessary conditions are present
- Some seeds fail to germinate due to lack of the necessary conditions for germination or due to dormancy.
- Germination success is calculated from the results of a germination experiment and is presented as a percentage

$$\text{percentage germination} = \frac{\text{number of seeds germinated}}{\text{number of seeds planted}} \times 100$$

Example Chipo planted 40 bean seeds. If the percentage germination was 20%, how many seeds germinated?

Example If the percentage germination when Chipo planted X seeds was 30% and this was equivalent to 12 seeds germinated. Find the value of X

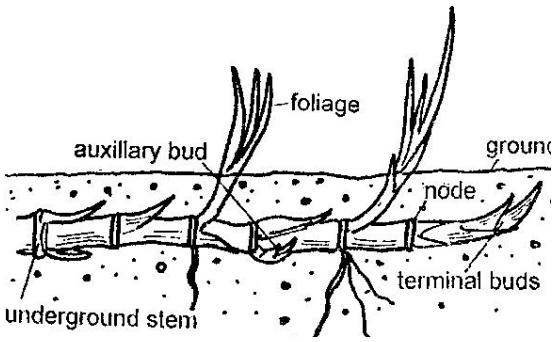
Example If 200 seeds of pumpkins were sown and 184 germinated. Calculate the % germination

VEGETATIVE/ASEXUAL REPRODUCTION

- Asexual reproduction is the production of new individual plants from vegetative structures without the use of seeds
- Many plants are capable of producing new separate plants from their existing non seed parts such as stems, roots and leaves

Methods of asexual reproduction in plants

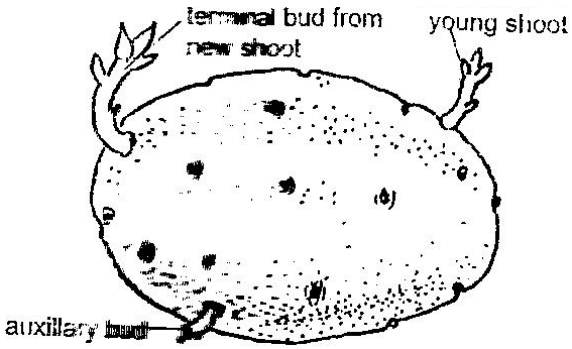
Rhizomes *e.g. grass*



- Main part of the stem remains below the ground and grow horizontally. Some of the terminal buds may produce an erect stem that emerges above the ground. These manufacture food which is stored in the part below
- New shoots develop from lateral buds

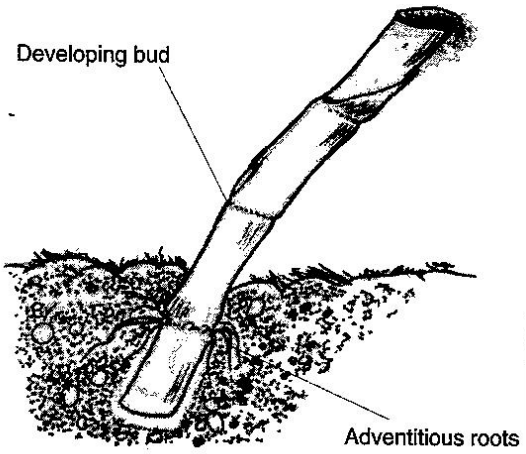
Tubers *e.g. Irish potato*

- Are short, thick underground stems or roots of plants
- These frequently bear buds from which new identical plants may grow using food stored in the tuber
- Stem tubers have tiny scale leaves and lateral buds. A root tuber is a lateral root that has been modified to function as a storage organ.



Cuttings *e.g. sugar cane, cassava, sweet potato*

- These are portions of stems, roots or leaves that are removed and planted in sand, loose soil or even in water. Roots grow from the base of the stem into the soil while the shoot continues to grow and produce leaves.



Advantages of asexual reproduction

- No gametes are needed
- Plants can grow quickly
- Plants have more chances of survival since food is readily available
- New plants established over large areas very rapidly
- All plants obtained are exactly the same as the parent, hence the favorable/desirable characteristics are retained

Disadvantages of asexual reproduction

- Plants are crowded and usually compete for light, water and nutrients
- There is no genetic variation, so adaptation to a changing environment is unlikely.
- All plants are identical and may be viable to attack by same pests and diseases

Differences between sexual and asexual reproduction in plants

- Sexual reproduction involves the fusion of specialized sex cells (gametes) derived from two different individuals. There is variation occur in offspring
- Asexual reproduction involves one organism where a part or parts of the existing parent produce genetically identical new independent organisms. There is no variation. No gametes are involved and all the new plants are produced by cell division from only one parent.

REPRODUCTION IN HUMANS

REPRODUCTIVE SYSTEMS

Male reproductive system

Testes make and produce sperm cells. Produce the hormone testosterone which causes secondary sexual characteristics in males.

Scrotum it is a sac that contains testes lies outside the abdomen to regulate their temperature, aiding optimal sperm production. The scrotum can contract or loosen to the testes closer or further from the body

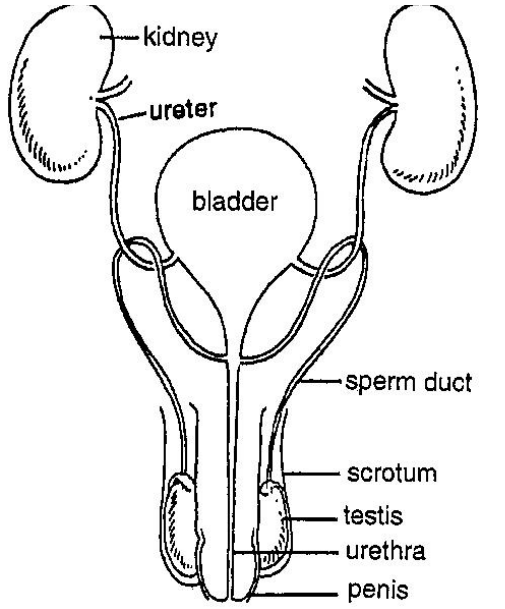
Epididymis temporary storage of sperms until they reach maturity. It is a coiled tube lined with a mucous membrane. Once mature the mucous membrane secretes a substance to help the sperm cell to move.

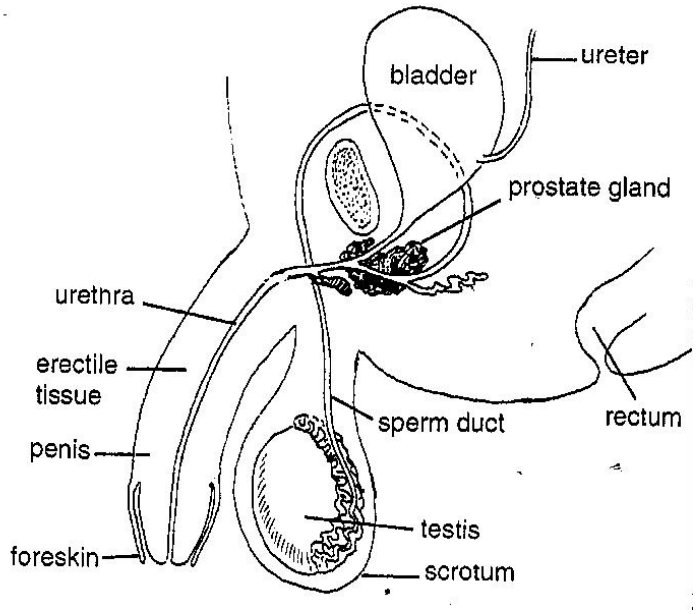
Sperm duct/vas deferens carries the inactive sperm from the epididymis

Prostate gland, Cowper's gland and seminal vesicle add a secretion to sperms during ejaculation which activates the sperm. They are a source of nourishment for the sperm and a medium in which the sperm can move. Secrete alkaline fluids to help neutralise any acidity and the sperm to move faster. Mucus secreted help to lubricate the penis during ejaculation

Urethra serves as a duct for passage of semen through the penis to the outside

Penis consist of erectile and connective tissue with numerous blood vessels. During sexual excitation, it becomes engorged with blood, stiffens and become erect.





Female reproductive system

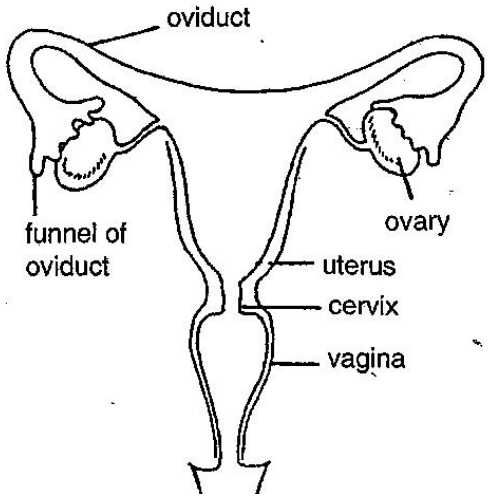
Ovaries produce female sex cells. They also produce the female hormones (progesterone and oestrogen). Progesterone controls the development of ova and thickening of uterus lining in preparation for pregnancy. Oestrogen causes female secondary sexual characteristics and is involved in the menstrual cycle.

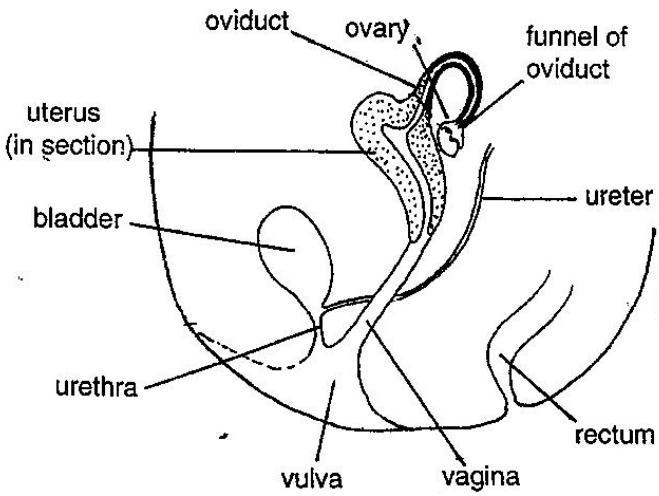
Oviduct is lined with projections that help to move the egg cell from ovary to the uterus. This is also where fertilisation takes place.

Uterus It has very thick muscular walls. The fertilised ovum implants itself in the uterine walls to develop into an embryo. Produce sex cells and hormones and also house the developing embryo after fertilisation and supply the embryo with nutrients while it develops.

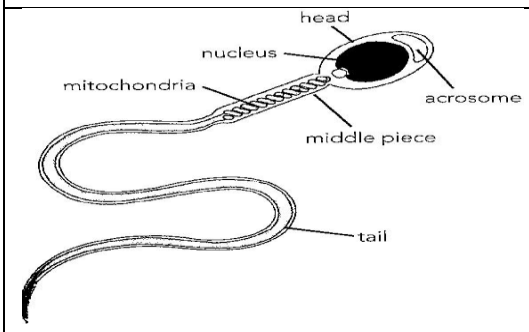
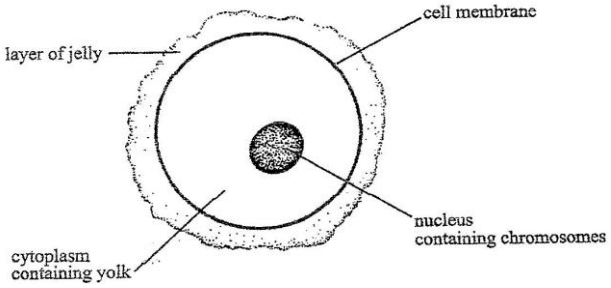
Cervix is a narrow ring of muscle that closes the uterus but can expand greatly during birth of a baby. It contains glands that supply the vagina with mucus.

Vagina is a muscular organ which opens to the outside of the body. This is where sperms are deposited during copulation. It acts as the birth canal during birth. It is richly supplied with mucus for lubrication





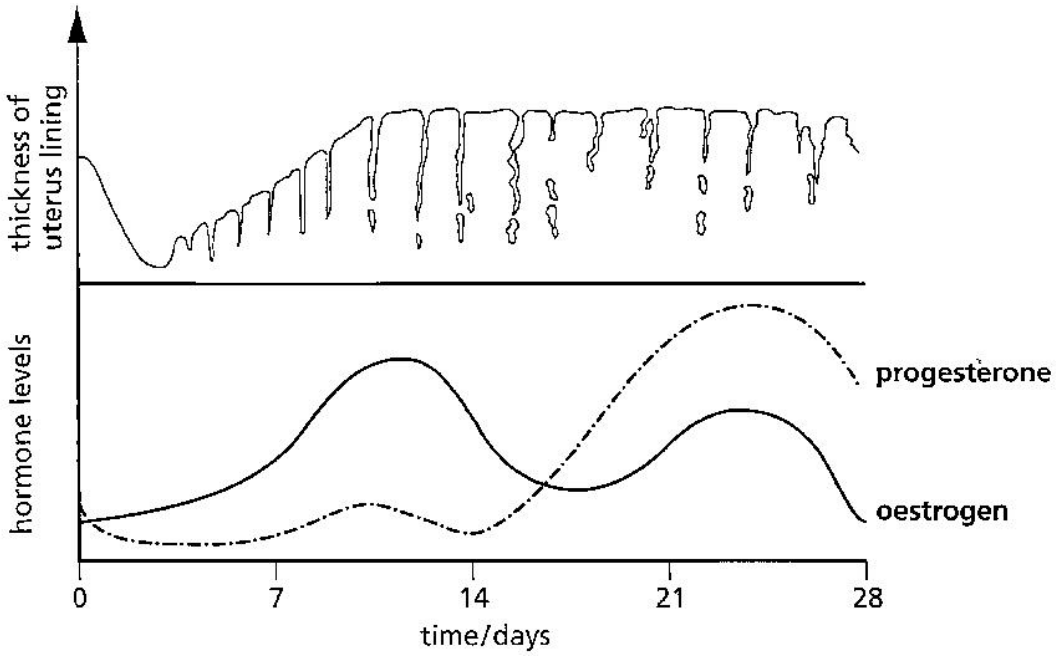
Structure and functions of sex cells

Sperm	Ovum
	
- surrounded by one membrane - Very small in size (microscopic) - Move on its own	- Surrounded by two membranes - Larger than the sperm - Has to be moved - More cytoplasm containing food

- Smaller or lesser cytoplasm - No nutrient store - More mitochondria to provide energy to move (swim) - Acrosome present which contains enzymes that breaks down the membrane of the ova - Elongated in shape	reserves - Food store present - Fewer mitochondria - No acrosome - Oval/round in shape

- The head of the sperm contains a nucleus that contains half the genetic material of the male and the nucleus of the ova contains half the genetic material of the female, which will fuse with the nucleus of the sperm.
- Many sperm cells are produced

THE MENSTRUAL CYCLE



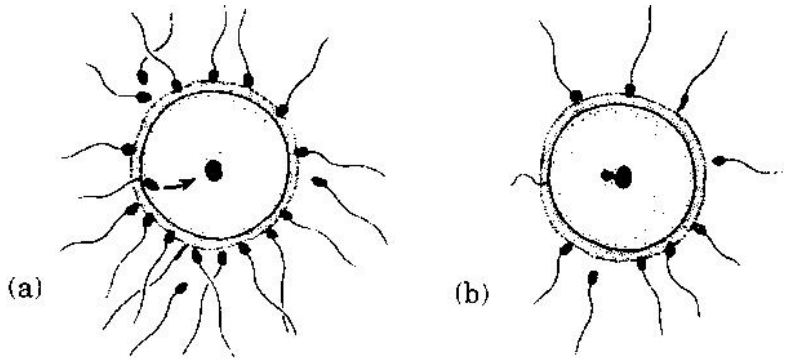
- This is a cycle which involves changes in the uterine walls, controlled by a number of hormones. Each cycle takes about 28 days on average

- It starts with menstruation which is the breakdown of the endometrium (uterus lining) due to a drop in the level of progesterone, and the cells and blood making the lining is shed via the vagina. It lasts for 4-5 days.
- From day 6, under the influence of oestrogen from ovaries, the uterus lining (endometrium) starts to build again, developing a mass of blood vessels so that it is ready to receive a fertilised ovum.
- The follicle stimulating hormone (FSH) causes a follicle in one of the ovaries to mature into an ovum.
- On day 14 (mid cycle), the level of oestrogen drops and stops the production of FSH, so that only one egg is released at a time and stimulates the release of luteinizing hormone (LH), stimulating ovulation. Body temperature increases from day 14 – 28.
- The corpus luteum (remains of the follicle) starts to secrete the hormone progesterone that stimulates the tissue of the endometrium to thicken and prepare for possible implantation of fertilised ovum. The release of FSH and LH is stopped.
- In the absence of fertilisation, the corpus luteum degenerates resulting in a drop in secretion of progesterone and the endometrium breaks down again, restarting the cycle again.

FERTILISATION, PREGNANCY AND DEVELOPMENT

Fertilisation

- Fertilisation is the fusion of male and female sex nuclei to form a zygote



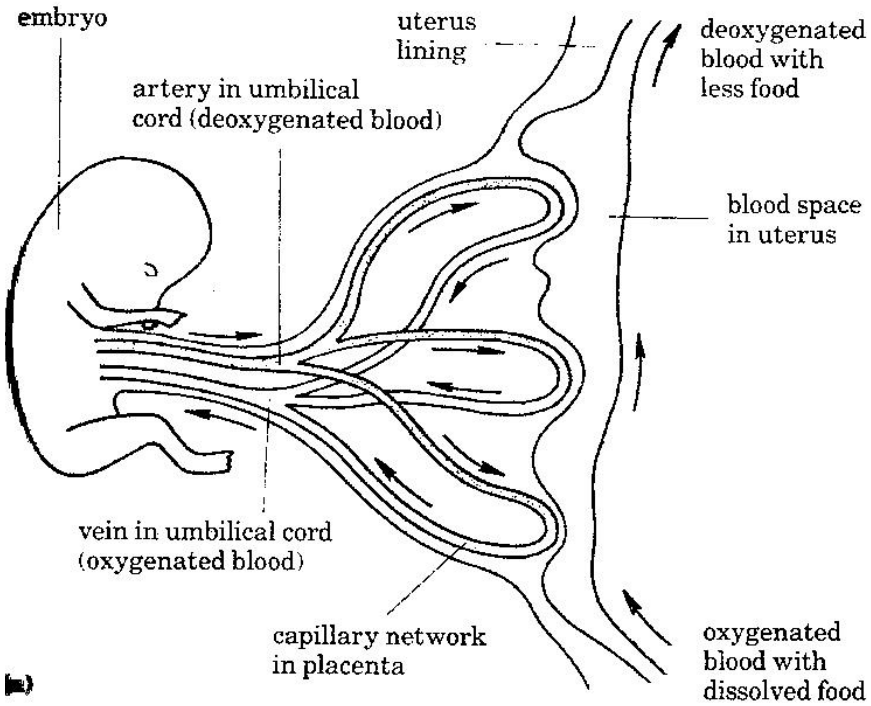
- The sperm swim through the cervix and into the uterus by wriggling movements of their tails. They pass through the uterus and enter the oviduct.
- If there is an ovum in the oviduct, the sperms stick to its surface. The acrosome at the head of the sperm secretes enzymes which digest part of the egg membrane.

- The sperm enters the cytoplasm of the ovum and the male nucleus of the sperm fuses with the female nucleus to form a zygote.
- A chemical change occurs at the membrane surface immediately after penetration.
- The zygote starts to divide into a ball of cells (blastula) and continues to move towards the uterus where it embeds itself to the spongy tissue of the endometrium (implantation) that lines the uterus forming the placenta marking the beginning of pregnancy.

Pregnancy and development

- The zygote divides to produce a ball of cells (blastula) which travels to the uterus where it sinks into the uterus lining (implantation).
- The embryo continues to grow and produce new cells that form tissues and organs. After 8 weeks when most organs are formed the embryo is called a fetus.
- As the embryo grows, the uterus enlarges to contain it. Inside the uterus the embryo is enclosed in an amnion which protects it from damage and prevents unequal pressures from acting on it.
- The oxygen and food needed to keep the embryo alive and growing are obtained from the mother's blood by means of a structure called the placenta

The placenta



- Soon after the ball of cells reaches the uterus, some of the cells, instead of forming the organs of the embryo, grow into a disc-like structure called the placenta.
- The placenta is a barrier that separates mothers' blood system from the fetal system preventing agglutination of maternal and fetal blood.
- It allows for exchange of substances between mother and foetus i.e.
    1. To the foetus – water, nutrients (food), antibodies (to help foetus to develop its immune system and oxygen
    2. From the foetus – urea and carbon dioxide (waste products)
- The placenta is connected to the embryo by the umbilical cord which contains umbilical veins and artery.
- The placenta filters many harmful substances but some viruses, smoke and alcohol are not filtered and can pose a health risk to the foetus.
- It also secrete hormones e.g. oestrogen and progesterone which stops menstrual cycle.

CONTRACEPTION METHODS

Natural methods

Abstinence

- This involves a couple avoiding sexual intercourse. In this way, sperms cannot come into contact with the egg and fertilisation cannot happen.

Advantages

- 100% effective
- No physical side effects

Rhythm

- Abstain from sexual intercourse during unsafe periods i.e. days 11-17. The woman's body temperature is monitored. When ovum occurs it is indicated by the a rise in the temperature

Advantages

- No side effects
- No chemicals or barriers used

Disadvantages

- Not reliable since periods maybe irregular
- Imposes restrictions to sexual activity
- Sexual frustrations

Barrier methods

Condoms

- Is a strong latex rubber sheath is placed over an erect penis or inserted into the vagina before sexual intercourse. During ejaculation the condom traps sperms and prevent them from reaching the uterus.

Advantages

- Protects against STIs

Disadvantages

- Can break
- Slightly decrease sensation for males
- Interruption of foreplay to fit

Diaphragm

- Is a dome shaped rubber device placed in the vagina to mechanically block entry of sperms into the cervix. Can be used with spermicides that kill sperms.

Advantages

- Can be inserted a few hours before intercourse
- May be reused for up to two years

Disadvantages

- Must be prescribed and fitted by a physician
- Must be inserted prior to coitus and left in left in place for several hours after intercourse
- Not suitable after three or more natural deliveries

Intra-Uterine Device

- Is a small plastic and copper device, inserted into the uterus to prevent implantation of the embryo in the uterus lining. It prevents implantation by stimulating inflammatory response.

Advantages

- Provides continuous protection
- Highly effective
- Can last for 5 years
- Does not interfere with love making
- Suitable for older women

Disadvantages

- Lead to cramps and pain
- Pelvic infection
- Increased menstrual flow
- Coil may come out
- Must be inserted by a specialists

Chemical method

Spermicides (foams, jellies, creams)

- Jelly placed into vagina before sexual intercourse and it chemically kills the sperms

Advantages

- No known side effects
- Easy to use
- Improves effectiveness of condoms/diaphragm

Disadvantages

- Not reliable due to high failure rate
- Best used in conjunction with diaphragm
- Messy
- Used with every sex act
- Must be applied not more than 30minutes before sexual intercourse

Hormonal methods

Oral contraceptive pill

- Contains hormones (oestrogen & progesterone) which suppresses and prevents ovulation so preventing conception. Cervical mucus thickens and prevents entry of sperm hence preventing fertilisation.

Advantages

- Highly effective
- One have sexual freedom
- Regular menstrual cycle
- Can be taken whilst breastfeeding without affecting quantity or quality of milk
- Lower dose of hormone and therefore less risk to older women.

Disadvantages

- Can cause thrombo-embolism, hypertension and heart diseases in some users.

- Monthly cycle maybe regular, with breakthrough bleeding.
- Minor side effects e.g. headaches
- Must be taken same time each day or more than three hours late

Injection (Depo-Provera)

- Progesterone into muscle for long term to slow release and stops ovulations.

Advantages

- One injection protects up to 12 weeks
- Convenient and private
- Reversible
- Does not interfere with sex

Disadvantages

- Can cause irregular periods
- May delay fertility when stopped

HEALTH AND DISEASES

SEXUALLY TRANSMITTED INFECTIONS (STIs)

Chancroid (veneral ulcers)

- Is caused by a bacteria i.e. *haemophilus ducreyi.*

Signs and symptoms

- Soft painful ulcers on genitals.
- Ulcers that cause a painful burning sensation during urinating or bowl movements in females
- Swollen glands in groin region
- Abnormal vaginal discharge in females

Effects

- Leads to brain damage

Treatment

- Early treatment with antibiotics like *penicillin, tetracycline and sulphonamide* which decrease scarring after the healing of the ulcers.

Gonorrhoea

- Is caused by a bacterium *Neisseria gonorrhorae*
- Infections occurs in the urethra, cervix, anal region and conjunctiva

Signs and symptoms

- The bacterium damages the urino-genital system including the kidneys, causing sores and other discomforts.
- It takes about 3 – 5 days for signs to appear after infection. In males signs are very clear early during infection*******

- Males
    - ✓ Inflammation and pain during urination
    - ✓ Painful yellowish discharge of pus in males after urination
    - ✓ Cloud urine due to the presence of pus in urine
    - ✓ Enlarged glands near the groin
- Females
    - ✓ Swelling of vulva in females
    - ✓ Abnormal vaginal discharge

- ✓ Abnormal menstrual bleeding
- ✓ Abnormal menstrual pain or pain with sexual intercourse

Effects

- If not treated in early stages gonorrhoea can;
  - ✓ Leads to sterility through infecting the prostate gland in males and the fallopian tube in females.
  - ✓ Can cause severe arthritis
  - ✓ Pelvic floor infection
  - ✓ Infected pregnant women may give birth to babies with eye diseases which can cause permanent blindness.

Treatment

- It is treated with antibiotics i.e. *penicillin and tetracycline*

Syphilis

- Is caused by a bacteria *Treponema Pallidum*

Signs and symptoms

- Signs and symptoms appear in about 10 to 25 days after infection.
- Signs and symptoms occur in three progressive stages and each stage lead to the next.

- *Stage one*
  - ✓ In both male and female, first sign of the disease is small painless lump or sore (chancre) on or near the genital organs. The sore could heal and disappear in a period of 3 to 8 weeks.
- *Stage two*
  - ✓ Begins 6 to 8 weeks after first symptom have disappear. The bacteria move deeper into the body.
  - ✓ Symptoms at this stage are rash or sores on or around genitals, the anus, mouth, eyes.
  - ✓ Lymph glands in the neck swell up. It lasts for 2 to 6 weeks.
- *Stage three*
  - ✓ Visible symptoms gradually disappear. This is the most destructive stage as the bacteria destroy nerves, heart disease sets in, blindness occurs and sometimes the patient become insane before death.

Effects

- If not treated earlier, it may cause

- ✓ Brain damage
- ✓ Obstruction of arteries
- ✓ Heart failure
- ✓ Death
- ✓ Still birth, low birth weight or premature birth
- ✓ May cause paralysis, insanity, blindness or death of foetus

Treatment

- Treated with antibiotics e.g. *penicillin* during the early stages. Once the disease has reached the third stage, it is difficult to cure as lesions may have already caused permanent damage to organs.

Genital herpes

- Is caused by the *herpes simplex virus* (HSV)

Signs, symptoms and effects

- Ulcers on or around genitals. The ulcers burst into small itching sores
- Pain, itching and sores in the infected area 2-10 days after infection.
- Fever, headache and muscle ache
- Swollen lymph nodes may also appear
- Ulcers that may make it painful to urinate
- Scabs that form as ulcers heal

Treatment

- It has no cure but the symptoms can be prevented with treatment using anti-virals to reduce the pain and discomfort from sores. It also suppresses the virus and reduces the risk of infecting others.

HIV/AIDS

- AIDS is caused by HIV. It is transmitted through certain body fluids.
- It is spread through the following ways
    - Through unprotected sexual contact with an infected partner
    - Sharing of contaminated needles when administering drugs
    - Use of contaminated cutting instruments
    - From an infected mother to foetus across the placenta
    - From an infected mother to infant through breast feeding or accidentally during birth

Effects of HIV on the body

- HIV attacks the white blood cell critical to immune system known as T-helper lymphocytes.
- HIV uses these cells to reproduce itself by using the lymphocyte's DNA to make new virus DNA thus destroying the lymphocytes.
- The virus infects and destroys cells of the body's immune system so that their numbers gradually decrease.
- When numbers are low, the body is unable to resist infection, so allowing a range of parasites to cause a variety of different infections (opportunistic infections) and the victim eventually dies from a combination of diseases (AIDS)

Controlling the spread of HIV/AIDS

- Abstinence from sexual activity
- Use of sheath or condoms correctly and consistently during sexual intercourse
- Having sex with only one faithful, lifelong uninfected partner
- Eliminate socio-economic disparities which force people to promiscuity
- Using sterilised or disposable instruments in activities which draw blood such as circumcision, tattooing and ear piercing
- Screening of blood before transfusion
- Educate the sex active age on the dangers and spread of HIV/AIDS
- An infected mother avoids pregnancy so as to prevent passing of HIV on to her baby
- Get tested and know your partner's status before having sex

Treatment of HIV/AIDS

- There is no cure for HIV/AIDS, it can only be controlled. The common treatment is by anti-retroviral drugs (ARVs) as HIV is retrovirus. ARVs slow down the reproduction of HIV by interfering with its life cycle and HIV numbers are reduced.

The control methods of STIs

- Abstinence
- Use of condoms correctly and consistently
- Contact tracing
- Behaviour change
- Having mutually faithful long life relationships
- Early treatment with antibiotics
- Regular tests for STIs

INFECTIOUS OR COMMUNICABLE DISEASES

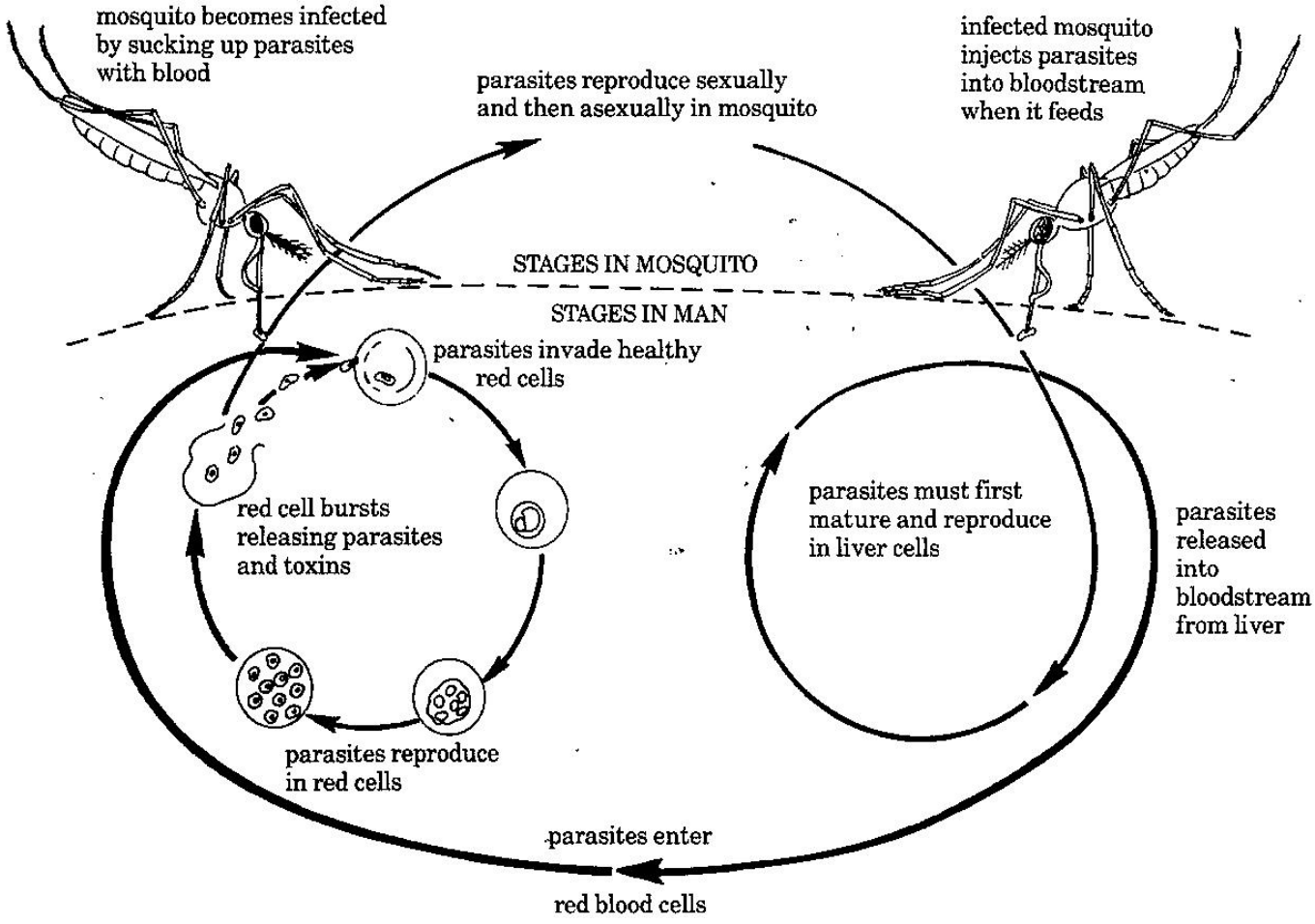
MALARIA

- Malaria is a caused by a protozoan called *plasmodium falciprum* found in the salivary glands of the female anopheles mosquito. A protozoan is a single celled organism.

Signs and symptoms

- High fever with a temperature of up to $41°C$
- Loss of appetite and Nausea
- Shivering and profuse sweating
- General body weakness or tiredness
- Headaches
- Aching joints
- Vomiting
- Enlarged spleen or liver

The life cycle of malaria parasite



- The parasite relies on humans and mosquitoes to carry out its life cycle.
- The infected mosquito bites a human, releasing the plasmodium from its salivary glands into the human host's blood. The parasite rapidly goes to the liver where it reproduces rapidly and after about 2 to 3 weeks, the protozoa escapes into the blood stream.
- The parasites enter the red blood cells and multiplication continues. The infected red blood cells raptures (breaks) releasing more parasites into the blood stream where they seek out and inject new red blood cells.
- As red blood cells break toxins are released into the blood resulting in fever, chills and a depletion of oxygen in the body. While the parasite is growing in red blood cells the person feels weak.
- Released parasites may be picked up by the anopheles mosquito and enters the stomach of the mosquito. Inside the mosquito the parasite reproduce sexually and grow to develop into the infective stage in numerous complicated developmental stages.
- The infective stage migrates to the salivary glands of the mosquito and these may later be injected into another person when the mosquito bites a healthy person.

Treatment

- Use of anti-malarial drugs such as chloroquine, quinine, coartemether and Fansidar which kills the parasite in the human body.

Methods of controlling malaria

- Use of prophylactic drugs like Deltaprim, Malasone and malaquine before visiting malaria zone. This help to prevent contraction of malaria
- Use of anti malarial drugs e.g. Chloroquine, Coartemether etc
- Use of insecticides to prevent mosquito from becoming an effective carrier e.g. DDT
- Avoid mosquito bites by wearing thick long sleeved shirts and trousers at night
- Destruction of mosquito larvae and pupa (breaking life cycle) by appropriate methods e.g. biological control of larva by using bacteria and fish which feed on mosquito larvae
- Destroy breeding sites of mosquito by clearing stagnant waters and keeping grass short.

CHOLERA

- Cholera is an intestinal disease caused by a bacterium called *vibrio cholarae.* The pathogen is transmitted through eating contaminated food or drinking contaminated water.

Signs and symptoms

- Severe diarrhoea (rice watery stools)
- Abdominal pains
- Fever
- Vomiting
- Dehydration leading to sunken eyes and pale skin.
- The body becomes weak and eventually causes death.

Treatment

- Use of antibiotics such as *tetracycline and chloramophenical*
- Oral rehydration therapy to replace lost fluids and salts

Control

- Good food and personal hygiene
- Proper sanitation
- Vaccination
- Drinking clean safe water

EBOLA

- Is spread by the deadly Ebola virus that is spread through close contact with blood or body fluids, secretions and organs of animals such as chimpanzee, gorillas and bats that are infected.
- Incubation period is 2 – 21 days

Signs and symptoms

- First signs include
    - ✓ High fever
    - ✓ Joint and muscle pain
    - ✓ Fatigue
    - ✓ headache

- It is followed by;
    - ✓ Vomiting
    - ✓ Diarrhoea
    - ✓ Rash
    - ✓ Liver and kidney problem
- This can be followed by external and internal bleeding of gums, nostrils and blood-stained feaces. This may eventually progress to organ failure and death.

Treatment

- Is limited to intensive supportive therapy and often includes
    1. Balancing patient's fluids and electrolytes
    2. Maintaining their oxygen levels and blood pressure
    3. Treating complicating infections early

Control

- Avoid eating wild meat
- Avoid direct contact with infected people and animals
- Practice good hygiene
- Isolate patients with Ebola
- Notify health officials if you have direct contact with blood or body fluids
- Restricting international travel
- Improving public sanitation, health care and health education

TYPHOID

- Is caused by a bacteria *salmonella typhosus.* It is common in places where there is poor sanitation and little access to clean water.
- The bacterium lives in the intestines and therefore is spread by contact with the feaces of an infected person. The bacteria can pass into water bodies through seepage, burst sewer pipes or sewage introduced directly into water bodies.
- Contaminated food is another way of transmitting the disease.

Signs and symptoms

- High fever
- Muscular pains
- Weakness

- Stomach ulcers
- Headaches
- Diarrhoea
- Poor appetite
- A rash may appear, as well as a white coating inside the mouth.

Treatment

- Use of antibiotics such as *ciprofloxacin and ceftriaxone* which kill salmonella bacteria.
- Rehydrate by drinking adequate water

Control

- Practice good hygiene (thorough cooking of food)
- Drink clean safe water
- Vaccination
- Proper sanitation
- Avoid travelling to places with high risk of typhoid.
- Avoid eating raw fruits and vegetables that cannot be peeled.

SUBSTANCE ABUSE

Effects of tobacco smoking on health

- Tar destroys cilia leading to lung cancer
- It can cause emphysema i.e. the build-up fluids in lung tissue
- It cause bronchitis where bronchioles become irritated and inflated
- It can cause Coronary Heart Diseases (CHDs) leading to heart attack
- It can cause low birth weight in babies of smoking mothers
- Addiction caused by nicotine

Effects of excessive consumption of alcohol

- It is a depressant to the central nervous system leading to reduced self control
- Causes liver cirrhosis
- Slows reaction time e.g. during driving and operating of machinery
- Alcoholism or addiction to alcohol
- Can lead to antisocial behavior due to poor decision making
- Can cause brain damage

Effects of breathing solvents e.g. glue, ethanol, benzene

- Hallucinations
- Reduced self control
- Damages nasal passages
- Damages muscles and heart
- Slows reaction times
- High doses can leads to unconsciousness, vomiting and brain damage
- Can cause drowsiness, headaches, nausea

Effects of mandrax and cannabis

- Alters personal behavior
- Loss of self control or maniac behavior
- Slows reaction times
- Hallucinations
- Low doses leads to Euphoria
- Relaxed and uncaring attitudes
- Overdoses are fatal
- Addiction
- Increased chances of unsafe sex and contracting STIs
- Increased criminal tendencies
- Insomnia, low blood pressure, seizures, depressions and reduced memory.

IMMUNITY

- Immunity is the body's ability to resist attack by antigens or pathogens or infection which may lead to infectious disease.

Active immunity

- Active immunity is a form of acquired immunity in which the body produces its own antibodies against disease causing organisms.
- It is defined as resistance that the body offers due to production of antibodies as a result of a secondary attack.
- The body actively produces antibodies against the antigen and this gives long term immunity.
- Active immunity may be;

- **Natural active immunity** – This occurs following attack of the disease e.g. whooping cough. During an infection the body produces specific antibodies against the pathogens or their products. Antibodies attach themselves to and immobilize the bacteria thus making it ready for ingestion by phagocytes. Once antibodies have been produced in large amounts they remain in the body and give protection against similar attack.
- **Artificial active immunity** – This which occurs following vaccination e.g. small pox vaccination or BCG injection against TB. A vaccine may be administered either through a suspension of immobilized or attenuated organisms whose strength has been reduced. When the body is injected with such vaccines, it reacts by producing antibodies which remains in the blood stream protecting the body from virulent organisms thus making the body immune to disease

Passive immunity

- Is defined as resistance acquired when ready-made antibodies are transferred to an individual.
- Passive immunity may be;
    - **Natural passive immunity** – This is acquired naturally in an unborn infant through the transfer of antibodies from the mother's blood via the placenta. Other antibodies may be transferred to the baby from the mother's breast milk
    - **Artificial passive immunity** – This is acquired by artificially transferring antibodies that have been produced in other individuals or animals into an individual. The serum provides immediate protection against an infection though protection is temporary.

How infants acquire immunity

- Breast feeding
- Antibody transfer via the placenta
- Immunization

Immunization Schedule

- Immunisation is a process of administering a vaccine to the body so that it can produce immunity against a specific disease

- Babies are generally immunised against six killer diseases i.e. measles, diphtheria, whooping cough, tetanus, polio & tuberculosis. This helps to prevent them from spreading in the community.
- Vaccinations are given at specific ages e.g. 6 weeks. Each time a vaccination is given, it has a higher dose so that the body can build up enough antibodies
- Normally in Zimbabwe the immunisation of infants and children include;
- First dose of Vitamin A supplementation is given at 6 months and thereafter a dose every 6 months up to 5 years of age.
    - BCG – at birth
    - 3 months – DPT1 Polio1
    - 4 months – DPT2 Polio2
    - 5 months – DPT3 Polio3
    - 9 months – Measles
    - 18 months – DPT and Polio (booster)