CLASSIFICATION OF LIVING THINGS

KINGDOM FUNGI

Member of the kingdom fungi include fairly familiar organism. Such as Mushrooms, toadstools, puff balls and bracket fungi.

There are also less obvious but very important members such as Mould which grow on bread, ripe fruits and other foods.

Characteristics of fungi:

Fungi are found in damp or wet places.

1. They have Eukaryotic cells with a rigid protected cell wall made of chitin (chitin contain polysaccharides and protein).

2. The body of fungi is organized into thread like structure called *hyphae* (singular hypha). A network mass of hyphae is called *mycelium.*

3. Fungi have no chlorophyll also they do not photosynthesize, their mode of feeding is heterotrophic, in this way some are saprophytic while others are parasitic.

4. They store food as glycogen

5. Fungi reproduce asexually by using spores.

PHYLUM IN KINGDOM FUNGI

There are three main phyla in kingdom fungi. These are;

1. Ascomycota
2. Zygomycota
3. Basidiomycota

1. Phylum Basidiomycota

Basidiomycota are characterized by the production of basidia.

These are microscopic of club shaped cell in which maturation of spore called (basidiospore) take place. Nature spore are prepared then are dispersed.

Examples of Basidiomycota are mushrooms, toadstool, puff balls and bracket fungi

STRUCTURE OF MUSHROOM

1. Mushrooms grow on dead and decaying matter (saprophytes)

2. They produce enzymes on the surface of their mycellium which help them to break down complex food particles.

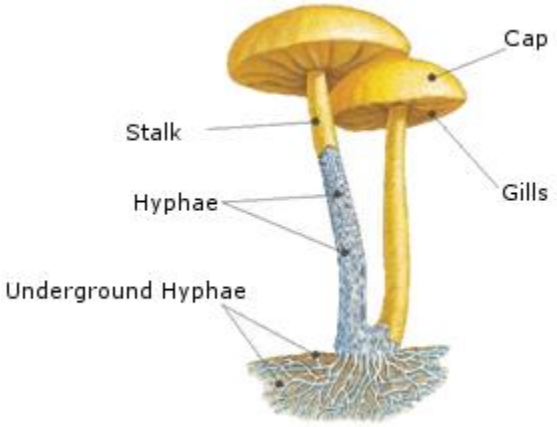
3. The pileus is the cap of the mushroom on the under ride of the pileus are special hyphae called gills.

4. The gills produce basidiospores at their tips.

5. The stalk (or stem like part) of the mushroom is called stipe.

6. The part of the mushroom that is above the soil called the fruiting body.

7. Hyphae lie in or on substrate (the source of food).



ADVANTAGE OF KINGDOM FUNGI

1. Saprophytic fungi are important in the decomposition of dead organism.

2. Yeast is used to ferment various types of carbohydrates in order to produce alcohol.

3. Some types of fungi for example mushroom are used as food.

4. Fungi are widely used in genetic engineering and research.

5. Yeast is a rich source of vitamin B and protein.

6. Some types of fungi are used in the production of antibiotics for example Penicillium

7. Yeast cells are used in the production of lactic acid and citric acid.

8. Fungi have been used to control pest that cause damage and disease to agricultural crops.

9. Some types of fungi are used in the dairy industry to flavor cheese.

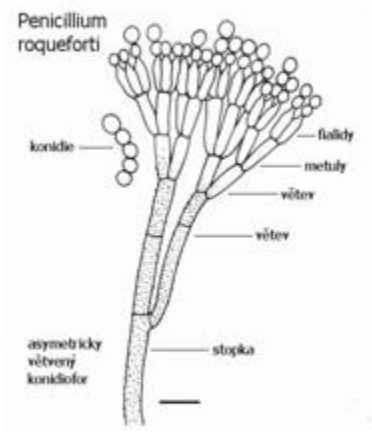
DISADVANTAGE OF KINGDOM FUNGI

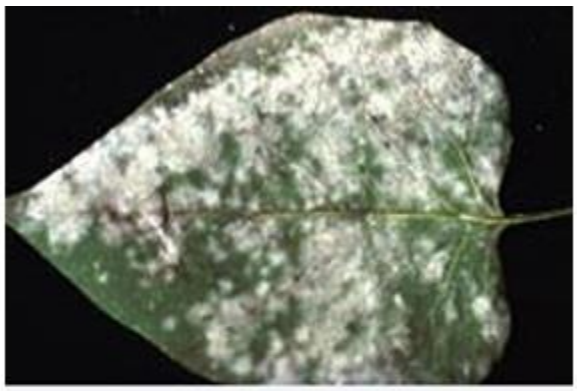
1. Parasitic fungi causes disease in plant and animal
2. Fungi produce poison called *mycotoxins*
3. Some fungi attack the timber used in building house and make furniture
4. Some fungi destroy food e.g. Bread mould

Phylum Ascomycota

Ascomycotes are also called sac fungi. They produce spores in sac like cells called **asci**. These spores are called ascospores.

Examples of ascomycotes are yeast, cup fungi, powdery mildew, penicillium and bread mould





Powdery mildew on lilac leaf.

Penicillium

Cup fungi ringworm fungi

Characteristics of Ascomycotes

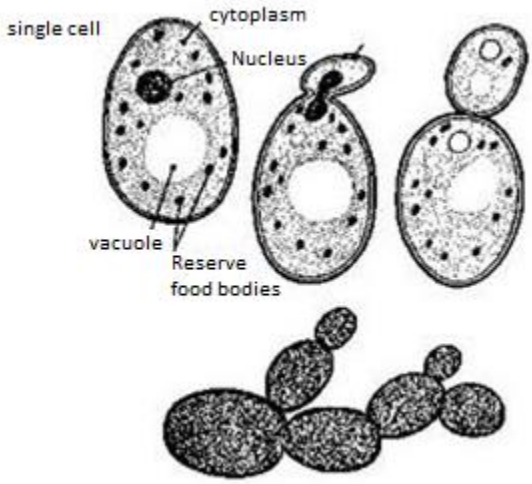
1. They are unicellular

2. Yeast can be found in plant leaves and flower, in salt water, in oil or warm blooded animals such as human beings.

3. Many types of yeast can ferment sugar to produce alcohol.

4. Some yeast is used in the production of beer, wine and bread. Other types of yeast cause disease.

5. They reproduce asexually by budding. Budding is where by a new organism develops as an outgrowth of the parents cell.

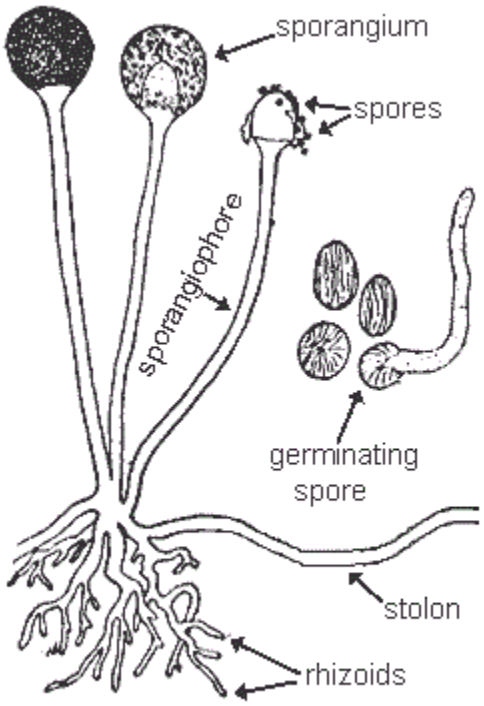


Budding cell

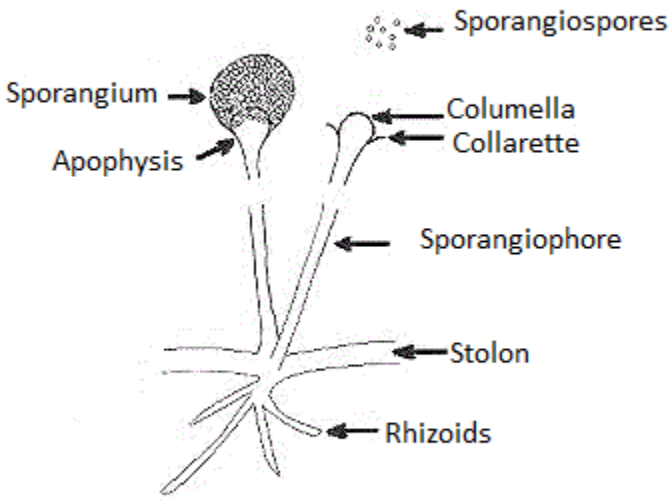
PHYLUM ZYGOMYCOTA (ZYGOMYCETES)

Zygomycota reproduce asexually through spores or sexually through formation of zygosporia.

These organisms are given this name because they produce *zygosporangia* during sexual reproduction. Zygosporangia are thick walled structures that contain spores and are highly resistance to unsuitable environmental condition. When condition improve the spores germinate example of zygomycotes are mould, mucor and rhizoid.



Black Bread mould (rhizopus)



mucor

KINGDOM PLANTAE

This kingdom is made up of plants. Their general characteristics are;

1. They are multcellular.
2. Their cells are eukaryotic with cellulose cell wall.
3. Plants are autotrophic they photosynthesize to produce their own food.
4. They store food as starch.
5. They are organized into tissues, organs and systems.
6. They show limited movement for example opening and closing flower petals and growth movement towards the stimulus.

DIVISION OF KINGDOM PLANTAE

The main 4 divisions of kingdom plantae are

1. Division Bryophyta
2. Division filicinophyta
3. Division coniferophyta
4. Division spermatophyta/angiospermatophyta.

Division Bryophyta

Plants in this division include Mosses and liverworts.

CHARACTERISTICS OF DIVISION BRYOPHYTA

1. They are generally small size, some mosses have only a few cells thick.

2. They have leaf – like thalamus and root – like rhizoids structure but not true leaves or roots.

3. They lack vascular tissues (xylem and phloem).

4. Bryophytes are commonly found in the moist areas such as along the river banks and tress and rocks in humid area.

5. They reproduce both sexually and asexually.

- They need water during sexual reproduction because the male reproductive cells can only reach the female reproductive cells by swimming.

- Asexual reproduction is by means of spores.

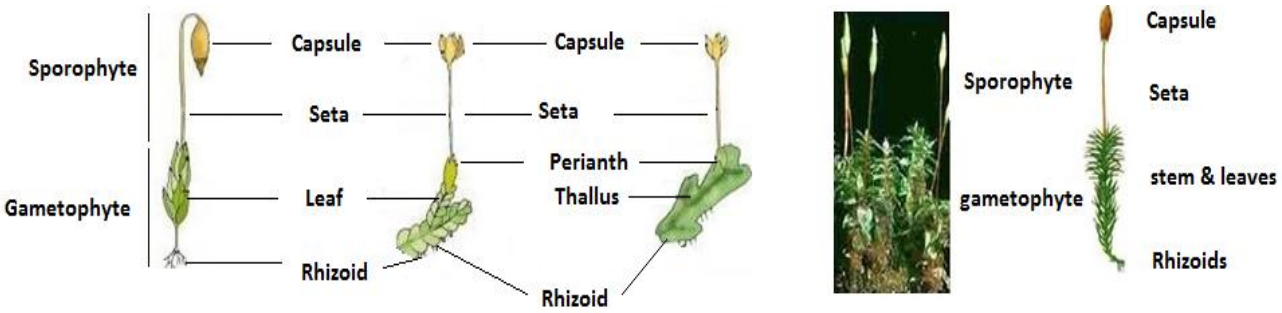
6. They show alternation of generation. This means that they have two distinct phases in their life cycle.

The gamete- producing phase called *gametophyte stage*, Gametes – are male or female reproductive cells.

The spore producing phase called *sporophyte stage*.

MOSSES

Moses consists of a stem- like structure bearing spirally arranged leaf like extensions. They are divided to the substratum by rhizoids.



The productive parts of mosses plants are the antheridium(male organ) and archegonium. (Female organ)

The antheridium and archegonium can be found on separate plants or on the same plant.

The antheridium releases mobile sperm. The sperm swim in water to reach and fertilize the egg in the archegonium to form a zygote.

The zygote develops into a young sporophyte plant which grows while still attached to the archegonium. It depends on the parent plant for nutrition and support

When it matures the sporophyte forms a capsule which contains spores. When the spores are mature the capsule bursts open and they land produce new mosses plants (gametophytes)

ADVANTAGE OF MOSSES

1. Mosses help to decompose dead logs.
2. Mosses serve as pioneer plants on bare ground and help to create a suitable environment for the growth and development of other plant.
3. Mosses retain a lot of water. They therefore help to keep the soil moist.
4. When mosses grow in a piece of land, they hold the soil particle together and help to prevent soil erosion.
5. Mosses also provide shelter for insects and other small animals.
6. Some birds and mammals use mosses as nesting materials.
7. Sporangium moss is harvested used in plants nurseries as a plant growing medium.
8. Peat derived from the remains of mosses as an important fuel in Scotland and Ireland.

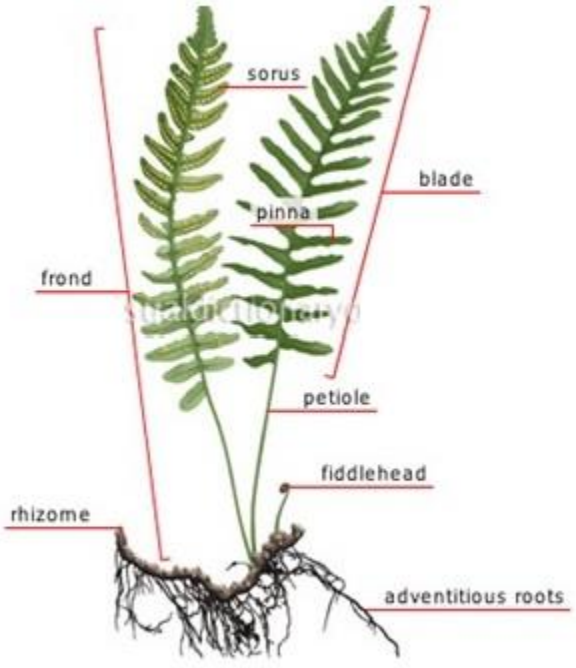
DISADVANTAGE OF MOSSES

1. Mosses occur as weeds in gardens and other places; they are very difficult to get rid of.

2. Mosses growing around ponds and other small water bodies can grow on the water and cover. It completely causing the area to become marshy

DIVISION FILICINOPHYTA (PTERIDOPHYTA)

This division is made up of ferns. A young fern's called a *fiddle head*



Characteristics of fern

1.They are vascular; they have xylem and phloem.

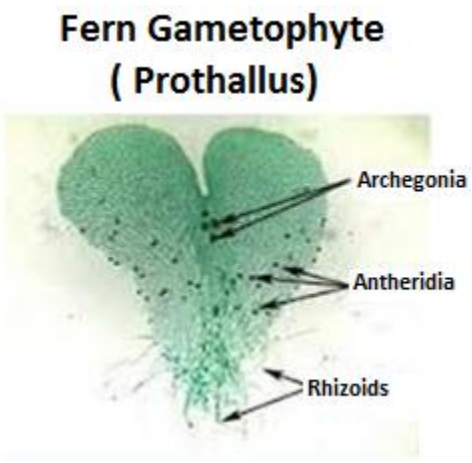
2. Ferns have leaves (called **fronds**), stem and root. Frond has small 'leaflets' called pinnae singular (pinna) which are connected to **rachis**. The rachis is the middle part of the frond. It has connected to the **rhizome** which is the short stem at the basic.

3. The life cycle of fens involves alternation of generations.
4. The sperm swims to the female egg through water. Fertilization produce a zygote (fertilized egg). The zygote grows into a new plant (sporangiosphore) that has leaves a steam and roots.

5. The fern plants has spore producing organs called sporangia (singular sporangium) on the underside of the leaves. The sporangia are arranged in compact groups called **sori** (singular sorus).

Sori with spores

When the spore are mature the sporangia releases them into the air. A spore germinate in an environment that is suitable for its development, what germinates is called a **prothallus**. Prothallus has antheridia and archegonia while produce sperm and egg respectively



Advantages of ferns

1**.** Many types of ferns are grown as ornament in homes and offices.

2. In some part of the world, the fiddlehead of some types of fern is eaten.

3. In southern Asia, ferns are used as a biological fertilizer. They are able to convert nitrogen from the air into compound that can be used by rice plants.

4. Ferns are major components of coal, a fossil fuel which is made up of the remain of primitive plants

5. Ferns serve as food for various wild animals.

Disadvantage of ferns

Ferns can be found as weeds in many places. The giant water fern is one the world worst aquatic weeds.
Ferns dont reproduce with seeds so they dont spread as much as plants that produce seeds.

NUTRITION -1

Is the process by which an organism provides itself or is provides itself or is provided with **materials necessary for energy release, growth and repair of body tissues and keeping the**

body in a good condition.

FOOD

Is any liquid or solid which provides the body with materials for growth and repair, energy release or keeping the body in a good (healthy) condition.

KINDS OR MODES OF NUTRITION

Basically there are two kinds of nutrition

1. AUTOTROPHIC NUTRITION

2. HETEROTROPHIC NUTRITION

AUTOTROPHIC NUTRITION

This is mode of nutrition where by organisms can make their own food from simple inorganic substance, such as carbon dioxide and water using either light energy (photosynthesis) or chemical energy (chemosynthesis). Organisms which feed by this way are known as **AUTOTROPHS**

Example

1. Green plants

2. Iron bacteria and sulphur bacteria

HETEROTROPHIC NUTRITION

This is the mode of nutrition where by organisms use organic materials as the only source of food. Organisms which feed by this way are known as **HETEROTROPHS.** They feed on already made food.

There are three types of heterotrophic nutrition

1. Saprophytic nutrition
2. Symbiotic nutrition
3. Holozoic nutrition

1. **Saprophytic nutrition**

This is the mode of nutrition where by organisms feed on dead decaying bodies parts of animals or their excrete; Organisms feeding by this way are known as **SAPROPHYTES**

2. **Holozoic nutrition**

This is mode of nutrition where by organism take food by mouth. It passes through a digestive system and broken down, finally absorbed into body tissue.

FORMS OF HOLOZOIC NUTRITION

1. **Herbivores –** Are animals which feed on plants only Example cow, goat and zebra

2**. Carnivores –** Are animals which feed on flesh only e.g. lion, tiger.

3. **Omnivores** – Are animals which feed on varieties o food (flesh, plants, insect etc) example. Man, monkey, pig.

4. **Insectivores** – Are animals that feed on insects e.g. shrews, ant

3. **Symbiotic nutrition**

This mode of nutrition in which an organism of different species exist in a nutrition relationship with other organism;

There are three kinds of symbiotic associations

1. Mutualism
2. Commensalism
3. Parasitism.

1. **Mutualism**

This is a nutritional relationship in which the two partners benefit each other by living together Example Nitrogen Fixing Bacteria in the roots of legumes.

2. Commensalism

This is an association of two group where by the host does not get any partnership. Example Epiphytes (are plants that grow on other plants) e.g. Moses and algae which grow on upper parts of big trees to get sunlight easily

3. Parasitism

This is a nutritional relationship between two organisms in which one organism live inside/on other living organism and depends on food. The parasite causes harm to the host. The host provides food and shelter for the parasite.

Endoparasites are living inside the body of the host e.g. tapeworm, roundworm and plasmodia.

Ectoparasites;Parasite that lives on host's surface [outside the body] examples includes some mites, flea and body lice.

The importance of nutrition

1. Nutrition enables an organism to get nutrients and energy required for various life processes. These processes include growth and development of cells.
2. To protect body against diseases.
3. Enable in replacement of worn out tissue and dead cell.

NUTRITION IN MAMMALS

HUMAN NUTRITION

FOOD SUBSTANCES

There are several types of substances that are needed by the human body for its proper functioning. The basic food substances include proteins, carbohydrates, lipids, vitamins, minerals, roughage and water.

1. **CARBOHYDRATES**.

These are compounds which contain the following elements

1. Carbon (C)
2. Hydrogen (H)
3. Oxygen (O)

Carbohydrates are also known as **SACCHARIDES**

There are three groups of saccharides

1. Monosaccharides
2. Disaccharides
3. Polysaccharides

1. **MONOSACCHARIDES**

   These are simplest form (basic unit of carbohydrates) which are absorbed directly in the blood. These are also known as REDUCING SUGARS

   Their general formula is $C_6H_{12}O_6$

Exampleof Monosaccharide

1. **Glucose**

   Occurs freely in grapes, honey, tomato and germinating maize

2. **Fructose**

   Occurs freely in all ripe sweet fruits E.g. banana, pineapple

3. **Lactose**

It is found in mammalian milk

(B) DISACCHARIDES

These are also known as NON – REDUCING SUGARS**.** They are found when two molecules of monosaccharides condense and release molecules of water. Their general formula is $C_{11}H_{22}O_{11}$.Example of disaccharides.

(1) Maltose is formed when two molecules of glucose condense.

Glucose + glucose = maltose + water

(2) Sucrose is formed by condensation of glucose and that of fructose.

Glucose + fructose = sucrose + water

(3) Lactose is found by condensation of galactose molecule and glucose molecule

glucose + galactose = lactose + water

(C) POLYSACCHARDES

These are formed when several units of monosaccharides linked together.

Example of polysaccharides

1) Starch

Starch is stored in plant cell, in the muscles and liver of vertebrates as (glycogen) in exoskeleton of arthropods and fungal cell as chitin

2) Cellulose

It forms the building material of the plant cell walls.

Source of Carbohydrates

Cereals - e.g. maize, rice, wheat

Sugar – e.g. honey, sugar cane, glucose, sweet fruits.

Function of Carbohydrates in the body

1) To provide the body with energy.

2) Carbohydrates combine with proteins, glucose and lipids which are important components of cell membrane.

Carbohydrate food

2. **PROTEINS**

Proteins are compounds of carbon, Hydrogen, Oxygen and Nitrogen. Some protein also contains sulphur and phosphorus. Proteins are long chains of Amino acid formed through condensation.

Approximately there are twenty Amino acids that occur naturally. The human body makes ten of this amino acids. These are called NON – ESSENTIAL AMINO ACIDS. The other ten amino acids must be obtained from the diet they are called ESSENTIAL AMINO ACIDS. We get essential amino acids by eating food rich in protein. Food that contains all the essential amino acid is called **first class proteins**, animal protein most fall in these group. **Second class protein** lack one or one more essential amino acids, most plant proteins fall in this group.

Functions of protein

1. The body use proteins for tissue growth and repair such as healing of wounds and replacement of skin and mucus membranes.
2. Antibodies are made of proteins, Antibodies are important in offering immunity to the body
3. Enzymes which help us to digest food are protein in nature. In addition hormones, the chemical messengers in our bodies are also protein.
4. They are alternative source of energy in the body

Protein food

3**. LIPIDS**

Lipids are compounds of carbon, hydrogen and oxygen. They are insoluble in water the mean form of dietary lipids is fats and oil. Fats are solid at room temperature while oil is liquid at room temperature. Lipids are made up fatty acid and glycerol. Fatty acid can be essential or non – essential. The body can make non essential fatty acids, it is not able to produce essential fatty acids. We therefore need to eat food that contain essential fatty acid, Example of such food are oil fish, nuts oil seed (such as sunflower seeds, maize, avocados and olives.

Functions of lipids

1) Lipids are source of energy; they produce energy more than all foods substances.

2) They are important component of cell membrane.

3) Fat deposits protect delicate organs such as heart and kidney.

4) Stores of fat under the skin help to insulate the body against loss of heat.

5) Essential fatty acids are important for the formation of substances that help to control blood pressure.

4. **ROUGHAGE**

This dietary fiber that is obtained from indigestive part of plants; Roughage does not have any nutrition at value as it is not digested and absorbed in the body. However it helps in the passage of food and faeces through the gut by avoiding contraction of the gut muscle.

Source of roughage : Whole grown cereals, fruits, beans, cabbage, spinach, cassava and whole baked potatoes.

5. **WATER**

Water does not provide energy to body the but there are several ways through which it is important

(i)It used in the digestion and absorption of food.

(ii) It is a medium of transport for food and hormonies.

(iii) It acts as lubricants e.g. eyeball eyelids.

(iv)It helps in excretion of harmful by product of metabolic process e.g. urine, sweat.

(v)It helps in regulation of heat loss (evaporation of sweat on body surface causes the body to cool)

(vi)It is used in the manufacture of different secretions e.g. tears, saliva.

Water can be replaced in the body through

a) Direct drinking

b) Eating foods and fruits.

6. **VITAMINS**

Vitamins are complex organic micro nutrient that is essential for growth and survival. Lack of vitamins in the body leads to deficiency disease. Vitamins can be grouped into two categories *water- soluble* and *fat soluble vitamins*.

- Fat soluble vitamin can be stored in the body and need not be consumed daily. Vitamin A, D, E and K are example of fat soluble vitamins.
- Water – soluble vitamins are not stored in the body. Therefore they should be consumed. Vitamins B and C are water – soluble. Vitamins B is named of various forms, namely vitamin B_1 B_2 B_6 and B_{12}

Source, functions and deficiency of vitamins

vitamins	source	Function	Sign of deficiency
Vitamin A (retinol)	Liver, milk, carrots, orange, and yellow vegetable	Essential for the formation of membrane of the eyes and the respiratory tract	Night blindness, increased risk of infection.
Vitamin B_1 (thiamine)	Lean meat, liver, eggs, yeast extract and brown rice	Carbohydrate metabolism, Coordinate of muscle	Beriberi, a diseases characterized by loss of appetite, muscle cramps disorder and heart failure.
Vitamin B_2 (riboflavin)	Liver, meat, whole, grain cereals, yeast extract.	Needed for metabolism of all food and release of energy to cell	Severe and cracking lips corner of the mouth.
Vitamin B_3 (niacin)	Nuts, fish, meat, yeast, extract unpolished rice.	Needed by enzyme to convert food into energy	Pellagra a disease characterized by skin lesions, loss of appetite and muscle weakness
Vitamin B_6 (doxine)	meat, vegetables, yeast, extracts, whole grown cereals	Essential in protein metabolism	Nerve irritability sores in the mouth, eyes and anemia.
Vitamin B_{12} (yanocobalamin)	Fish, meat, eggs, milk, and lever.	Builds genetic material, helps to form	Anemia nerve damage weights loss.

		bloods cells.	
Vitamin C (ascorbic acid)	Citrus fruits, fresh green vegetables and tomatoes.	Antioxidant improves absorption of iron used in synthesis of collagen in the bones and gums.	Muscle weakness, easy bruising, joint pains, scurvy (bleeding gums), poor healing of wounds and frequent infection.
Vitamin D	Egg yolk, milk oily, fish and liver	Helps to build and maintain teeth and bones.	Rickets in children, osteoporosis (soft bones) in adult
Vitamin E	Corn of sunflower oil, butter, brown, rice and peanuts	Antioxidant prevents damage of all membranes	Nerve abnormalities infertility in rats.
Vitamin K	Green vegetables and liver	Needed for normal clothing	Detective blood coagulation resulting in excessive bleeding.

7.**Minerals**

Certain mineral elements are vital for the proper functioning of the body. Some are required in relatively large quantities and are therefore called *macro minerals*. Others are required in very small quantity are referred to as *micro minerals* or *trace element*.

The following are example of minerals, their sources and their functions in the body.

a) Macro minerals

Minerals	**Source**	**Function**	**Deficiency symptoms**
Calcium	Milk, yoghurt, cheese, sardines, egg, green vegetable	Helps build strong bones and teeth, promote muscle and nerve functions, and important in clotting of blood.	Weak bones, bleeding easily
phosphorus	Meat, milk, fish, eggs and nuts	Builds bones and teeth, help muscle and nerve activity, aids	Impaired nerve activity bone and teeth formation

		formation of genetic materials	
potassium	Peanut, bananas, orange juice, green beans and meat.	Help maintaining regular fluid balance needed for nerve and muscle	Poor muscle contraction
Iron	Liver, meat, beans and green vegetables	Essential formulating hemoglobin [the red pigment in blood)	anemia
Zinc	Oysters, shrimp, crab, meat, yeast extracts	Activates enzymes, helps to heal wounds necessary for a healthy immune system	Impaired teeth, poor immune response, skin problems
Sodium	Table salt	Necessary for nerve and muscle activity	Muscle cramps
Chlorine	Table salt	Maintenance of water and ionic balance, formation of hydrochloric acid in the stomach	Poor digestion of proteins
magnesium	Spinach, pumpkin seeds, sesame seeds and black beans	Relaxation of nerves and muscle strengthening of bones.	Muscle weakness, irregular heartbeat and weaker bones

b) Micro minerals

Iodine	Iodinated table salt and sea food	Production of thyroid hormone which regulate growth, development of bones and teeth, helps prevent tooth decay	Goiter (enlarged thyroid gland)
Fluoride	Fluorinated water and fluoride tables	Development of bones and teeth, helps prevent tooth decay	Poor development of bones and teeth , tooth decay
	Kidneys, liver, tea, coffee nuts and fruit	Formation of bones and activation of enzymes	Nausea, dizziness, loss of heating loss of bone mass
Copper	Meat, fish, and liver	Synthesis of bones and haemoglobin,	Bleeding under skin, easy rupturing of blood

		activation of enzymes	vessel, bones and joint problems, anemia

A BALANCE DIET

A balanced diet refers to food containing all types of food nutrients in the correct proportion. We should eat a diet low in fats, sugar and salt but high in proteins, carbohydrates, vitamins, minerals, and roughage, more importantly we should take in large amounts of water.

However, it is recommended that we eat more fish, poultry products and legumes (such as pea, beans and peanuts)

Instead of taking red meat as protein sources. The following should be done in order to maintain a healthy body.

1. Physical activity can preserve and improve your health. Therefore, it is important to balance your food intake and exercise.

2. Minimize your intake of fats and oils by eating foods low in fats, sugars and salts. This will reduce your risk of heart attacks, tooth decay and high blood pressure respectively.

3. Include plenty of grains, fruits, and vegetables in your diet.

4. Eating a variety of food will provide the body with energy and nutrients that is required in maintaining proper health.

Nutritional requirements for different groups of people

Nutritional requirement differ for different groups of people. The ratio of nutrients varies depending state of the body. The following are some groups of people and the special nutritional needs.

1. **Expectant and lactating mothers.**

Expectant and lactating (breast feeding) mother need to get enough nutrients.

They should thus eat a balanced diet because they require nutrients for themselves and the growing foetus or babies.

Protein is needed for the build – up of the mother muscles, breast, uterus, blood supply and the baby or foetus tissue and organs.

Folic acid and vitamin B help to lower the risk of birth defects such as *spina bifida*. Spina bifida is a spinal disorder characterized by a hole in the spine.

It results from incomplete formation of the spinal cord and the bones of spine. Often the spine protrudes through the hole and sometimes a fluid filled sac may surround the protruding spinal cord.

Calcium helps in the development of the foetus or baby's bones, if the mothers' diet does not contain adequate calcium; it is derived from her bones for the foetus or baby. This weakens the mother bones.

Zinc is important for the proper progression of labour and proper growth and development of the baby.

The mother to be requires iron for her blood supply need, the foetus also needs to store iron for use during the first few months after birth.

Expectant mother requires adequate amounts of dietary fiber to reduce the likelihood constipation, which is a common complaints during pregnancy.

2. **Children**

Children require enough proteins for the growth and development of body tissues. Inadequate of proteins can lead to stunted growth.

Minerals like calcium are necessary for the formation of strong bones and teeth. Zinc is important for body growth. The zinc resources in the body can be depleted by vigorous physical exercise.

Vitamin B_{12} is required for the formation of red blood cells. Because a growing baby needs more oxygen and more blood) for growth while vitamin C helps children to build their immunity.

Children also require more energy – giving foods because they are active than adult.

3. **Adolescent**

- Need food rich in carbohydrates because of high body metabolism
- Food rich in protein and mineral salt such as calcium, iron and phosphorus
- Adolescent girl require additional supply of iron to compensate for the blood loss during menstruation.

4.**The elderly**.

Elderly people require less energy – giving foods because they are generally less active than young people. This group should eat food that is rich in fiber in order to reduce constipation and bowel problems that come with age.

They also need minerals such as iron, zinc and calcium. Iron is necessary because anemia is a frequent problem in older age; zinc is required for a healthy immune system and to increase the rate of healing of wounds.

Old age comes with the loss of calcium from bones leading to soft and weak bones that can break easily. Old people therefore require adequate amounts of calcium and vitamin D to counter the loss.

The elder often have problems of chewing tough foods because of weakened teeth and swallowing because of the decreased production of saliva. It is therefore important to ensure they get food that are nutritious as well as easy to chew and swallow. For example they can get proteins from eggs or liver instead of meat.

5. **Sedentary workers**

These are individuals who stay in one place for a long time while performing their daily occupational activities. They include workers potter's weavers, clerk, receptionists and doctors.

Sedentary workers are encouraged to balance their diets with physical exercise. Due to their lifestyle and occupation obesity increasingly is common among them. Therefore, it is recommended that they limit their intake of foods rich in lipids.

6. **The sick**

Sick people require plenty for nutrients to help recover their health, those who have incurable disease such as HIV and AIDS should get food that will help them to manage their conditions.

Proper nutrition helps to keep their immune system strong and helps the body to fight opportunistic infections and disease.

Rapid weight loss is a major problem in the late stage of AIDS. It is therefore important to get enough nutrients so as that the body can compensate for this.

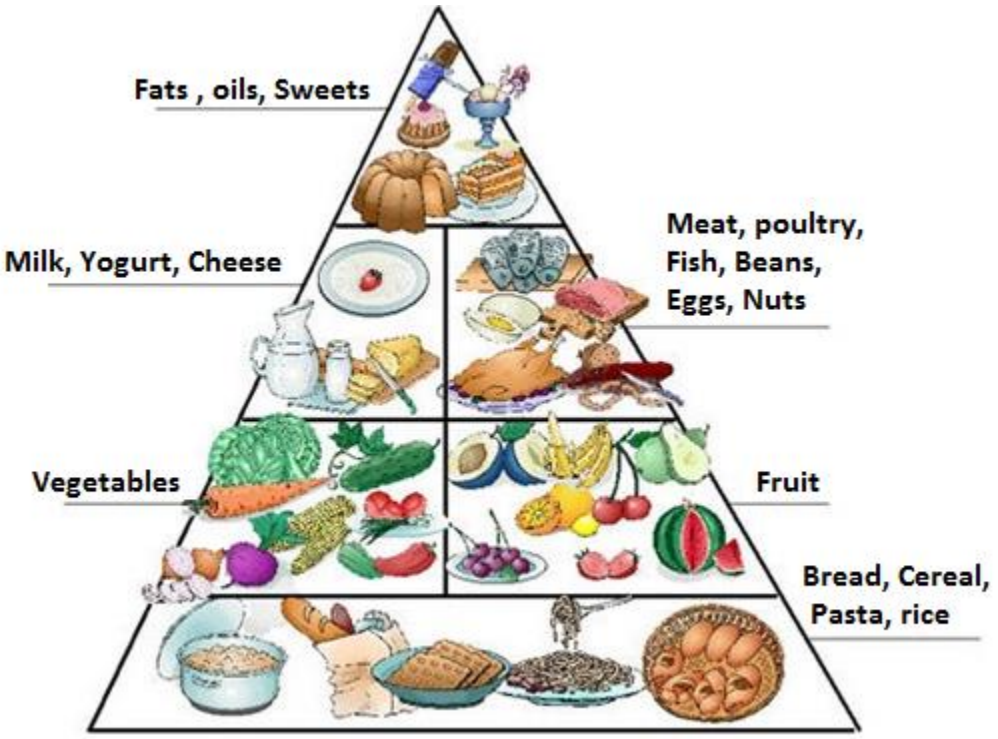
Proper nutrition helps the body to withstand heavy medication.

Proper diet and exercise helps to combat symptoms such as fatigue, nausea, diarrhea and high blood sugar.

Excess caffeine sugar, dried foods, spicy foods and alcohol should be avoided because they are harmful to a body whose immune system is already weak.

They need to take plenty of fruits and water. Fruits provide vitamins which are required to fight disease. Water replaces the amount lost through diarrhea or vomiting.

It is advisable to use food guide pyramid to know what to eat. The food guide pyramid is a chart showing the recommended amounts of different food types that dietician considers healthy eating.



Nutritional deficiencies and disorders

Malnutrition

Malnutrition (limiting the intake of one or more essential nutrients) results from eating too little from eating the wrong food. There are different types of nutritional deficiencies and disorders in human beings, these deficiencies and disorders include obesity, rickets, kwashiorkor, marasmus,

anorexia nervosa and bulimia nervosa.

Nutritional disorders

Nutritional disorders are conditions of ill health in a person which arise as a result of lifestyle (poor eating habits) as discussed below.

1. **Obesity**

Obesity is where by a person has excess body fat. A person sex, age and level of activity among other factor determine his or her ideal body fat. To maintain fertility, women need more body fat. Women also store more fat in their breasts, hips and thighs.

Another important influence of body fat is a person frame size. Individuals with larger bones carry more fat.

Obesity mostly results from eating too much and not exercising enough. Body weight and health risks associated with it are correlated by the body mass index (BMI). BMI gives the relationship between the estimated body fat and the risks of certain disease or conditions.

$$\text{BMI} = \frac{\text{Body mass (in kilograms)}}{\text{persons height (in meters)}^2}$$

OR

$$\text{BMI} = \frac{\text{Body mass (kg)}}{(\text{Person's height})^2\ (\text{m}^2)}.$$

For example if your height is 1.65 meters and your body mass is 60 kilograms your BMI can be calculated as

$60/\ (1.65)^2 = 60/\ (2.7225) = 22.04$

If an individual's BMI falls in the range of 20 – 25, this is considered to be healthy. On the other hand if the BMI is over 30, one may be at risk of diseases associated with obesity.

The following table shows a general guide of how different values of BMI are used to define the condition of the body.

Table BMI guide

BMI	Body condition
Below 20	Underweight
20 – 25	Advisable range
25 – 30	Overweight
30 – 35	Obese
Above 35	Very obese

Obesity increases the like hood of conditions such as high blood pressure, diabetes and certain types of cancer, stroke, and respiratory problems.

Obesity can be prevented by eating properly and engage in regular exercise. The intake of calories should balance one's physical activity. It is also important to avoid eating too much fat foods such as butter, fat meat, chips, margarine, sausage and vitumbua. Avoid also unhealthy dieting.

Anorexia nervosa and Bulimia nervosa

Anorexia nervosa is also called slimmer's disease or self starvation syndrome. It occurs when a person intentionally refuses to eat enough, leading to a severe loss of body mass.

Sign and symptoms of anorexia

1. Muscle wasting (including weakening of heart muscle)

2. Excessive loss of body mass

3. Extreme fear of being fat.

4. Disturbed body image or feeling fat even when one is very thin.

Bulimia nervosa involves excessive eating followed by efforts to remove food from the body. This effort could involve self- induced vomiting, fasting, excessive exercising or taking drugs that stimulate, emptying of the bowels or excessive urination. Bulimics usually have a normal body mass and keeps their eating behavior secret. Hence it may be difficult to tell that they have a problem.

Causes of Anorexia and Bulimia

Both Bulimia and Anorexia have underlined psychological causes, such as depression, low self esteem and bottled up emotions and the need to fit contemporary standard of beauty Bulimia and Anorexia mostly affect women.

Effects of Anorexia and Bulimia

- The effects of Anorexia and Bulimia are demonstrated by heart problems due to weak cardiac muscles or an imbalance of mineral salts.
- There is an impaired mental function because the brain lacks adequate amount of glucose. Victims also exhibit dehydration. During vomiting, the acidic present in the stomach come into contact with the teeth and gums, the eventually causes, serious damage to the gum and erosion of the teeth. Other effects include anemia, stomach ulcers, abdominal cramping and inflammation of the gut, irregular or absent menstrual periods and dry skin.

Treatment for Anorexia and Bulimia

Anorexia and Bulimia can be treated by resolving the underlying psychological problems, seeing a medical practitioner who can prescribe a way of getting back one's healthy and making the necessary lifestyle and dietary change.

Nutritional deficiencies.

These deficiencies arise when the body does not have sufficient supply of a particular food or nutrient. The following are some of the common nutritional deficiencies.

1. **Marasmus**

Marasmus is a form of malnutrition in children caused by lack of adequate amount of food

Sign and symptoms of Marasmus

A child suffering from marasmus shows weight loss, slowed growth, decreased activity and lack of energy. They also have wrinkled skin, are irritable and have extreme hunger

Treatment of Marasmus

Getting adequate amount of food that contains all the nutrients in the right proportions.

2. **Kwashiorkor**

Kwashiorkor is caused by a deficiency of proteins. It affects children, mostly after stopping to breast feed.

Signs and symptoms of kwashiorkor

The signs and symptoms of kwashiorkor include extremely thin arms and legs, poor growth, swollen thin arms and legs, swollen abdomen due to enlargement of the liver and reddish or yellowish thin and weak hair. Other symptoms are weakened immunity, diarrhea, anemia, and dry skin that cracks easily

Treatment for kwashiorkor

Kwashiorkor is treated by providing a child with a diet that has adequate amounts of proteins.

3. **Rickets**

Rickets is a condition where by the bones of a child soften, leading to fractures and deformities. The cause of rickets is lack of vitamin D, phosphorous and calcium.

Sign and symptoms of Rickets

A child suffering from rickets can be identified by observable skeletal deformities such as bow legs, knock knees, an odd – shaped skull and a deformed spine. A child feels bone pain, experiences dental problems such as weak teeth or delayed formation of teeth and develops weak muscles. The child's bones are easily fractured, shows slow growth and gets muscle spasms and muscle cramps.

Prevention of Rickets

Rickets is prevented by increasing the amount of vitamin D, phosphates and calcium in the diet and by ensuring exposure to sufficient amount of sunlight.

FOOD TEST

Food test is used to determine which nutrients are present in a food specimen. At this level we will learn how to test for carbohydrates, proteins and lipids.

1. **Test for carbohydrates**

	Procedure	**Observation**	**Conclusion**
	Test for reducing sugar		
	Dissolve specimen in water	colour changes from blues to green to yellow then orange	Reducing sugar is present
	Add an equal amount of Benedict's solution to the solution		
	Boil the mixture		
	Test for non reducing sugar		
1. 3. 5.	Dissolved the specimen in water Put $2cm^3$ of the solution in a test tube. Add $1cm^3$ of(dilute hydrochloric acid neutralizes disaccharides to monosaccharide's) Boil the mixture Allow the mixture to cool Add small amounts of sodium hydroxide at a time (sodium addition) Continue until fizzing stops. Add $2cm^3$ of Benedict's solution, then boil the mixture	Colour changes from blue, green to yellow to orange.	Non – reducing sugar is present
	Test for starch		
	Add a few drops of iodine solution to the specimen	Colour changes to blue - black	Starch is present

Test for Protein

Procedure	**observation**	**Conclusion**

Biuret test		
The specimen should be in solution form	Color changes to purple	Proteins are present
Pour $2cm^3$ of specimen in a test tube		
Add $1cm^3$ of sodium hydroxide solution then a drop of copper sulphate solution shaking the mixture after each addition		

Test for lipids

	Procedure	**observation**	**Conclusion**
	Grease spottiest		
	Rub the specimen on a piece of dry filter paper	a translucent mark is formed	Specimen contain lipids
	Hold the paper against the light		
	Sudan III test		
	The specimen should be in solution form	Droplets of oil turn red	Specimen contains lipids
	Add some drops of Sudan III test		
	Emulsion test		
	Ensure the specimen is in solution form	The clear mixture turns cloudy forming a milky suspension	Specimen contains lipids are present.
	Put the specimen in a test tube along with an equal amount of acetone, benzene or ethyl alcohol.		
	Shake the mixture		
	Add an equal volume of water		

DIGESTIVE SYSTEM IN HUMAN

Some common terms concerned with the movement of food along the alimentary canal.

INGESTION – This is taking in a food to the mouth.

DIGESTION – This is the process by which food is broken down to small particles which are absorbed and assimilated in the body.

ABSORPTION – This is the process by which soluble end products of digestion diffuse into the blood stream.

ASSIMILATION – This is the incorporation of products of digestion into the cell metabolism.

EGESTION –This is the process by which indigested food particles are removed from the body through the anus.

The digestive system is made up of alimentary canal (gut) and associated organs such as the pancreas and liver

PARTS OF ALIMENTARY CANAL

The alimentary canal is a long hollow tube that runs from the mouth to the anus. It is also known as digestive tract.

- It consists of the mouth, pharynx, gullet, stomach, duodenum, ileum, caecum, colon and rectum

DIGESTION

Digestion is a process by which food is broken down into form that can be absorbed and used by the body. It involves both mechanical and chemical breakdown of food. Mechanical take place in the mouth; the teeth chew the food to reduce it to small piece that can be swallowed easily

The small pieces have a large surface area to facilitate the action of digestive juice called enzymes

Chemical breakdown is achieved by digestive enzymes. The digested food is absorbed and assimilated in the body. The undigested and indigestible materials are egested as faeces.

THE DIGESTIVE SYSTEM AND DIGESTION PROCESS

The major regions where digestion occur in the alimentary canal are mouth, stomach, duodenum and ileum

DIGESTION IN THE MOUTH

In the mouth, food is chewed by teeth and mixed with saliva to form a ball like to break down food into small particles thus increase the surface area for enzymatic activities.

-Saliva is alkaline in nature, so it makes the food alkaline when in the mouth.

- Secretion of saliva is controlled by the nervous system. These smell, taste, sight or thoughts of food cause saliva to flow from the gland.

-Saliva is a mixture of mucus water, a variety of salts and the enzymes known as salivary amylase.

FUNCTION OF SALIVA

1. Water acts as solvent for dissolving food substance

2. Mucus lubricates thus food for easy swallowing.

3. Salivary amylase turns starch to maltose.

- The tongue rolls the food in the round mass known as bolus(plural is boli)

- The boli are pushed down the oesophagus by the tongue

THE PHARYNX

- The region which crosses the air passage is known as glottis

- There is a structure known as epiglottis which prevent food from entering the wind pipe or trachea.
- There is no digestive enzymes

THE OESOPHAGUS (GULLET)

- This is the tube which connects the pharynx and the stomach.
- The food passes the gullet rapidly by contraction and relaxation of the gullet mode this is known as PERISTALSIS
- Peristalsis is the process by which food substances move down the alimentary canal in the form of bolus through muscle valve known as sphincter
- There is no digestive enzymes.

DIGESTION IN THE STOMACH

- The food is mixed with hydrochloric acid and gastric juice to produce a semi – solid mass known as chyme.
- The wall of the stomach contains gastric glands which secrete gastric juices.
- The gastric juices contain water, hydrochloric acid, mucus and enzymes(pepsin and rennin).

FUNCTION OF THE HYDROCHLORIC ACID

1) Provides suitable acidic medium for enzymes to work best

2) Hydrolyses or breaks down food to simple particles

3) Kills bacteria present in food

- The function of pepsin is to breakdown proteins into peptides.

- The function of rennin is to coagulate (solidifies) soluble milk protein (casein) into an insoluble form which is then acted on by the enzymes pepsin. This enzyme is mostly found in young mammals during sucking period.

The function of mucus is to protect the stomach against corrosion by the hydrochloric acid.

GENERAL FUNCTIONS OF THE STOMACH

- It is a temporary storage of food
- Digestion of proteins starts in the stomach
- Helps in mixing food during churning, also absorb water alcohol and some vitamins.

There is a muscle valve between the stomach and the duodenum known as **pyloric sphincter**

The chyme (liquid food) passes periodically from the stomach through the pyloric sphincter to the duodenum.

DIGESTION IN THE DUODENUM

- Duodenum is the first part of the small intestine
- It is associated with the liver and pancreas.

THE LIVER

- The liver has cells which secrete bile.
- Bile is stored in the gall bladder and is released through the bile duct. It is greenish yellow in colour and contains bile salts.

FUNCTION OF THE BILE

i) It emulsifies fats (lipids) i.e. break down fats into tiny fat droplets to increase the surface area for enzymatic activities.

ii) Provides an alkaline medium for enzymes to work best.

iii) It neutralizes the acidic food from the stomach.

THE PANCREASE

The pancreas secretes digestive juices known as pancreatic juice. The juice contains the following.

1. Pancreatic amylase – it breaks down the starch into maltose.

2. Pancreatic lipase – digest the fat droplets into fatty acids and glycerol.

3. Sodium hydrogen carbonates ($NaHCO_3$) provides basic medium for pancreatic enzymes to work best i.e. neutralize the acidic chyme from the stomach. The resulting food mixture in the duodenum is known as chyme.

4. Trypsin – break down proteins into peptide.

DIGESTION IN THE ILEUM (SMALL INTESTINE)

- The ileum is the largest section in the alimentary canal.
- The intestine contains secretory cells which secrete mucus and digestive juice known as intestinal juice or succus entericus.
- The juice has 4 enzymes

  1. Erepsin or peptidase digests peptides to amino acids.

  2. Maltose – breaks down maltose to glucose.

  3. Lipase – breaks down fat droplets to fatty acids and glycerol.

  4. Sucrose – breaks down sucrose (cane sugar) to glucose.

- The ileum has two main functions

  a) Digests all types of food.

  b) Absorption of end products of digestion into the blood stream

  NOTES: The walls of the alimentary canal secrete mucus which performs two major functions.

  a) Allows smooth movement of food materials along the alimentary, absorption of the end product of digestion into the blood of stream

  b) Protect the wall of the alimentary canal against corrosion (digestion) by digestive enzymes.

  -End products are:

- Amino acids – simple form of proteins.
- Glucose – simple form of carbohydrates.
- Fatty acids and glycogen – simplest forms of lipids.

ABSORPTION

Absorption is the process by which the soluble end products e.g. glucose diffuses into the blood stream.

- Absorption takes place mainly in the small intestine however; absorption of some water, soluble vitamins B and C, and soluble salts take place into the stomach.

PROCESS OF ABSORPTION

1. Amino acids and glucose. These materials are absorbed into the blood stream through the process of active transport

- These materials diffuse into the blood with the dissolved materials to the HEPATIC PORTAL VEIN

- The hepatic portal vein takes the blood with the dissolved materials to the river and then joins the general body circulation.

2. Fatty acids and glycerol.

- They are absorbed into the location of the villi

- They can drain into lymphatic vessel and finally join the body circulation at the vena cava.

NOTE: The wall of the small intestine has numerous fingers – like structure called villi: (singular villus) which increase the surface area for digestion and absorption of food to take place.

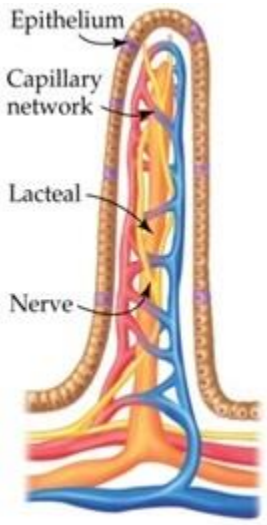


Diagram of villi

Adaption of ileum to its functions

1) It is long to provide large surface area for digestion and absorption.

2) It is highly coiled to increase the surface area for digestion and absorption.

3) It has villi and micro – villi which increase the surface area for absorption.

4) It has dense network of blood capillaries which facilitate easy diffusion of digested materials.

ASSIMILATION

- This is the process by which the end products of digestion are incorporated in the cell metabolism. Assimilation occurs as follows:

  Glucose: some is oxidized during respiration to produce energy (ATP) some is stored as glycogen in muscle some is converted to fats and stored as tissue beneath the skin.

  AMINO ACIDS

  Some are used in the synthesis (formation) of proteins, some are used in growth and repair of worn out cells. In absence of glucose and fats they may be oxidized to release energy during respiration.

FATTY ACID AND GRYCELOR

- Are oxidized to release energy during respiration.
- Stored as a dispose tissue beneath the skin. This helps in insulating the body.

THE CAECUM AND THE APPENDIX

- These have no function in man.
- In herbivores the caecum and appendix contain bacteria that secrete an enzyme known as cellulose.

THE LARGE INTESTINE (COLON)

- The large intestine has four functions.

1. Absorb water from the undigested materials
2. Absorb small amount of digested food.
3. Glandular lining of the colon produces mucus which lubricate the passage of faeces
4. It is a temporary storage of faeces up to the time of defecation (egestion).

EGESTION: The undigested and indigested materials are known as faeces. The faeces are removed from the body through anus by the process of egestion.

SUMMARY OF DIGESTION

Part of alimentary canal	Enzymes secreted	Substance digested	Product of digestion
Mouth	Salivary amylase	Carbohydrates	Maltose
Stomach	Pepsin	Protein	Peptides
	Rennin	Soluble milk protein (caseinogens)	Insoluble milk protein e
	Trypsin	Protein	Peptides
Duodenum	Pancreatic amylase	Starch	Maltose
Ileum	Pancreatic juice	lipase	Fattys acids and glycerol
		Maltase	Glucose
		Sucrase	Glucose and fructose

		Lactose	Glucose and galactose

NUTRITION -2

The ruminant digestive system

A ruminant is an animal that chews food, swallows it then returns it to the mouth later for further chewing. This is called **chewing cud.** Examples of ruminants are cows, goats, sheep, antelopes and giraffes.

The digestive system of a ruminant is different from that of a human being. Ruminants have a more elaborate system to enable cellulose digestion.

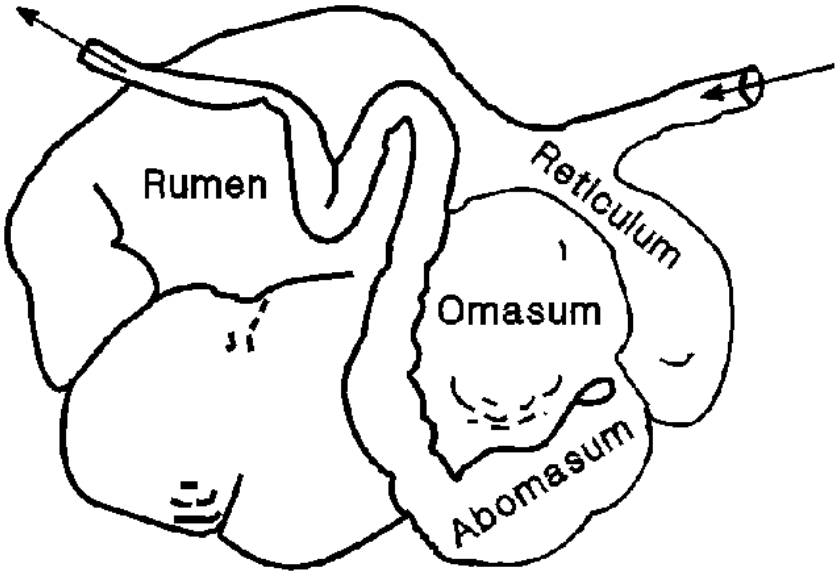
The stomach of a ruminant has four chambers: rumen, reticulum, omasum and abomasum.

When a ruminant first chews and swallows a mouthful of plant matter, the food enters the rumen. Bacteria in the rumen immediately start digesting the cellulose present in the material. Chewing cud softens and helps down plant fibres, making them more access to digestion by the bacteria. When the food in the rumen, it is coarse and very green. The food then regurgitated and chewed again. It passes the reticulum. The reticulum has a 'honeycomb" appearance. In the reticulum, the food is mixed thoroughly with water. The food coarse, more watery, less green and very small compared to the food in the rumen.

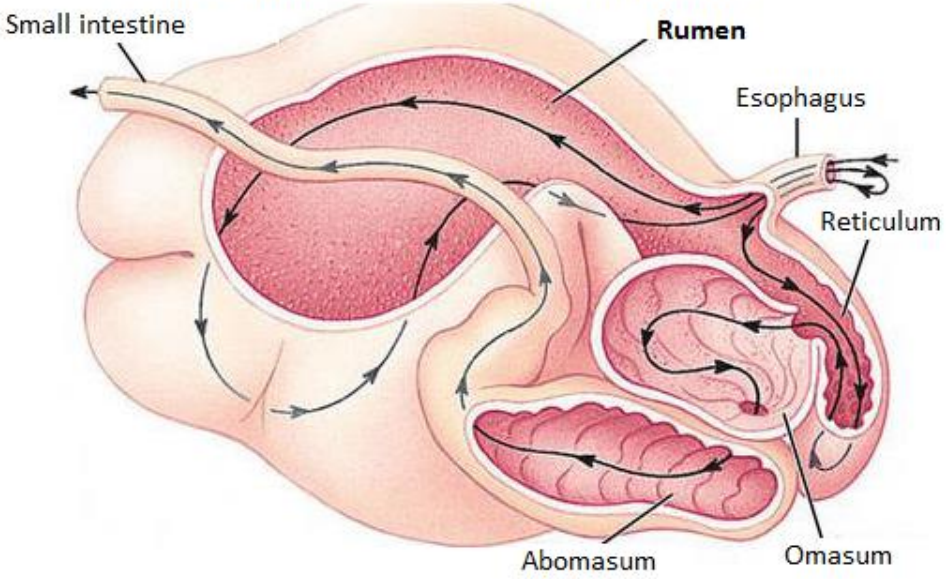
The food is regurgitated, chewed again and passed to the omasum. The abomasum has longitudinal folds like the leaves of a book. *The* folds help to remove water from the food. The food in the omasum is in form of fine particle and has very little water.

The abomasum is the ruminant's stomach. The abomasum has gastric acid facilitates the digestion of proteins. It also has microorganisms that may have spilled over the rumen.

OUTER SIDE OF RUMINANT STOMACH



Four-Chambered Stomach of Ruminant



Differences between the ruminant System and the human digestive system are:

- Ruminant digestive system has four chambers. Human beings have one stomach chamber.
- Ruminants have no upper incisors. Instead, they have a horny pad. This helps in the chewing of food. They also have a gap on the lower jaw called diastema. –*humans* have upper incisors and no diastema. Ruminants chew cud. They regurgitate what they had swallowed and chew it again. Human beings do not chew cud.
- Ruminant's digestive system has organisms(bacteria) that help to digest fibre and synthesize vitamin B. Human beings cannot digest fibre.

Diseases and disorders of the digestive system

This includes diseases and disorders that affect; the oesphagus, the stomach and the

large intestines. Examples include dental caries heartburn, stomach ulcers, constipation flatulence and cancer.

1. **ULCERS**

1. These occur as a result of the action of enzymes and acid on the epithelial membrane lining of the stomach and duodenum walls. The mucus coating can be broken by bacteria called *Hericobacter pylori*

Cause

- Ulcers can be caused by stress which stimulates acid production
- Ulcers can also be inherited.
- Certain medication like aspirin
- Smoking and taking alcohol
- Caffeine

Sign and symptoms of ulcers

1. Burning pain in stomach or the middle of thorax
2. Nausea and vomiting
3. Tiredness and weakness
4. Blood in vomiting or stool (a symptom of breeding ulcer)

CONTROL OF ULCERS

Ulcers can be controlled as follows

1) Have stress reduction programs

2) Eliminate smoking and drinking alcohol

3) Changing diet and taking meals on time

- The ulcers can be corrected or reduced by the following treatment

1. Drinking milk

2. Taking magnesium trisilicate tablet

3. Surgery which include

- Cutting the vestigial part

- Gastrectomy removal of the duodenum and the stomach.

2. **CONSTIPATION**

- This is the frequent passage of hard faeces

Constipation is caused by the following:

(i) Abnormally slow movement of faeces matter through colon. As a result maximum absorption of water takes place leaving very dry hard faeces.

(ii) A diet low in fibre such as roughages

(iii) Failure of the sensory cells to signal the presence of faecial matter in rectum.

CONTROL

Constipation can be controlled by

(i) Eating high fibre rich food.

(ii) Drinking a lot of water.

3. **HEART BURNS**

This is the burning sensation along the alimentary canal or in the chest cavity as a result of accumulation of too much acid in the stomach.

- An individual with this problem feels uncomfortable all the time
- Prolonged heart burn can lead to oesophagus ulcers

CONTROL

Heart burn can be reduced by drinking milk or taking tablets which neutralize the acid of the chyme.

4. **FLATULENCE**

This is a condition caused by excessive gas in the digestive track it causes pain and embarrassment to many individuals.

- The intestinal gas such as oxygen and nitrogen are gulped in while breathing and at the same time eating
- Other gases such as methane, carbon dioxide and hydrogen are produced from fermented undigested food
- The gases in the intestine can be minimized by

  (i) Eating slowly

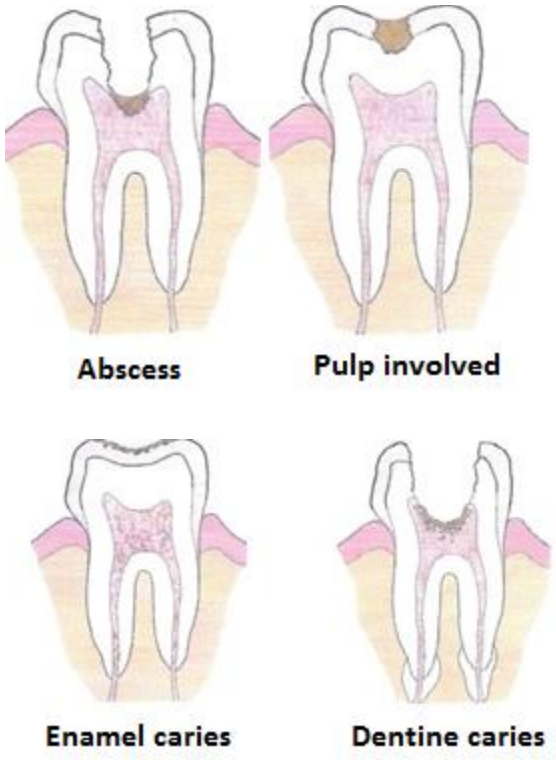
  (ii) Avoid milk if you are lactose intolerant

  (iii) Not eating gas – inducing food such as beans, cabbage, onions

  (iv) Using antacids

1. DENTAL CARIES

This is commonly referred to as tooth decay. It occurs when bacteria destroy the outer part of the tooth.



Development of dental caries

There are always bacteria present in the mouth. The bacteria combine with acid, saliva and remains of food to form **plaque.** Plaque is the sticky substance often found between teeth. Plaque begins to form within 20 minutes after we eat. The bacteria in plaque convert the remains of food (especially sugar and starch) into acids.

The acid dissolves the enamel in the tooth, forming **a cavity.** If this cavity is left untreated, it reache**s** the pulp cavity and nerve endings inside the tooth causing an infection.

This disease is caused by a number of factors including:

(i) Lack of hard food

(ii) Too much sweet food

- Sweet food tends to encourage growth of bacteria

  (iii)Lack of calcium in the diet

  (iv)Lack of vitamin D

  (v) General ill health

6. **CANCER**

- Cancer is a disease which affects the digestive tract include

1. Cancer of oesophagus
2. Cancer of the colon

- **There are various causative agents of cancer**, Their common ones include

  i) Mutation of genes

  ii) Cancer inducing foods we eat. They affect the colon when they come in contact over a long direction of time

  TREATMENT

- It has not been up to date easy to treat or prevent cancer. The following methods are applied in treating it.

  1) Chemotherapy – During treatment to supplement surgery

2) Radiation – Bombardment using radioactive particles to eliminate the cancerous cells

3) Surgery – Removal of all cancerous cells

NOTE: The outlined treatment are not 100% perfects, they will affect other cells or induce other cells to become cancerous

CONTROL

Taking the fibre food in the food to come into contact with the cells leaving the colon wall

NUTRITION IN PLANTS

AUTOTROPHISM

This is the mode of nutrition used by green plants to manufacture their own food.

- The process is used by green plants to manufacture their food is known as ***photosynthesis***.

  Definition – photosynthesis is the process in which green plants manufacture complex food substances from simple inorganic substances such as carbon dioxide and water in the process of sunlight and chlorophyll

- This process of photosynthesis occurs in the green parts of the plants mostly in leaves

STRUCTURE OF THE LEAF

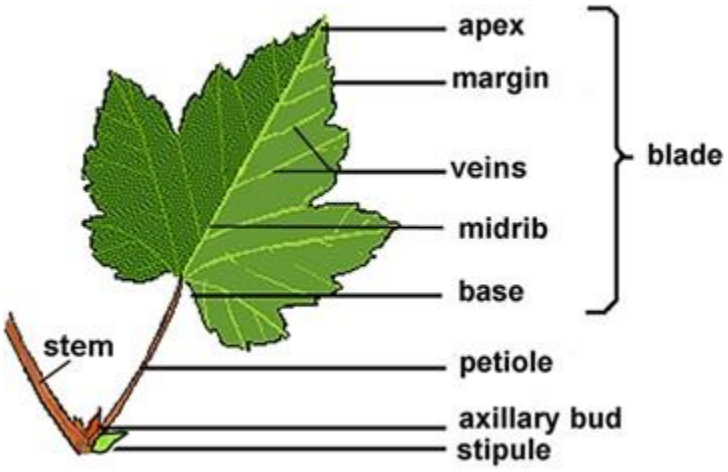
A) EXTERNAL PARTS OF THE LEAF

1) Petiole – attaches the leaf to stem or branch.

2) Veins – Transport materials within the leaf

3) Midrib – gives rise to veins. Transport materials to the leaf

4) Lamina- photosynthesis takes place in it.



B) **INTERNAL PARTS OF THE LEAF**

The internal parts of the leaf consist of

1) Cuticle

2) Epidermis

3) Guard cell

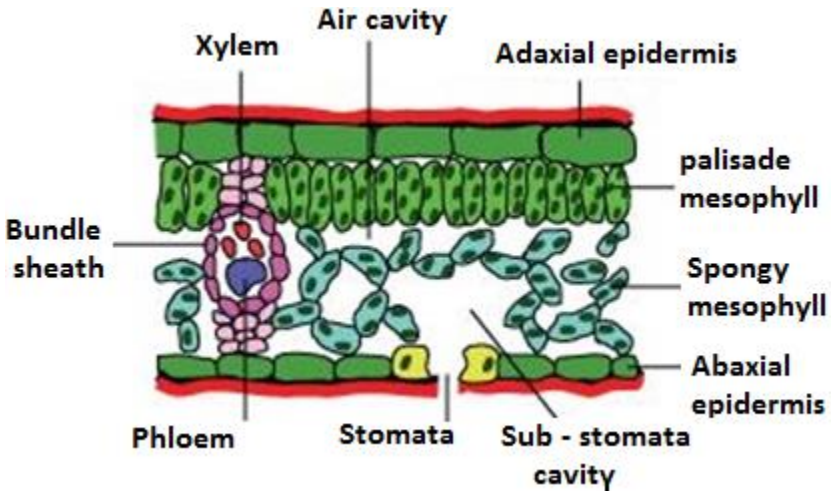
4) Palisade layer

5) Spongy mesophyll layer

6) Leaf veins

7) Chloroplast

Diagram showing the internal parts of a leaf



FUNCTION OF THE INTERNAL PARTS OF LEAF

a) **CUTILE** – This is a thin wax transparent and water proof

- It is found on both sides of the leaf

Functions

(i) Reduce excessive water loss

(ii) Protects inner tissue from damage

(iii) Prevents entry of pathogens

b) EPIDERMIS – This is a thin layer found on both sides

Functions

i) secretes (makes) the cuticle

ii) Protects inner tissue from damage

c) **GUARD CELLS**

Are bean shaped epidermal cells mostly found on the lower surface.

Functions

i) Control opening and closing of stomata

ii) Control water loss

iii) Allow gaseous exchange

iv) Contain chloroplasts with chlorophyll used to trap sunlight for the process of photosynthesis.

d) PALISADE LAYER

This is the layer between the upper epidermis and the spongy mesophyll layer

- It is made up of palisade cells

Functions - trap sunlight by using chlorophyll for the process of photosynthesis

e) SPONGY MESOPHYLL LAYER

This is found between the palisade layer and the lower epidermis

Function

i) Used for gaseous exchange

ii) Photosynthesis takes place in it

f) LEAF VEINS

Consist of both xylem and phloem

Functions:

1. Xylem transport water and mineral salts from the root to the rest parts of the plants.
2. ii) Phloem transport manufactured food from the leaves to the rest parts of the plant.

g) CHLOROPLAST

These are disc shaped organelles that contain chlorophyll

Functions:

1. Chlorophyll absorbs (traps) sunlight for photosynthesis

REQUIREMENTS AND CONDITIONS NECESSARY FOR PHOTOSYNTHESIS

The raw materials of photosynthesis are:

a) Carbon dioxide

b) Water

- Carbon dioxide is obtained from the atmosphere and water is absorbed by the roots from the soil.
- The conditions necessary for photosynthesis to take place are

  (i) Chlorophyll

  (ii) Sunlight

- Chlorophyll is used to absorb light energy needed during photosynthesis and sunlight (solar energy) is converted to chemical energy (ATP) needed by all living organisms

PROCESS OF PHOTOSYNTHESIS

The process of photosynthesis occurs in two stages which are:

(i) The light stage.

(ii) The dark stage.

THE LIGHT STAGE

- It occurs in the chloroplasts
- The chlorophyll absorbs light energy from the sun
- The light energy is used to split the water molecules to oxygen and hydrogen

  The process is known as photosynthesis

$$2H_2O \xrightarrow{\text{light}} 2H_2 + O_2$$

Hydrogen Oxygen

Oxygen is released to the atmosphere while some is used in respiration

- Hydrogen enters the dark reactions
- Some of the solar energy absorbed by the chlorophyll molecules is used in the formation of energy rich compound known as Adenosine triphosphate (ATP) which later is used in the dark stage of photosynthesis

THE DARK STAGE

- It occurs in the stomata and it doesn't need a light
- Carbon – dioxide combines with hydrogen to form sugar such as glucose
- This process is called **carbon dioxide fixation**
- This process requires energy (ATP) and enzymes i.e.

$$CO_2 + 2H_2 \xrightarrow{\text{energy}} C_6H_{12}0_6 + H_20$$

END PRODUCTS OF PHOTOSYNTHESIS

The end products of photosynthesis are:

i) Glucose

ii) Oxygen

iii) Water

Glucose – is used in respiration to release energy. Some is stored as starch or oils during exchange.

Oxygen – Some oxygen is used during respiration while the rest is released into the atmosphere during exchange.

Water – some water is used in various chemical reactions within the cells, some water is released to the atmosphere during transpiration

The overall chemical equation representing the process of photosynthesis

$$6C0_2 + 12H_20 \xrightarrow[\text{sunlight}]{\text{chlorophyll}} C_6H_{12}O_6 + 6H_2O$$

ADAPTATION OF THE LEAF IN THE PROCESS OF PHOTOSYNTHESIS

(i) Cuticle and epidermis are transparent to allow easy penetration of light

(ii) Presence of stomata on the leaf allows easy diffusion of carbon dioxide

(iii)The network of veins allows movement of materials in and out of the leaf

(iv)The air spaces in the spongy mesophyll layer allow gases to circulate easily.

(v) Presence of large numbers of chloroplasts in the palisade layer enables maximum sunlight absorption.

(vi) The leaves are well arranged to avoid overlapping and overshadowing

(vii) Broad and flat lamina allows maximum absorption of sunlight and carbon dioxide.

FACTORS AFFECTING THE RATE OF PHOTOSYNTHESIS PROCESS

1. **LIGHT INTENSITY**: A good quality of light enhances the rate of photosynthesis.

- Very bright light damages the plant due to strong sun rays

- Plants under shade receive poor quality of light

2. **CARBON – DIOXIDE CONCENTRATION:** An increase in carbon dioxide concentration results to an increase in the rate of photosynthesis up to a certain level

- Any further increase in the carbon dioxide concentration after the maximum point induce the stomata to close and therefore cutoff the supply of carbon dioxide.

3. **TEMPERATURE**: Photosynthesis is controlled by enzymes. Enzymes are affected by changes in temperature.

- High temperature destroys the enzymes, very low temperature inactivate them.

- The rate of photosynthesis increase as the temperature increase up to maximum point i.e. 40^0c.

4**. WATER**: Plants require water for the various chemical reactions of the cells.

-Water is also a raw material for photosynthesis.

5**. MINERAL SALTS:** Some minerals such as magnesium and iron are responsible in the formation of chlorophyll.

- The availability of these minerals results in the chlorophyll synthesis and the rate of photosynthesis increases.

6**. LEAF AGE**: As the leaf ages chlorophyll breaks down hence the rate of photosynthesis is reduced.
7. **PRESENCE OF MANUFACTURED CARBOHYDRATES**: This will reduce the rate of photosynthesis since carbohydrates are product of photosynthesis

IMPORTANCE OF PHOTOSYNTHESIS

(i) Food substance like glucose is formed. Plants and animals use these food substances.

(ii) Release oxygen in the atmosphere for respiration of organisms

(iii) Purify the atmosphere by removing carbon dioxide.

(iv) Light energy is converted into a form that can be used by all other organisms. This energy is known as **ATP**.

STORAGE ORGANS

Plants store food for future use

Foods in plants can be stored in:

(a) Leaves e.g. Onions, cabbage

(b) Fruits e.g. Mango, pineapple, pawpaw

(c) Seeds e.g. Beans, peas, rice, maize

(d) Stems e.g. Irish potato, ginger, sugar cane

(e) Roots e.g. Sweet potato, cassava, carrots

ADVANTAGE OF FOOD STORAGE ORGANS

i) Some organs give rise to new plants e.g. Seeds, stem, tubes

ii) Permits the survival of plants over dry seasons.

iii) Some are used as source of food by man and other animals e.g. Rice, wheat, potatoes etc.

iv) The stored food is used during germination before the leaves form.

v) Some are used for commercial purpose by man e.g. Sugar cane

MINERAL REQUIREMENTS IN PLANTS

- The mineral elements required by plants are grouped into two;

1. Macro elements or Macro nutrients

These are elements required in large quantities by the plants.

They include; manganese, carbon, calcium, oxygen, phosphorus, sulphur, hydrogen, potassium and nitrogen.

2. Micro element or micro nutrients
   These are elements required in small quantities by the plants.

They include; manganese, zinc, sodium, boron, chlorine, copper, cobalt and silicon.

NOTE: Nitrogen, iron and magnesium are used to synthesize carbohydrates

- Lacking of these elements cause yellowing of leaves
- Carbon, Hydrogen and oxygen are used to synthesize carbohydrates
- Lack of these elements show stunted growth in plants.

FOOD PROCESSING, PRESERVING AND STORAGE

Food processing: This refers to all the ways in which food is treated in order to make it edible, appetizing and safe to eat or keep it fresh for a long time

- Some of the activities involved in food processing are:

  (i) Picking, sorting and washing fruits and vegetables

  (ii) Converting raw material into other products

  Examples – Making cheese from milk

  - Making sugar from sugar cane

FOOD PROCESSING TECHNIQUES

Common food processing techniques include

i) Removing unwanted outer layers e.g. peeling potato

ii) Chopping or slicing e.g. Bananas, mangoes and cassava

iii) Liquefaction e.g. producing juice by squeezing fruits

iv) Fermentation e.g. making wine from banana and grapes and beer brewing

v) Cooking e.g. boiling, frying, steaming or grilling

vi) Deep freezing

vii) Baking

FOOD PRESERVING

This is a method that involve special methods of food processing that are used to prevent food from getting spoiled or going bad. These methods include:

1. Canning or bottling; this is used for getting rid of micro – organisms.

2. Pasteurization and boiling; this involves using high temperature to kill micro – organisms that cause spoilage

3. Refrigeration – using very low temperature to slow down the growth of micro – organisms

4. Irradiation – this involves using radiations to kill micro – organism that might make food go bad.

5. Drying salting, applying honey or smoking eliminate the moisture that is needed for growth of micro organisms.

6. Adding chemicals such as salt, sugar and carbon monoxide to prevent physical changes in food.

IMPORTANCE OF FOOD PROCESSING, PRESERVING AND STORAGE

1) Prevents wastage of food

2) Saves money by preventing spoilage of food

3) Maintains the quality of food.

4) Prevents growth of micro – organisms that can cause illness and improves the flavor of food.

5) Removes harmful toxins and micro – organisms from food

6) Makes food available even when they are not in season

7) Enables transportation of delicate and perishable food such as milk and fruits over long distance

TRADITIONAL METHODS OF FOOD PROCESSING AND PRESERVING

1. **CURING:** This involves the addition of substances such as sugar, salt, spices and vinegar to animal foods e.g. Meat and fish.

- Curing binds or removes water making it unsuitable for the growth of micro – organism

- It also improves the taste of food. Example sausage and canned beef are made by curing meat.

2**. DRYING IN THE SUN**

The food is left in the sun for long periods of time in order to reduce its moisture content.

- Removing the amount of water in the food discourage the growth of micro – organism This method is used to reserve rice, maize, cloves, bananas, beans, peas, meat, fish, cassava and green vegetables.

  NOTE: Dried grain or cassava can be pounded or ground into flour and dry cloves are used for making spices.

3**. SMOKING**

Smoke reduce the moisture content of food to prevent the growth of micro – organisms

Example: Grains, meat and fish can be dried slowly over a smoking wood fire.

4**. COOKING:** This includes boiling, steaming, baking in hot ash, grilling and roasting.

- These processes help to soften food, improve flavor and preserve food. Examples: potatoes, banana, and maize can be boiled before being dried

- Meat can be grilled or deep fried.

5**. SALTING**: Salt removes water from the food and kills micro – organisms that would otherwise spoil the food.

6**. FERMENTATION**

Fermentation is the conversion of carbohydrates such as sugars into acids and alcohol

Fermentation can occur naturally or can be induced

Example: Milk can be fermented into yoghurt by keeping in a container for some time.

Picking foods such as cucumbers and mangoes can be fermented by putting them in salty water for some time, bacteria produce lactic acid that gives the food its distinctive flavor and helps to preserve it.

MODERN METHODS OF FOOD PRESERVATION AND PROCESSING

1. PASTEURIZATION: This is the method of heating food to very high temperature for a short while in order to kill micro – organism that can cause food spoilage

Pasteurizations maintain the nutrients content and flavor of food. Example: Food which can be pasteurized is milk and fruit juice

2. LIQUEFICATION; this is the making of liquids from solid food

- It is mostly applied to fruits where by juice is made out of them.

- The juice is then pasteurized and post into cans or containers.

3. CANNING AND BOTTLING

This is the method where by food is preserved by heating it in air tight vacuum – sealed bottles or cans.

- First the container is filled with food then the air is pumped out to form a vacuum.
- The container is sealed and heated to kill micro – organisms and enzymes fruits and fruits juices, beef, fish and baked beans.

  NOTE: Bottled and canned foods can be kept for months or even years.

4. USING ADDITIVES – This is the addition of chemicals such as sodium benzoate, sodium chloride and vinegar to slow down the growth of micro – organisms. Examples the food can be preserved by this process are fish and meat.

5. DRYING OR DEHYDRATION: This is where food is dried by using either hot blasts of air from vacuum dryer or a freezer (freeze drying).

- After drying, the food is then sealed in moisture proof containers

6. IRRADIATION – This is the use of ray's energy to stop growth of micro – organism in stored food stuff.

- This makes food last longer

- Also prevents spoiling.

Examples: the foods that can be preserved by this method are onions, beans and potatoes

FOOD STORAGE

Food storage is a method used to keep reserves of food for future use

- Food storage can be done on a small side at the family level. Examples in the food storage, or on a large scale for populations. Example in government sides for grains

TRADITIONAL METHODS OF FOOD STORAGE

1) Storage in granaries and pits

- Dry grains are stored in granaries which are usually raised above the ground.

The gains are sometimes mixed with neem leaf ash or groundnuts to further prevent attack by micro – organisms.

- Granaries keep grains safe from insects, rodents and birds
- Harvested yams, potatoes and cassava can be stored in large the ground after drying.

2) Storage in pots and tins

- Preserved foods such as flour, dried vegetables and cassava can be in large dry puts or tightly covered for future use.

- Foods can be stored for months by using this method.

ADVANTAGE OF TRADITIONAL METHODS OF FOOD PROCESSING, PRESERVATION STORAGE

i) They are simple and can be done by most people

ii) They use locally available materials and simple technology, the keeping costs low.

iii) No harmful chemicals are added to the food.

iv) Curing and smoking add a distinctive flavor to the food

v) Most methods do not destroy nutrients

DISADVANTAGES OF TRADITIONAL METHODS OF FOOD STORAGE, PROCESSING AND PRESERVATION

i) Food can be preserved and stored for only limited periods of time

ii) Traditional method is difficult to do on a large scale.Traditional methods are highly limited in the variety of foods that can be processed, preserved and stored

MODERN METHODS OF FOOD STORAGE

1**. Refrigeration**

- This is the temporary storage of food at temperature of up to 4^0c in order to slow down the growth of micro – organism

- Refrigeration can be done in refrigerators or cold rooms

Example: The foods that can be refrigerated are milk, fresh fruit, fresh vegetable, juice and bottler.

2. Freezing: This is the strong food at very low temperature i.e. below -10^0c in order to stop the growth of micro – organisms

Food is frozen in freezers. Example the foods that can be frozen are: poultry, fish and meat.

ADVANTAGES OF MODERN METHODS OF FOOD PROCESSING, PRESERVATION AND STORAGE

(i). Food can last for many months or even years

(ii). Modern methods can process, preserve and store a large variety of foods.

(iii). The advanced technology used is fast and can handle large quantities of food

DISADVANTAGES OF MODERN METHOD OF FOOD PROCESSING, PRESERVATION AND STORAGE

- The chemicals used can be harmful if eaten in excess.
- These methods can only be used in a certain area. Example – refrigeration and freezing require electricity.
- The process used for example radiation; canning and pasteurizing require special skills.
- Sometimes nutrients are lost thus lowering the nutritional value of food.

BALANCE OF NATURE

THE NATURAL ENVIRONMENT

- The natural environment is made up of all living and non – living thing that occur naturally on earth, it includes; air, water, animals, plants, micro – organism, stones, cloud and rock soil.

IMPORTANCE OF THE NATURAL ENVIRONMENT

1) It is a source of food for organisms.

2) Provides shelter and security for organisms.

3) It provides an appropriate setting for organism to reproduce and increase in number

4) It allows living and non – living things to interact.

THE COMMONS TERMS IN STUDYING THE NATURAL ENVIRONMENT

BIOTIC FACTORS: Are all the living components of the environment. They are plants, animals and micro – organisms

ABIOTIC FACTORS: Are the non – living components of the environment e.g. light, water, rocks and soil.

ECOLOGY – Is the branch of biology that deals with the study of the relationship between living things and their natural environment

POPULATION – Is the total number of a certain species of organisms in a community. Example; number of frogs in a pond

COMMUNITY – This refers to the populations of different organisms living in a specific area called a *habitat*. Example a grass land community could include grass, acacia trees, lions, antelope, giraffe and cheetah.

HABITAT – Is a specific area with a specific set of conditions that is appropriate for a certain community and where the community ties or it is the home of living organisms. Example; tropical rain forest, a desert, a swamp, a pond, a grassland and ocean

ECOSYSTEM – This is a natural unit made up of living and non – living thing whose interactions lead to a self – sustaining system

- An ecosystem is made up of communities.

BIOTIC FACTORS

Biotic factors are the living components in the environment. They can either be population factors or community factors.

1. **POPULATION FACTORS** – This include:

i) Population density – The number of organisms in a given area

ii) Dispersion – the geographical distribution of organism in an area

iii) Age structure – the distribution of population according to age

iv) The ratio of males to female

v) The number of births

vi) The number of deaths

vii) Population growth – The rate of growth at which the number of organism is increasing

2. **COMMUNITY FACTORS** – This includes food chains and food webs,

- These are feeding relationships that represent the flow of energy and recycling of nutrients in a community.

ABIOTIC FACTORS

These are non – living components of the environment. They can be climatic, soil or geological.

CLIMATIC FACTORS

1. **Temperature**; is the degree of heat in a place

- Organisms adapt to the temperature in their habitats in various ways.

Example some plants shed their leaves or roll them when it is very hot so as to avoid excessive loss of water

- Animal in very cold place has extra fat for insulation

2. **Light:** it is obtained from the sun

- It affects opening of stomata

- It is important during photosynthesis

Example some animal hunt in bright daylight (e.g. hawks) while others hunt at dark or dawn when there is dim light (e.g. lions) and others hunt at night (e.g. owls and bats)

3. **Wind:** It increases the rate of water evaporation from water bodies as well as for living organism

- Wind is important in the formation of rain and the disposal of some plant seed.

4. **Atmospheric pressure:** when atmosphere pressure is high concentration of oxygen and carbon dioxide are also become high so the threaten of gaseous exchange and respiration is high. The opposite is also true. This affects the distribution of both plants and animals.

5. **Water serves as habitat for a large variety of organism**. Water serves as solvent a medium of transportation and a temperature regulatory.

AQUATIC FACTORS

These are factors that affect water bodies and life in water

1. **Salinity**: This is the quantity of salts dissolved in water.

- Aquatic plants have roots that absorb mineral salts and water depending on the concentration in the plant cells

- Some aquatic organisms are adapted to live in fresh water habitat while others live in salt water habitants.

2. **WAVE ACTION:** It is important for organism to live in artificial zone. These organism are covered by water during high tide and low tide

- Such organism includes shrines, different types of sea weeds, crabs and prawns.

SOIL FACTORS

1. Soil texture – this refers to the size of soil particles.

- Soil texture affects drainage of the soil, fertility and distribution of plants.

2. Soil composition: This is the proportion of components of soil including mineral salts, Air and micro – organism, water and remains of living things

- These components affect soil fertility and hence plant growth.

3. SOIL PH: This is the degree of acidity or alkalinity of soil

- Different types of plants grow into soil with different PH value. Example; tomato and pineapple grow in slight acidic soil while onions and cabbage prefer slightly alkaline soil.

GEOLOGICAL FACTORS

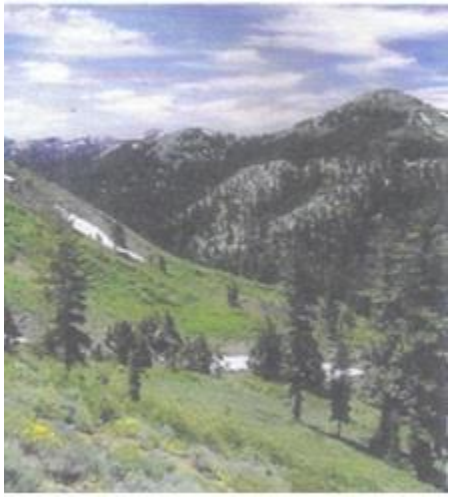
- These are factors concerned with the features of the land surface.

(i) ALTITUDE – Is the height above sea level

- At high altitudes, atmospheric pressure, temperature and oxygen concentration are lower while the rain fall are higher compared to low altitude. This affects distribution of both plants and animal.

(ii) GEOLOGICAL SUBSTRATUM – refers to the various types of rocks that disintegrate to form the soil in an area. The chemical composition of the rocks is reflected in the chemical composition of the soil, this determines soil PH and fertility.

(iii)SLOPE – refers to gradient of land. Slope can be steep, moderate or gentle. Soil erosion is highest in steep slopes and lowest in gentle slope, soil erosion removes top soil making the soil less fertile. This interferes with plant growth.



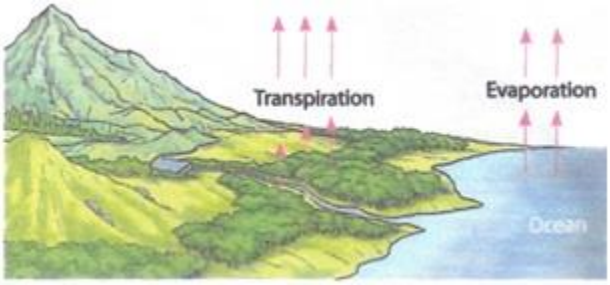
Interaction of living and non-living things

The interaction of biotic and abiotic components "of the environment is important for the completion of natural cycles such as the water cycle, the carbon cycle and the nitrogen cycle.

The water cycle

Water cycle refers to how water circulates in the environment. Movement of water in the environment occurs as shown in the figure below:

Precipitation



In the water cycle:

(i) Groundwater and run-off (water from rain) flow into streams and rivers,

(ii) The streams and rivers flow into lakes and oceans

(iii) Water evaporates into the atmosphere from water bodies such as oceans and lakes and from plants through transpiration

(iv)The evaporated water precipitates to form water vapor. Water vapor condenses to form clouds

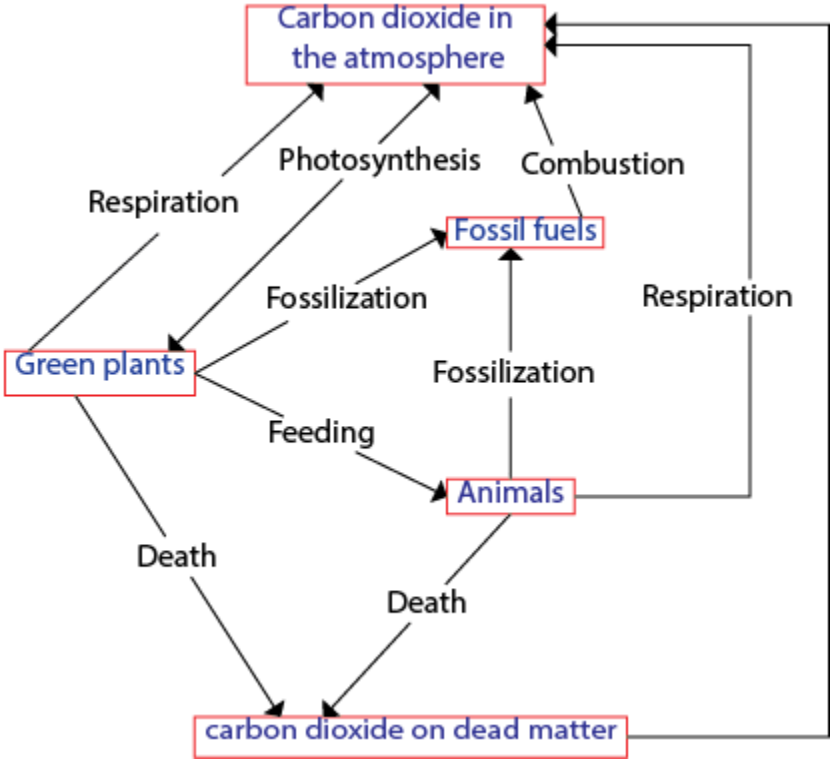
(v) Wind causes clouds to move, for example from above the ocean to above the land.

(vi) Rain falls and is absorbed by plants or forms groundwater and run-off. The cycle thus begins again.

Forests act as water catchment areas and prevent excess loss of water from the land. Wetlands, such as swamps and marshes, help to control flooding and are also important for water purification.

The carbon cycle

Carbon cycle refers to a biochemical cycle in the environment where by carbon dioxide is taken up from the atmosphere and incorporated into the plant tissues during photosynthesis.



Carbon cycle

Carbon dioxide from the atmosphere is absorbed by plants and used for photosynthesis. These plants serve as food for herbivores, which are in turn eaten by carnivores.

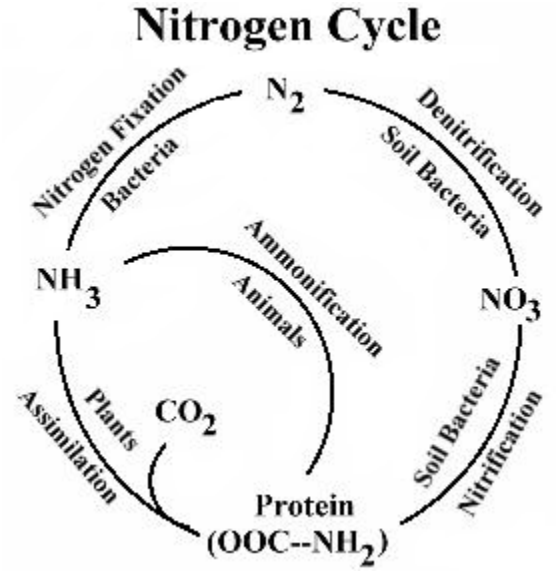
When plants and animals die, microorganisms cause decomposition and carbon dioxide is released into the atmosphere.

The remains of plants and animals after millions of years result in the formation of fossil fuels such as coal, natural gas and oil. When these fuels are burnt, they release carbon dioxide into the atmosphere.

Respiration of living things also releases carbon dioxide into the atmosphere. The carbon dioxide is absorbed by plants and then the cycle starts again.

The nitrogen cycle

Nitrogen cycle refers to a biochemical cycle in the environment whereby nitrates in the soil are taken up by plant roots and may pass along food chains into animals absorb it in this form. It must first be converted into either nitrates or ammonium compound. Figure below shows the nitrogen cycle.



1. Nitrogen-fixing bacteria in the root nodules of legumes plant carry out fixation by converting atmospheric nitrogen to nitrates.

2. Lightning converts atmospheric nitrogen into nitrates. The nitrates get into the soil and are later absorbed by plants.

   Plants use nitrogen compounds to produce plant proteins. Plants are eaten by animals. Animals use the nitrogen to produce animal proteins. When plants and animals die, decomposers such as bacteria and fungi feed on them. The decomposers release ammonia gas (NH_3) which contains nitrogen. The ammonia is converted into nitrites and then nitrates by bacteria. Denitrifying bacteria release nitrogen from nitrates back into the atmosphere.

INTERACTION AMONG LIVING ORGANISM

The relationship among organisms in the environment can be explained in the form of predation, competition and symbiosis.

PREDATION – This happens when one organism captures, kills and feeds on another in order to get nutrients. Example cats eat mice and sharks eat fishes.

COMPETITION – This is a relationship where organisms both need the same limited environment resources for survival. Examples lions and leopards both hunt antelope and zebra. Hence lions and leopards are competitors. Organism from the same places can also be competitors, Example cow competing for grass

SYMBIOSIS – This is a relationship whereby there is a close association between organisms. This association could take various forms, such as mutualism, commensalism, Neutralism, syn-necrosis, amensalism and parasitism.

MUTUALISM – This is the relationship in which two organisms benefit each other. Example: The rhizobium bacteria in the root nodules of legumes convert nitrogen into nitrates for use by the plant. The bacteria get protection and nutrients from the plants.

COMMENSALISM – This is interaction that is beneficial to one organism and is neutral to the other organism. Example when a bird builds a nest in a hole, in a tree.

PARASITISM – In this association one organism benefits while the others is harmed. Example: Plasmodium that causes malaria in human beings.

FOOD CHAINS AND FOOD WEBS

Food chains and food webs show the flow of nutrients and energy among organisms in the environment.

- Each organism in a food chain or food web represents a trophic level a food chain.
- **Trophic level** - is a position that organism occupies in food chain or food web.
- Examples; producers like green plants, primary consumers like herbivores and secondary consumers like carnivores

PRODUCERS: These are organisms that can manufacture their own food example: green plants and photosynthesis bacteria, this is the first trophic level.

- *Producers* are eaten by *primary consumers*
- Primary consumers are mostly herbivores such as rabbits, cows, buffaloes, wild beasts, goat and sheep.
- Primary consumers form the second trophic level.

SECONDARY CONSUMERS:

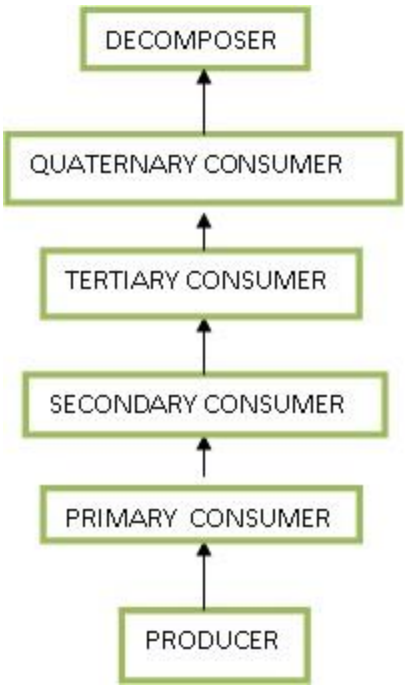
These form the third trophic level.

- They feed on primary consumers
- They are mostly *carnivores* such as – domestic cats, dogs, hyenas, lions, leopards and cheetahs.
- This level can be followed by **tertiary consumers** which feed on secondary consumer then quaternary consumer feed on tertiary consumers.

DECOMPOSERS

These are organisms that decompose dead organic matter

- This is the final trophic level.
- These organisms feed on dead matter and break it down there by facilitating decomposition.
- The two main decomposers are the *saprophytic fungi* and *saprophytic bacteria*.
- The relationship between organisms at different trophic levels can be presented diagrammatically as follows;



FOOD CHAINS- a food chain is a linear relationship among the organisms of a community in which each organism feeds on the one preceding it.

- It presents energy flow from one trophic level to the next.
- Each organism feeds on therefore derives energy from the proceedings one in return it is eaten by the other and therefore provides energy for the one following it.
- The arrows indicate the direction of energy flow

Example of food chain:

1) Grass → Grass hoppers → birds

2) Grass → sheep → Man

3) Rhodes → mouse → snake → hawks

4) Plant debris → Bacteria → Protozoa → Mosquito larvae

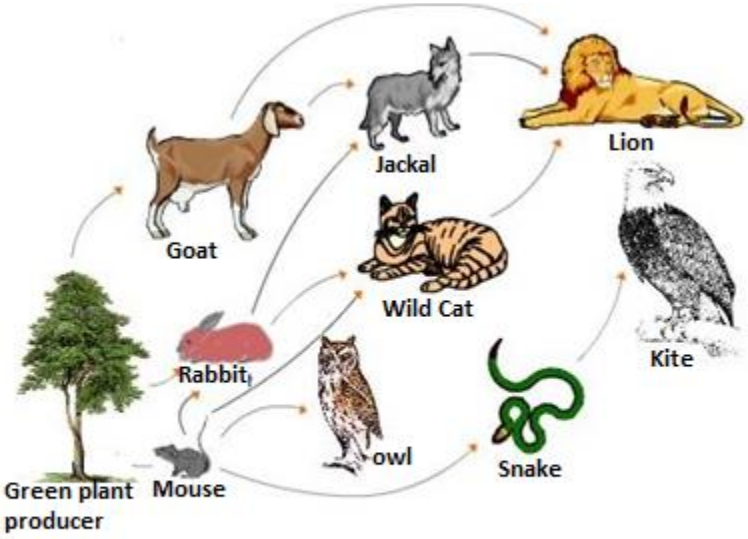
5) Photosynthesis → fish → bird

FOOD WEBS

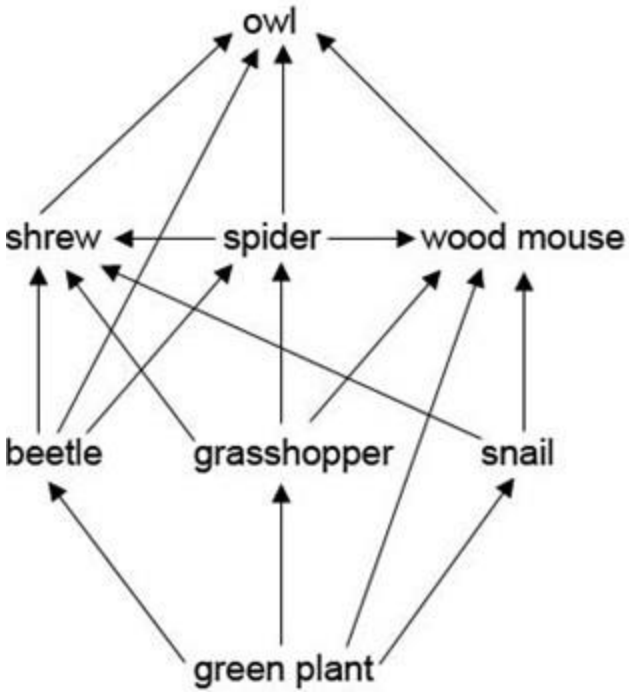
A food web refers to the several food chains interlinking together(A network of food chain).

- Most herbivores consume more than one kind of plants and omnivores consume more than one kind of plant and animal and the decomposer consume more than one kind of herbivore

Example of food web



Food web in a forest



SIGNIFICANCE OF FOOD CHAINS AND FOOD WEBS

i) Food chains and food webs facilitate the flow of energy in the environment.

ii) Helps to maintain the balance of the total numbers of organisms in the environment

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TRANSPORT OF MATERIALS IN LIVING THINGS.1

Introduction

The basic characteristics of all living things are nutrition, respiration, excretion, growth and development, movement, reproduction and sensitivity. In order for these life processes to take place, there must be transportation of materials. Materials are transported either from the environment into the organism or from one part of the organism to another. They can also be transported from the organism into the environment.

For example, during nutrition, organisms take in food substances that they need to provide them with energy. The food must also be transported to all parts of the organism. Respiration requires oxygen, which must be taken in from the environment. During excretion, waste materials from the organism are transported to the excretory organs and removed from the body. Growth requires the production and transportation of growth hormones to the growing parts of the organism. Movement and locomotion are made possible by the transportation of impulses to the

relevant organs. Reproduction requires the movement of gametes (sex cells) or the transportation of genetic material. Sensitivity is made possible by the transportation of messages about the presence of a certain thing in the environment.

Transportation is therefore very important for the survival of living things.

Transportation is therefore very important for the survival of living things.

Ways of transportation of materials

Life processes in organisms take place at the cell level. Therefore, it is necessary for substances to move in and out of the cells. There are two ways through which substances can move across the cell membrane:

Passive transport; which occurs spontaneously without the need of energy to transport materials through the cell membrane.

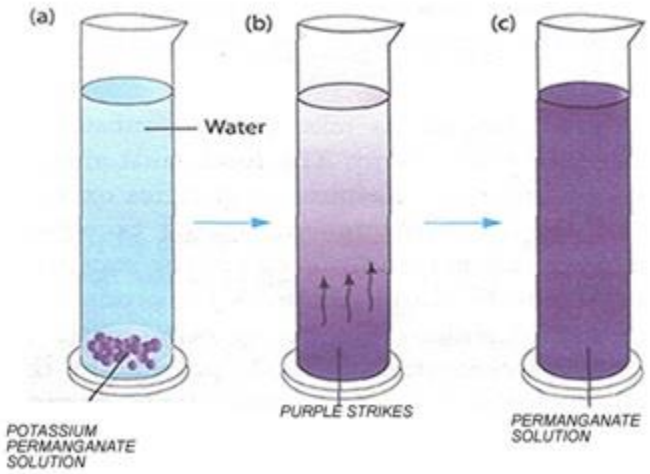
Active transport; where the cell has to use energy to move materials across the cell membrane.

Processes like diffusion, osmosis and mass flow involve passive transport.

Diffusion

Diffusion is the movement of particles from an area of high concentration to one of low concentration.

A difference in the concentration of a substance between two regions is known as a concentration gradient. Diffusion causes particles to move from the area of high concentration to a low concentration area. This process continues until the particles are distributed evenly throughout the liquid. Figure below shows the diffusion of potassium permanganate in water.



FACTORS AFFECTING RATE OF DIFFUTION

- **Concentration gradient**: high diffusion rate with higher concentration and vice versa
- **Surface area to volume ratio:** the higher it faster the diffusion rate.
- **Distance over which diffusion takes place**: example a thin layer of cells increases diffusion rate

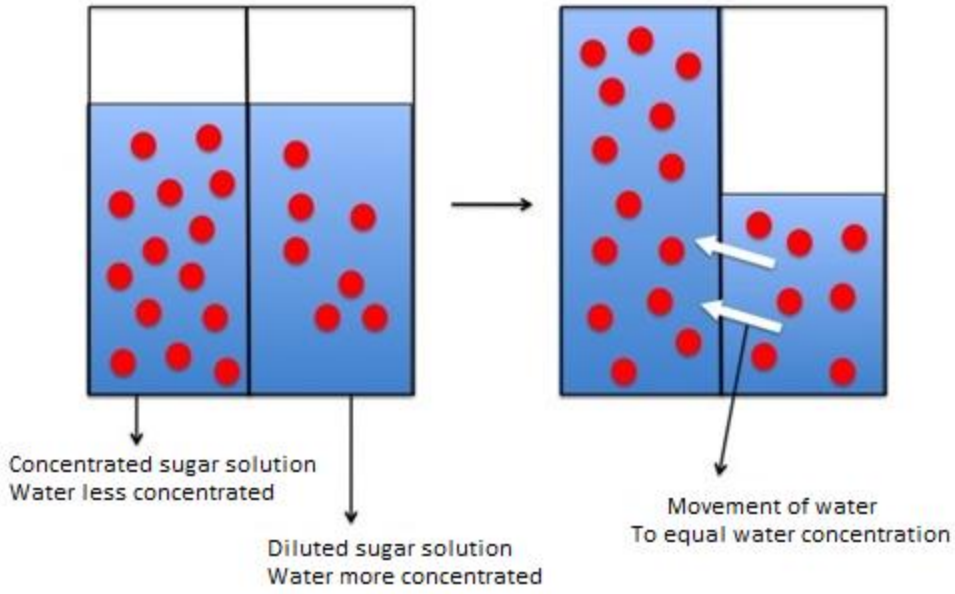
Osmosis

Osmosis is a form of passive transport considered as a special form of diffusion involves movement of water molecules through semi-permeable membrane.

Osmosis defined as the process by which water move from a weak solution into a strong through a semi-permeable membrane. The semi permeable membrane is only permeable to some solutes (dissolved substances).

For osmosis to take place there must be two separated solution by a semi-permeable membrane. One solution should have greater water and a lesser quantity of solute than other solution. This solution is hypotonic, it has a lower water potential. The second should have a lesser volume of water andvolume of solute than the other solution. This solution is hypertonic, meaning it has greater water potential.

Two solutions have the same water potential are said to be isotonic



Effects of osmosis in living organisms

Osmosis and animal cells

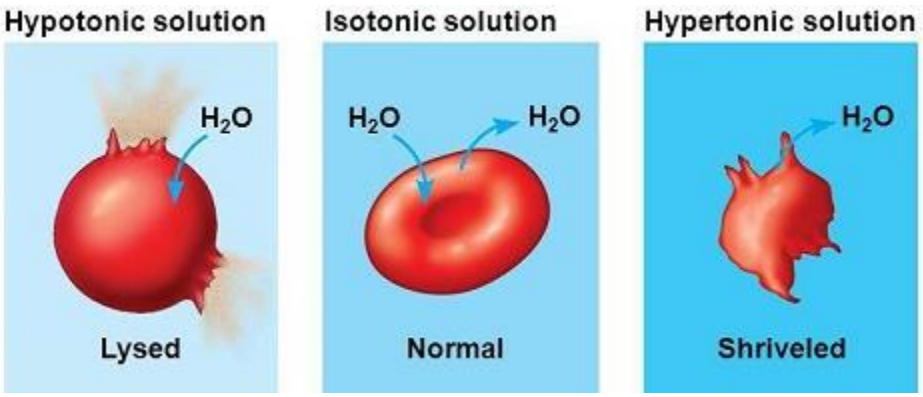
When an animal cell is put in a hypotonic solution, it absorbs water. If it remains in the solution for a long time, it absorbs excess amounts of water. A cell that does not have a mechanism for removing the excess water bursts due to the excessive internal pressure.

When an animal cell is placed in a hypertonic solution, it loses water. If it remains in the solution for a long time, it loses a lot of water, shrinks and shrivels.

These effects of osmosis on animal cells can be observed in red blood cells. Under normal conditions, the osmotic pressure of red blood cells is equal to that of the blood plasma, i.e. they are isotonic. Thus, there is equal movement of water in and out of the cells. This helps to maintain the disc shape of these cells.

When red blood cells are put in a hypotonic solution, they absorb water, causing the cell volume to increase. Excessive amounts of water cause **haemolysis (bursting).**

When red blood cells are put in a hypertonic solution, they lose water, leading to shriveling of the cell. This is referred to**crenation**



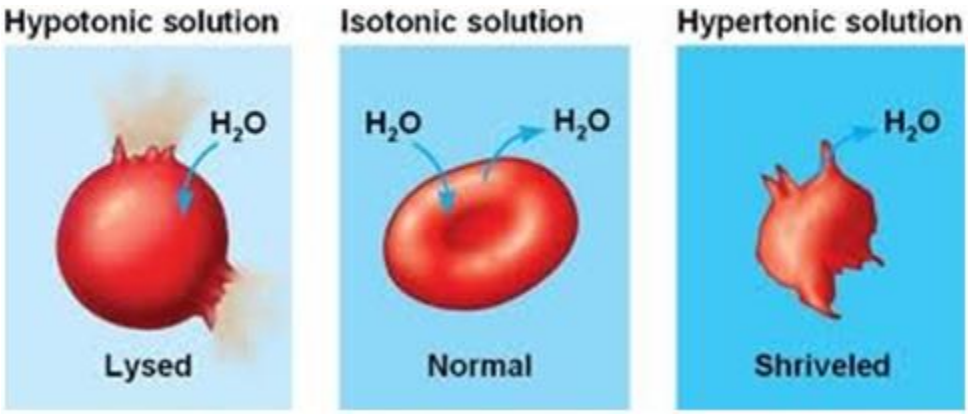
Osmosis is important for the reabsorption water in the colon and the kidneys. This help to maintain the body's water balance.

Osmosis and plant cells

In an **isotonic solution**, plant cells neither lose nor gain water. In a hypotonic solution cells absorb water, causing the cell membrane to push against the cell wall. The cell is to be turgid. It does not burst because membrane exerts pressure on the cell wall restricts additional intake of water. Turgid plants to maintain their shape.

In a hypertonic solution, plant cells lose water this causes the vacuole to shrink and their cell membrane to pull away from wall, making the cell flaccid. Such a **cell is to be plasmolyzed** and the process **plasmolysis.**

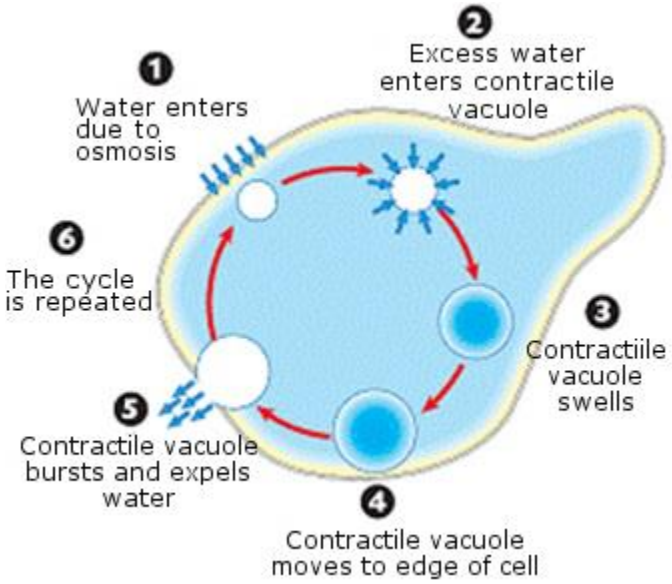
If a plasmolyzed cell is placed in a hypotonic solution, it absorbs water and becomes turgid.



Osmosis is importantforthe absorption of water by plant roots. Opening and closing of stomata also depend on osmosis. When guard cells absorb water the stomata open and when they lose water the stomata close.

Osmosis and unicellular organisms

Unicellular organisms that live in fresh water, for example amoeba and euglena, are hypertonic to surrounding so water enters the organisms by osmosis. These organisms have a contractile vacuole. The contractile vacuole collects the excess water and removes it from the cell. This prevents the cells from bursting



Mass flow

Mass flow is the bulk movement of substances from one region to another due to the difference in pressure between the two regions. Mass flow occurs within a cell or along a vessel.

This mode of transport is important in large complex organisms where substances are required in large amounts and also have to be transported over large distances.

Examples of systems where mass flow occurs are:

- The circulatory system (flow of blood) in animals.
- The lymphatic system (flow of lymph) in animals.
- Transport of manufactured food material in plants from the site of manufacture (mostly leaves) to the point of use (all plant parts) through the phloem. This process is called translocation

Differences between diffusion, osmosis and mass flow

The following table gives a summary of the differences between diffusion, osmosis and mass flow.

Differences between diffusion, osmosis and mass flow

Characteristics	Diffusion	Osmosis	Mass flow
Substance transported	liquids and gases	Water molecules	Solids and liquids
Transportation	None structure	Semi permeable membrane	Cytoplasm and vessel
Causes of movement	Diffusion gradient	Osmotic pressure	Different in pressure

Chapter summary

1. Transport is necessary for the movement of substances within, into and out of cells so as to enable vital life processes to occur.
2. Transport can be carried out through diffusion, osmosis or mass flow.
3. Diffusion is the movement of particles from a region of high concentration to a region of low concentration.
4. Osmosis is the movement of water molecules from a weak solution to a strong solution through a semi-permeable membrane.
5. A hypotonic solution has a lower water potential.
6. A hypertonic solution has a higher potential.
7. A red blood cell haemolysis in a hypotonic solution and crenates in a hypertonic solution.
8. A plant cell becomes turgid in a hypotonic solution and plasmolyzed in a hypertonic solution.
9. Mass flow is the bulk movement of substance due to pressure differences in two regions.

TRANSPORTATION IN MAMMALS

Introduction

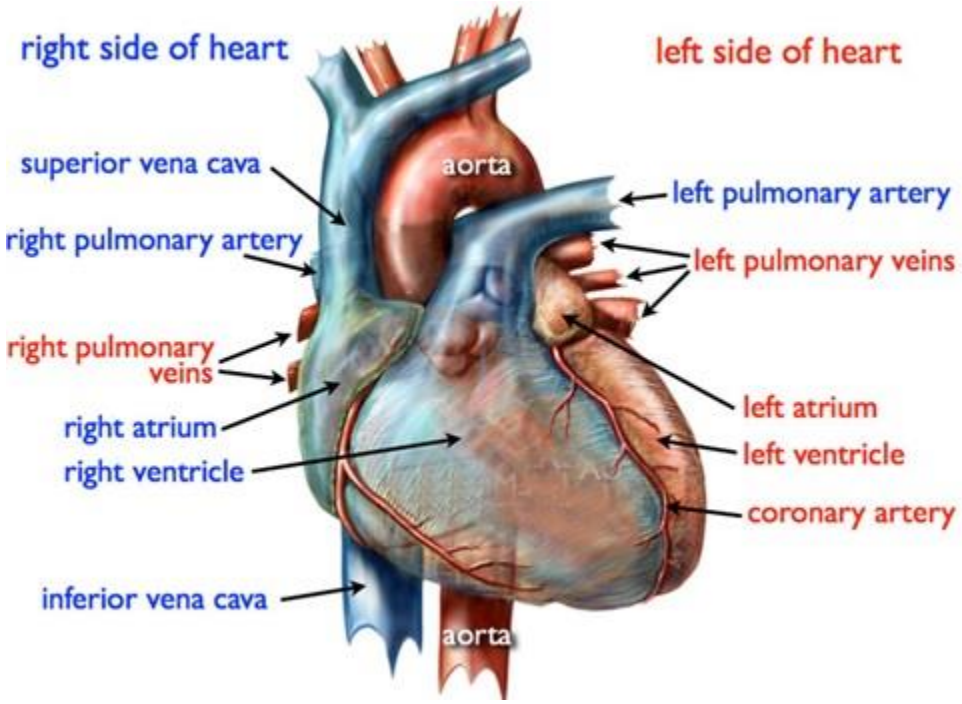
Mammals are complex multicellular organisms. Their bodies are made up of numerous cells and tissues. Hence, diffusion alone is not enough to ensure efficient carrying out of life processes. Mammals therefore have an elaborate transport system called the circulatory system. The circulatory system is made up of the heart, the blood and the blood vessels**.**

The mammalian heart

An example of the mammalian heart is the human heart. The human heart is approximately the size of a clenched fist. It is located in the chest cavity between the two lungs.

The external structure of the mammalian heart

The mammalian heart is broader at the top and narrower at the bottom. It is enclosed by a double layer of tough inelastic membranes called the **pericardium**. The membranes prevent the heart from over-expanding when it is beating very fast. The pericardium also secretes a fluid called **pericardial fluid**. This fluid enables the membranes to move smoothly against each other.



The wall of the heart is made up of the **cardiac muscles**. Cardiac muscle is never fatigued (tired). It works continuously as long as a person is alive. This type of muscle is found only in the heart.

The wall of the heart has three layers:

The epicardium is the outer protective layer.

The myocardium is the middle layer.

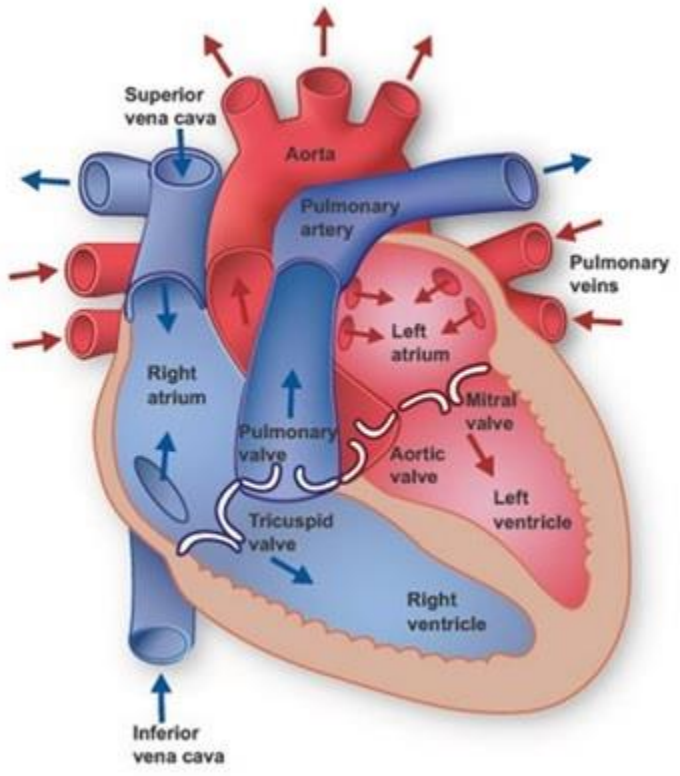
The endocardium is the inner most layer. This layer is continuous with the lining of the blood vessels attached to the heart.

The coronary artery supplies the heart with oxygenated blood. The coronary vein carries blood containing waste materials away from the heart.

The vena cava and pulmonary vein bring blood from the rest of the body to the heart. The aorta and pulmonary artery transport blood from the heart to the rest of the body.

The internal structure of the mammalianheart

Figure shows a longitudinal section of the mammalian heart



The heart has four chamber right auricle, right ventricle, left auricle and left ventricle. The auricles are also called atria (singular: atrium). The walls of the ventricles are thicker than those of the auricles. This is because the ventricles pump blood to a greater distance than the auricles. Auricles pump blood to the ventricles. Ventricles pump blood to all other parts of the body. The left ventricle is thicker than the right ventricle because the right ventricle pumps blood to the lungs while the left ventricle pumps blood to the rest of the body.

The heart has several valves. Valves have flaps that ensure that blood flows in one direction only. **The tricuspid**valve is found between the right auricle and right ventricle. The **bicuspid valve** is found between the left auricle and left ventricle. Semi lunar valves are located at the bases of the pulmonary artery and aorta to prevent blood from flowing back into the ventricles.

Valves close when blood tries to flow back.

The left and right sides of the heart are separated by the **septum**. The septum is a thick muscular wall that prevents mixing of oxygenated and deoxygenated blood.

The flow of blood through the heart;

The vena cava brings **deoxygenated** blood to the heart. Deoxygenated blood contains low amounts of oxygen**.**

The vena cava has two branches:

The superior vena cava which transports deoxygenated blood from the upper parts of the body such as head, neck and upper limbs.

The inferior vena cava which transports deoxygenated blood from the lower parts of body such as the lower limbs, kidney, liver, stomach and intestines.

The inferior vena cava and the superior vena cava unite to form the **vena cava**; the vena cava is connected to the right auricle.

When the right auricle relaxes, it fills up with deoxygenated blood from the vena cava. There is increased pressure in the right auricle when the muscles contract. This pushes the blood trough the tricuspid valve. The muscles of the

Right ventricles relax and it fills up with blood. The tricuspid valve closes to prevent blood from owing back into the right auricle. When the right ventricle is full, the increased pressure causes the muscles to contract and the Semi lunar valve in the pulmonary artery to open. The blood flows into lie pulmonary artery and the bicuspid valve closes prevent back flow of blood.

The pulmonary artery transports blood to the lungs. Blood absorbs more oxygen in the lungs, and thus becomes oxygenated.

Oxygenated blood flows to the heart through the pulmonary vein. This vein is connected to the left auricle. When the left auricle relaxes, the semi lunarvalve opens and blood from the pulmonary veinflows in. Pressure increases in the left auricle as itfills up with blood. The pressure causes the musclesof the auricle to contract and pump blood throughthe bicuspid valve into the left ventricle.

The muscles of the left ventricle contract, allowing blood to flow in. The bicuspid valve closes to prevent blood from flowing back into the left auricle. Pressure builds up in the left ventricle as blood flows in.

The muscles of the left ventricle contract, pumping blood through the semi lunar valve into the aorta. The aorta branches into smaller arteries that transport blood to all parts of the body. The heart beats in such a way that when the auricles contract, the ventricles relax and vice versa.

In the right atrium, there is a small patch of muscle called the **sinoatrial node** (SAN). This node acts as a pacemaker, setting the time and rate of cardiac muscle contraction.

Adaptations of the heart to its functions

Table below shows how the heart is adapted to its functions.

Adaptations of the heart

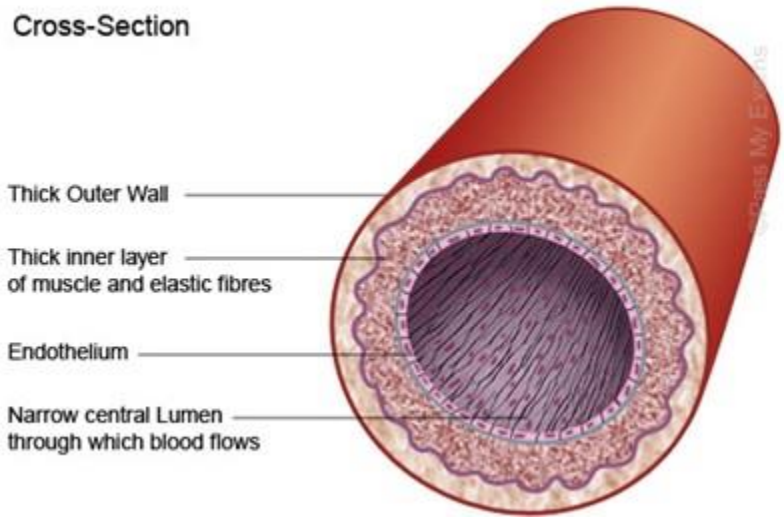
Adaptation	Function
Muscular walls	Contract to pump blood
Cardiac muscle	Contract and relax continuously without being fatigued. This ensures continuous pumping of blood
Valves	Ensure blood flows in only one direction
Septum	Separates oxygenated blood from deoxygenated blood
Connection to large blood vessels	Enables transportation of deoxygenated blood from all parts of the body to the heart and transportation of oxygenated blood from the heart to all parts of the body
Sinoatrial node	Sets time and rate of contraction of cardiac muscle
Coronary artery and coronary vein	The coronary artery nourishes the heart and supplies it with oxygen, The coronary vein removes wastes which would harm the heart if left to accumulate

Blood vessels

Mammals have three types of blood vessels: arteries, veins and capillaries.

Arteries

Arteries are thick-walled, muscular and elastic vessels that transport blood from the heart to all parts of the body. All arteries transport oxygenated blood, except the pulmonary artery which transports deoxygenated blood from the heart to the lungs



The **endothelium** is the innermost layer of the artery. It has only one layer of cells. The endothelium surrounds the **lumen** (the central tube of the vessel). The lumen of an artery is narrow and smooth so that it can transport blood at high pressure.

The muscular layer is made of smooth muscle and elastic fibres. Smooth muscle is arranged in circles round the endothelium. This layer makes it possible for the artery to contract and relax for the efficient movement of blood.

The outermost layer is the fibrous layer made of connective tissues such as collagen. The fibres are arranged parallel to the length of the vessel. They enable the artery to withstand the pressure caused by the blood coming from the heart.

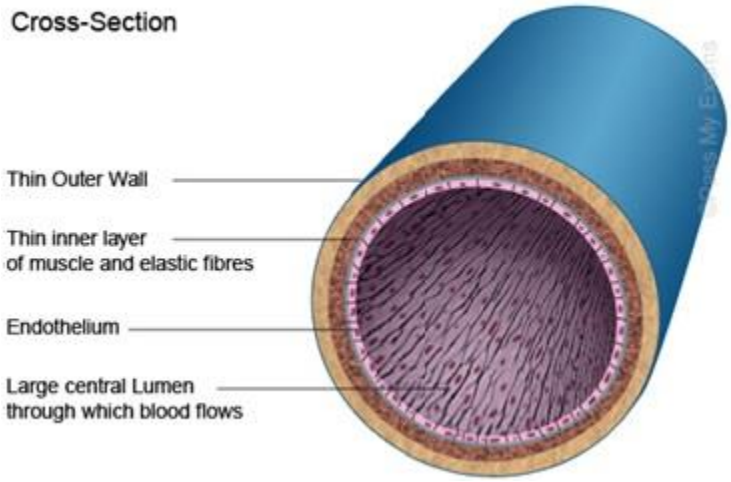
When the ventricles contract, the arteries relax allowing blood from the heart to flow into them. When the ventricles relax, the arteries contract, forcing the blood forward. This contraction and relaxation of arteries is felt as a **pulse.**

Pulse rate is the number of pulses per minute. The pulse rate reflects the heartbeat. An adult human's heart beats at an average of **72 times a minute**. However, this can increase or decrease due to physical activity, emotional state or health factors

Arteries branch to form **arterioles.** Arterioles in turn branch to form **capillaries**. Capillaries are joined at the other end by v**enules** which join to form **veins**.

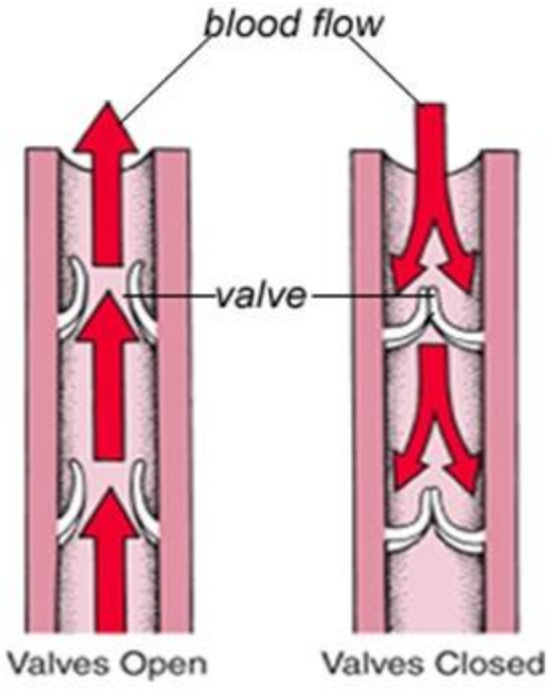
Veins

Veins are vessels that transport blood to the heart from all parts of the body. All veins transport deoxygenated blood except the pulmonary vein. The pulmonary vein transports oxygenated blood from the lungs to the heart



Veins have a larger lumen and less muscular walls compared to arteries. This is because the blood in the veins flows at low pressure.

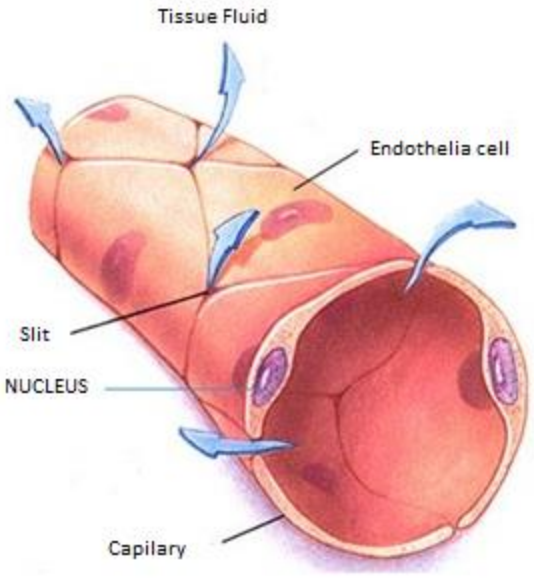
Vein have valves at regular intervals. The valves prevent the back flow of blood.



The muscles next to the veins squeeze the veins and help to force blood to flow towards the heart. The contraction of the ribs during breathing also helps to squeeze some veins and keep blood flowing.

Capillaries

Capillaries are the smallest blood vessels. They are narrow and have walls that are one cell thick



Capillaries are in direct contact with the tissues of the body. They form a network for the efficient diffusion of substances. Their thin walls maximize the rate of diffusion.

The thin walls of the capillaries enable oxygen and nutrients to diffuse from the blood to the cells, carbon dioxide and other waste products to diffuse from the cells into the blood and white blood cells to reach sites of infection.

Capillaries join to form venules (small veins) which join to form veins**.**

Differences between arteries, veins and capillaries

Table below gives a summary of the structural and functional differences between arteries, veins and capillaries.

Differences between arteries, veins and capillaries

Arteries	**vein**	**Capillaries**

Have narrow smooth lumens	Have wide irregular lumens	Have narrow smooth lumens
Have thick muscular walls	Have thin, less muscular walls	Have one cell ' thick walls
Lack valves except where they are connected to the heart	Have valves at regular intervals	Lack valves
Transport blood at high pressure	Transport blood at low pressure	Transport blood at low pressure
Transport blood away from the heart	Transport blood towards the heart	Transport blood within the tissues
Transport oxygenated blood, except the pulmonary artery	Transport deoxygenated blood, except the pulmonary vein	Transport either oxygenated or deoxygenated blood
Contract and relax to create a pulse	Blood flows smoothly	Blood flows smoothly

Blood

Blood is a fluid tissue. It consists of cells (red blood cells and white blood cells) and platelets (fragments of cells) suspended in a fluid called plasma. An adult human has 4 to 6 liters of blood. The pH of blood is 7.4.

Plasma

Plasma is a pale-yellow fluid. Approximately 55% of the blood is plasma. Plasma is mostly made up of water but it also has dissolved substances such as food nutrients, metabolic wastes, oxygen, proteins and mineral ions. These solutes make up 8% of the plasma while water makes up 92%.

The major functions of plasma are the transportation of:

1. nutrients from the digestive system to the whole body
2. red blood cells containing oxygen to the tissues
3. wastes such as carbon dioxide and urea to the excretory organs
4. white blood cells and antibodies to sites of infection
5. hormones to the target organs
6. mineral ions such as sodium, potassium and chlorides
7. Platelets to sites of bleeding.

Plasma is also important for distributing heat to all parts of the body, regulating the pH of body fluids and it is where the exchange of nutrients and waste products takes place in the body.

Red blood cells

Another name for the red blood cells is **erythrocytes**. They are red, round biconcave cells with no nucleus. One milliliter of blood has approximately 5 to 6 million red blood cells

Normal red blood cell

Red blood cells are formed in the bone marrow. Their lifespan is about 120 days. The liver and the spleen destroy old red blood cells and release **haemoglobin** for the formation of new cells.

Haemoglobin is the red pigment in erythrocytes. It has a high affinity for oxygen.

The function of red blood cells is to transport oxygen and carbon dioxide. The adaptation red blood cells that make them suited forthis function are the presence of haemoglobin, their large numbers, biconcave shape and the lack of nucleus which increases the total surface area of gaseous exchange.

Transport of oxygen

In the lungs (where there is a high concentration of oxygen), haemoglobin combines with oxygen to form oxyhaemoglobin. This is an unstable compound which releases oxygen when it reaches tissues that have a low concentration of oxygen. The formation of oxyhaemoglobin and release oxygen and haemoglobin can be shown using the following equation.

Haemoglobin + oxygen = Oxyhaemoglobin

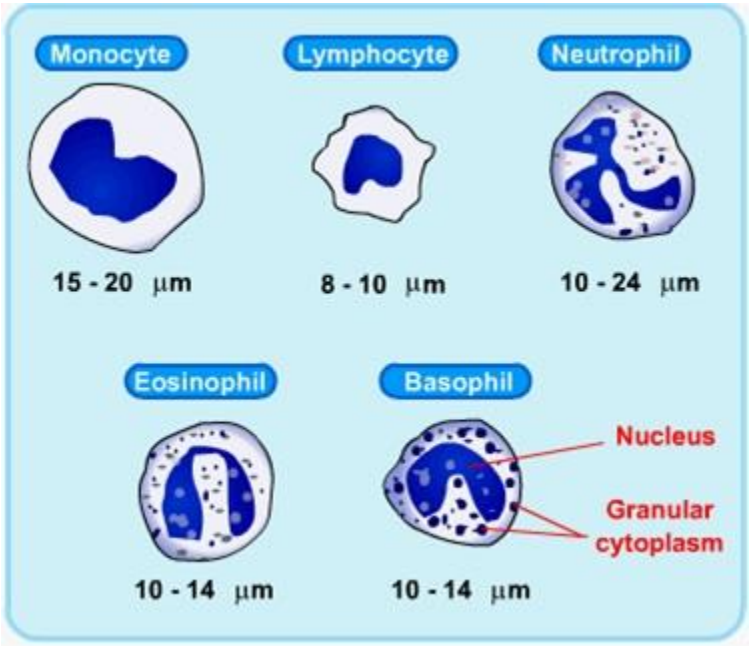
Oxygen diffuses out of the red blood cells, through the capillary walls to the tissues.

Transport of carbon dioxide

In the red blood cells, carbon dioxide combines with haemoglobin to form carbominohaemoglobin. This compound is transported to the lungs where carbon dioxide is released and expelled from body.

White blood cells

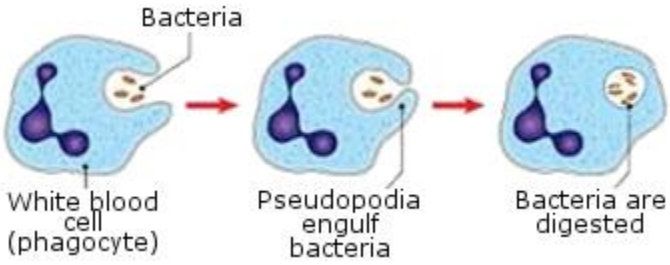
Another name for the white blood cells is leucocytes. These cells have irregular shapes; milliliter of blood has approximately 5000 to 10 white blood cells.



White blood cells are produced in the bone marrow and in the lymph nodes.

The function of white blood cells is to protect body against infection. They perform this function by:

Phagocytosis in a white blood cell



1. Engulfing and destroying pathogens (a process called phagocytosis).
2. Producing substances that neutralize toxins produced by pathogens.
3. Causing clumping together of foreign materials in the body.
4. Killing infected body cells.
5. Preventing clotting in damaged tissues.

The effect of HIV on white blood cells

The Human Immunodeficiency Virus (HIV) attacks a type of white blood cells called helper-T cells. These cells are essential for body immunity. When they encounter an antigen, the helper-T cells divide themselves to form new cells. This increases the number of cells available to fight the infection. After the infection, some cells remain as memory cells to activate an immune response if the infection happens again, in addition helper-T cells activate other cells in the immune system.

HIV has a protein envelope that can only bind to its receptor called CD4 found on the cell membrane of the helper-T cell. When it enters the human body, HIV fuses its protein envelope with the CD4 then enters the cell. Once inside the cell, the virus becomes part of the helper-T cell and replicates together with it as it undergoes division. This increases the amount of HIV in the blood. The HIV destroys helper-T cells resulting in the reduction of the number of helper-T cells and reducing the CD4 count.

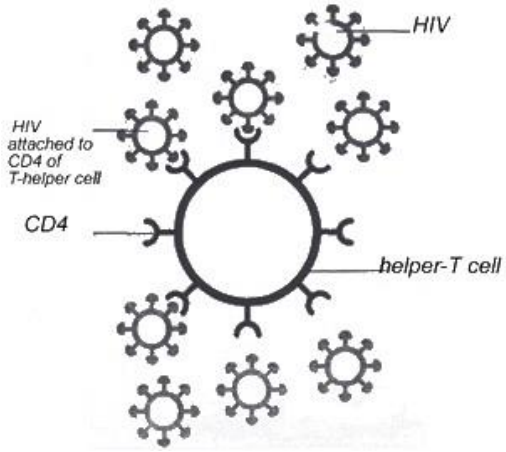


Diagram HIV attacking T-helper

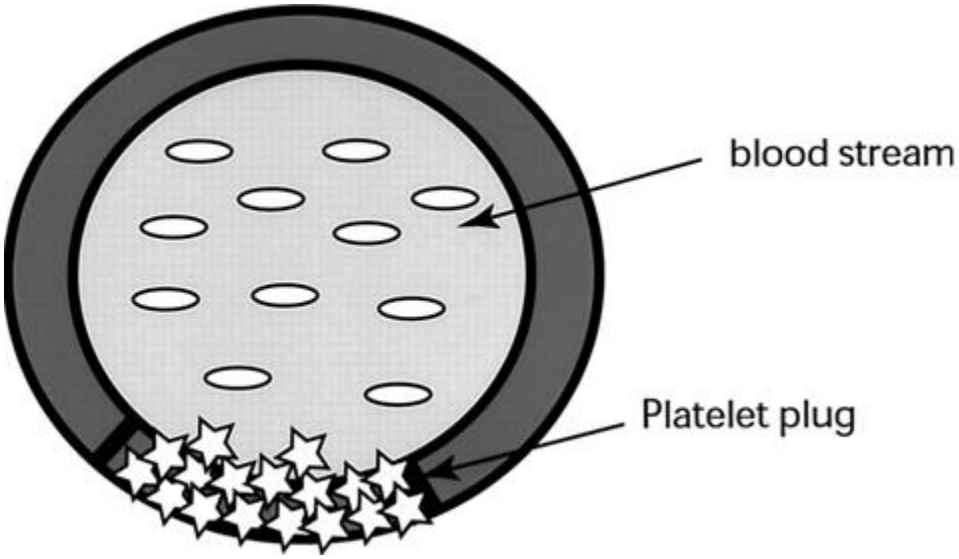
HIV destroys helper-T cells in the following ways:

1. It reproduces inside the helper-T cell, and then ruptures the cell's membrane and the new viruses are released.
2. It alters the helper T-cells so that when it responds to an infection, it kills itself instead of dividing to form new cells.
3. It marks helper-T cells as targets for destruction by other cells in the immune system.
4. It causes the fusion of many helper-T cells to form a giant' cell. Such a cell can survive but it cannot perform normal helper-T cell functions.

Thus, HIV lowers the body's immunity significantly making it vulnerable to opportunistic infections.

Platelets

Platelets are also called thrombocytes. They are fragments of cells produced in the bone marrow. One milliliter of blood contains about 250 000 to 400 000 platelets.They play an important role in the clotting process.

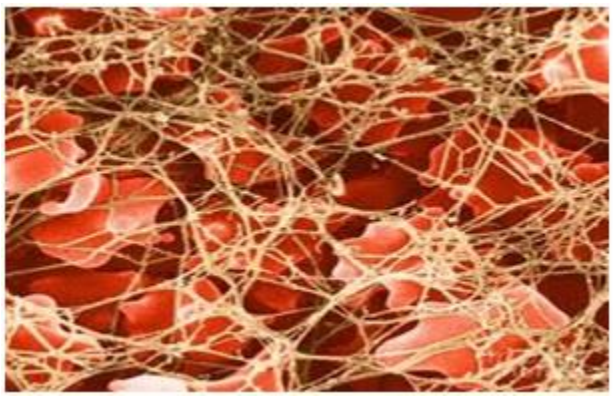


The clotting process

Platelets at the site of an injury produce **thromboplastin** which starts off the clotting process. Thromboplastin, with the help of vitamin *K* and calcium neutralizes **heparin**, an anticoagulant in blood.

Heparin converts **prothrombin** (which is an inactive plasma protein) to **thrombin** (an active plasma protein).

Thrombin catalyzes the conversion of soluble **fibrinogen** to insoluble **fibrin**. Fibrin forms a network of fibres that traps debris and blood cells. The result is a clot at the site of the wound preventing further loss of blood.



Blood clot

Blood Groups and Blood Transfusion

Grouping of human blood is done using the ABO system and the Rhesus factor.

The ABO system

The ABO system of grouping blood depends on two things. First is the presence or absence of antigen A or antigen B on the membranes of the red blood cells. Second is the presence of antibody A or antibody B in the blood plasma.

A person cannot have a certain antigen membrane of the red blood cell and also have the corresponding antibody in the plasma. For example, you cannot have both antigen A antibody a. This would cause agglutination clumping together of red blood cell. Agglutination can cause fatal

The various blood groups and the antigens a antibodies present in them are summarized

Blood group	Antigen on the membrane of the blood cell	Antibody in the plasma
A	A	A
B	B	B
AB	A and B	(none)
O	(none)	a and b

Rhesus factor

This factor is named after the Rhesus monkey in which it was first observed. When the rhesus factor is present on the red blood cell membrane, a person is said to be rhesus positive. This is abbreviated as Rh+. If it is absent, the person is rhesus negative this is abbreviated as Rh-. Thus, a person's blood is said to be A+ if it is blood group A and has the Rhesus factor or A- if it is blood group A but lacks the Rhesus factor. There is also B+ or B-, O+ or 0- and AB+ or AB- blood groups.

If a rhesus negative woman marries a rhesus positive man, their children are highly likely to be rhesus positive. During the last months of pregnancy, the rhesus antigen from the foetus passes into the mother's blood. This causes the mother's body to produce antibodies which destroy some of the foetus's red blood cells. This destruction is minimal in the first child but in the children that follow, a lot of destruction could take place, killing the foetus. This is called haemolytic disease of the newborn or erythroblastosis foetalis. To prevent this, the mother

is treated with anti-rhesus globulin. This prevents her body from forming antibodies against the rhesus antigen.

Blood transfusion

Blood transfusion is the transfer of blood from one person (the donor) to another (the recipient). It is necessary to replace blood when the recipient has a blood disorder or has lost a lot of blood due to surgery or an accident.

Blood transfusion

In order for blood transfusion to be successful, the blood of the donor and that of the recipient must mix without agglutination. When this happens, the blood is said to be compatible. If the blood is incompatible, agglutination occurs.

Blood compatibility depends on the blood groups of the donor and the recipient. For example, if a person of blood group A receives blood from a person of blood group B, the recipients' body produces antibodies against antigen B. This is because the antigen is seen as foreign material.

Individuals with blood group AB are called universal recipients. They can receive blood from people of any blood group. However, they can only donate blood to someone with blood group AB. Those with blood group O are universal donors. They can donate blood to people of all blood groups. On the other hand, they can only receive blood from someone with blood group O.

The following is a compatibility table for the different blood groups.

Compatibility of blood groups Donor's blood group Recipient's blood group

	A	B	AB	O

A	√	×	√	×
B	×	√	√	×
AB	×	×	√	×
O	√	√	√	√

Key:

v - Means compatible

X - Means incompatible.

If blood from a rhesus positive person is transfused to a rhesus negative person, the recipient produces rhesus antibodies. If such a transfusion is done a second time, massive agglutination can occur. This can lead to loss of life.

Precautions taken during transfusion

- Blood from the donor must be checked for compatibility with blood from the recipient in terms of both ABO blood group and Rhesus factor in order to avoid agglutination.
- The donor's blood must be screened to ensure that it does not have pathogens that can cause diseases such as HIV and AIDS, syphilis and hepatitis B.
- Donated blood is stored in special bags and an anticoagulant is added to prevent it from coagulating.
- Donated blood is kept in a refrigerator for a maximum of 21 days. After that it expires and should not be used.
- Transfusion should be done only when extremely necessary.

Advantages of blood transfusion

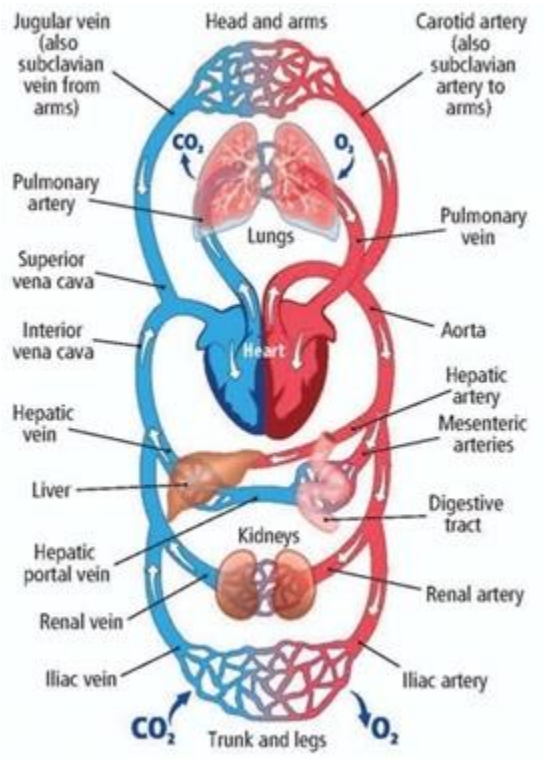
- It ensures rapid replacement of blood lost from the body, for example during surgery or due to an accident.
- Blood transfusion is used to treat diseases such as sickle-cell anaemia

Disadvantages of blood transfusion

- There are no exact blood matches. Blood is a complex tissue that contains many different. One person's blood cannot be exactly the same as another's. Hence, there are chances of developing a reaction to transfused blood.
- Transfused blood may not always be 100% free of infections.

Blood circulation in human being

Blood circulation is the movement of blood from the heart to all part of the body and back to the heart. Human being exhibit **double circulation** where by the blood passes through the heart twice for each complete circulation



Double circulation in human being

In other less complex organisms like the fish, blood goes through the heart only once; this is known as **single circulation.**

Pulmonary circulation

- During pulmonary circulation, deoxygenated blood is brought to the heart through the vena cava. This blood is emptied into the right auricle. The right auricle pumps blood to the right ventricle. When the right ventricle contracts, it pumps blood to the lungs through the pulmonary artery.
- In the lungs, the blood is oxygenated. It then flows back to the heart through the pulmonary vein. The movement of blood between the heart and the lungs is called the pulmonary cycle.

Systemic circulation

- In systemic circulation, the pulmonary vein transports blood to the left auricle. The left auricle then pumps the blood into the left ventricle. The left ventricle has strong muscles that pump blood to all parts of the body through the aorta.
-
- After the tissues have derived their requirements from the blood, it flows back to the heart through the vena cava. This movement of blood between the heart and the various parts of the body is called the systemic cycle.

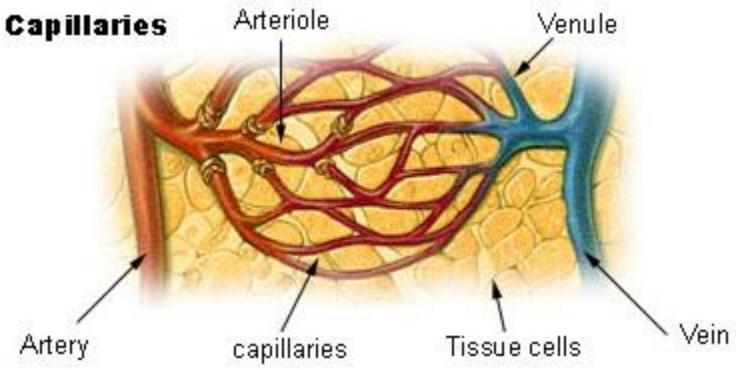
Formation of tissue fluid

The aorta is the largest artery in the body. It braches into smaller arteries, which in turn branch into even smaller vessels called arterioles. Arterioles branch into capillaries which are in contact with the tissue of the body. The capillaries have tiny pores that allow some components of blood to filter into the tissues.

At the arterial end of the capillary, there is high blood pressure. This forces fluid out through the any pores in the capillaries

The fluid is composed of water, oxygen, hormones and nutrients. This fluid bathes the cells. It is called tissue fluid or interstitial fluid.

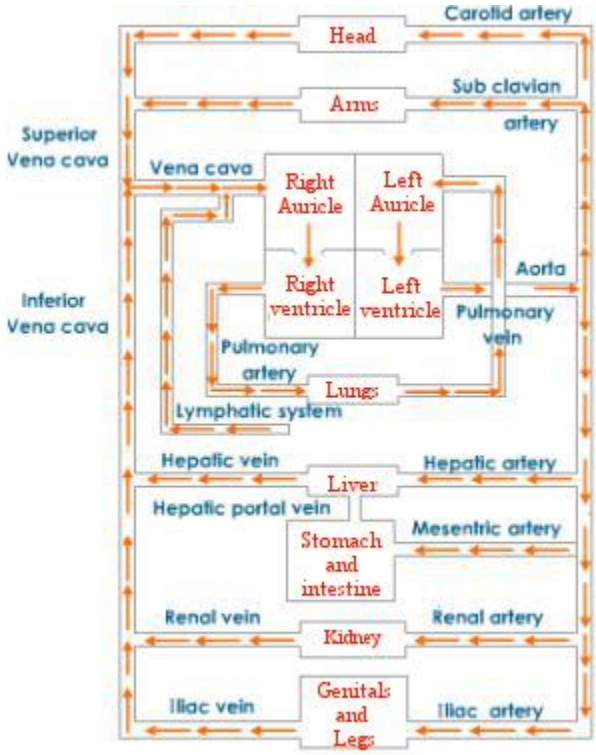
The substances in this fluid diffuse into the cells through the cell membrane. In addition, the waste products from the cells diffuse into the tissue fluid. These wastes include carbon dioxide, minerals, heat and nitrogenous wastes.



Formation of tissue fluid

At the venous end of the capillary, blood pressure is low; water potential is also low. The pressure of the tissue fluid is higher. This forces the tissue fluid back into the capillaries. Diffusion also helps in the re-entry of tissue fluid to the capillary. However, some tissue fluid remains within the cells. This later enters the lymphatic system to form **lymph**.

The capillaries join to form venules. Venules join to form veins. The veins transport blood back to the heart. Veins in the lower part of the body unite to form the inferior vena cava while veins in the upper part of the body unite to form the superior vena cava. These two large veins join to form the vena cava which transports blood to the right auricle of the heart.



Importance of blood circulation

1. It enables the transportation of cell requirements such as oxygen and nutrients to all the body tissues.
2. It ensures that waste products from the cells are removed in order to prevent accumulation. Accumulation of waste products is harmful to the body.
3. Blood circulation is important for the regulation of body temperature. Body heat is transported to all parts of the body through this system.
4. Blood circulation also transports hormones from the organs that produce them to the organs where they are needed. For example, insulin from the pancreas is a hormone necessary for the regulation of blood sugar levels

Blood pressure

Blood pressure is measured by considering the systolic pressure and the diastolic pressure.

Systole occurs when the ventricles contract and pump blood into the arteries.

Diastole is the phase when the auricles contract to pump blood into the ventricles.

The pressure developed during these actions can be felt in the arteries. It is measured in millimeters of mercury (mmHg).

For example, if the pressure during systole is 120 mmHg and the pressure during diastole is 80 mmHg, the blood pressure is 120/80 mmHg. This is the average blood pressure in a normal human being. A **sphygmomanometer** is the instrument used to measure blood pressure.

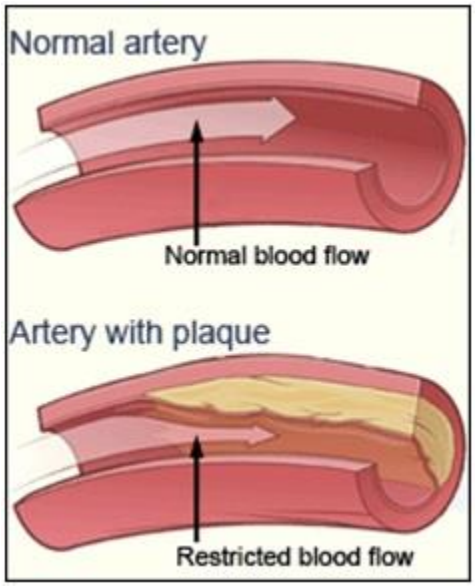
Diseases and disorders of the human circulatory system

The diseases and disorders of the human circulatory system are increased by eating habits and lifestyles. Eating food with high levels of cholesterol and fat causes narrowing of blood vessels due to deposition in blood vessels. Lifestyles such as smoking, lack of exercise, stress and taking alcohol also put one in danger of developing heart problems such as coronary heart disease and high blood pressure.

Arteriosclerosis

Arteriosclerosis is the hardening of arteries. It happens when there are fat deposits on the wall of the artery or when fibrous tissues form in the artery wall or artery walls degenerate;

Arteriosclerosis hinders the arteries from pulsating normally. The lumen is narrowed, affecting the efficiency of blood flow



As a result, the heart has to pump harder in order to supply the tissues with enough blood. The result of this is high blood pressure (hypertension). High blood pressure usually has no specific symptoms. However, it can cause headaches, dizziness and ringing in the ears.

Causes of arteriosclerosis

Arteriosclerosis is mainly caused by excessive alcohol and smoking, stress, too much fat in the jet, lack of exercise or old age,

Effects of arteriosclerosis

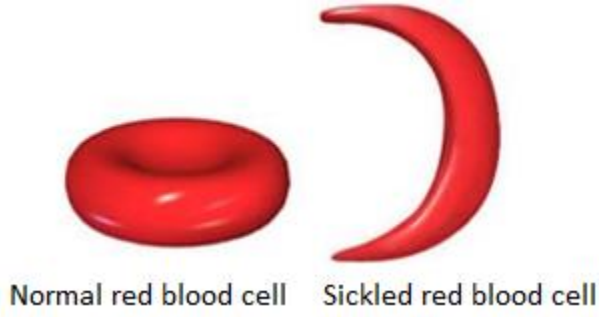
Arteriosclerosis causes swelling of part of a blood vessel and rupturing of the artery walls. It also causes total blockage of an artery, thus depriving some tissues of oxygen. This can cause the affected tissue to become severely damaged or to die.

Prevention and treatment of arteriosclerosis

People can prevent themselves from arteriosclerosis by avoiding alcohol and smoking, reducing stress, minimizing intake of fatty foods and engaging in regular exercise. Arteriosclerosis can be treated by medication or surgery.

Sickle-cell anaemia

This condition is a genetic disorder which causes production of abnormal haemoglobin and malformed red blood cells. The effect is a reduction of the blood's capacity to transport oxygen. The disease gets its name from the crescent or sickle shape of the red blood cells.



Signs and symptoms of sickle-cell anaemia

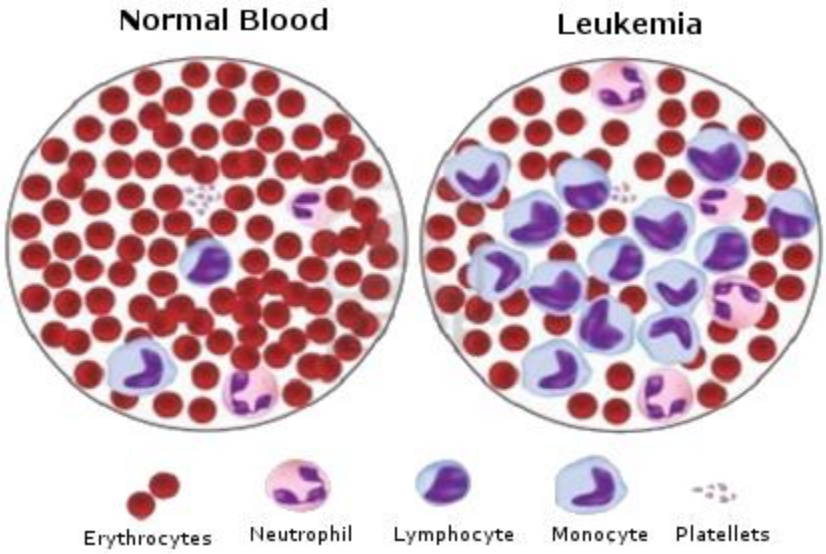
Sickle-cell anaemia is characterized by fatique or excessive tiredness, shortness of breath during exercise, headaches, dark-coloured urine, abdominal pain, abnormal heartbeat and general body weakness.

Treatment and prevention of sickle-cell anaemia

Sickle-cell anaemia has no cure. It is difficult to prevent since it is inherited. However, patients can be helped by making sure that they avoid excessive physical exercise and eat a well-balanced diet that is rich in minerals and vitamins.

Leukemia

Leukemia is a type of blood cancer. It is caused by the over production of white blood cells and the suppressed production of red blood cells



The excess white blood cells infiltrate body organs, for example the liver and the spleen. This causes reduced efficiency in the functioning of these organs and their abnormal enlargement.

Signs and symptoms of leukemia

Leukemia is characterized by abnormally high numbers of white blood cells, abnormal bleeding, e.g. nose bleeding, bleeding even from minor cuts, extreme body weakness, anaemia, and throat and mouth infections that may be recurrent.

Treatment of leukemia

Leukaemia cannot be cured. However, it is controlled by frequent blood transfusions, radiotherapy and chemotherapy to kill the abnormal cells, and bone marrow transplants

High blood pressure (Hypertension)

The blood pressure of a normal human being is $^{120/80}$ mmHg. Very high blood pressure (over $^{140/90}$) strains the blood vessels and causes hypertension and sometimes heart failure. Increase in blood pressure may be caused by high fat levels due to over-consumption of fatty foods, lack of exercise, obesity, high emotional stress, alcoholism and smoking, and arteriosclerosis.

Signs and symptoms of hypertension

The signs and symptoms of hypertension include feeling dizzy, ringing sound in the ear and severe headaches.

Prevention and treatment of hypertension

Hypertension can be prevented by engaging in regular exercises, avoiding alcohol and smoking, eating a balanced diet with less fat to control weight and reducing stress as much as possible. Hypertension can be treated using drugs.

Coronary thrombosis

Coronary thrombosis occurs when there are blood clots in the blood vessels that supply blood to the heart (coronary arteries). This prevents blood from reaching some tissues of the heart. The affected tissues lack adequate amounts of oxygen and waste materials accumulate in the cells to toxic levels.

Symptoms of coronary thrombosis

Coronary thrombosis is characterized by uncomfortable pressure or sharp pain in the chest, sometimes extending to the neck, shoulders and arms, excessive sweating, dizziness or fainting, nausea or a feeling of severe indigestion and shortness of breath.

Effects of coronary thrombosis

Coronary thrombosis can cause death of some cardiac tissue or sudden death.

Prevention and treatment of coronary thrombosis

People can avoid coronary thrombosis by doing regular exercise, avoiding sudden strenuous activity, avoiding alcohol and smoking, minimize intake of fatty foods and avoiding excessive stress Thrombosis can be treated by drugs.

Stroke

A stroke occurs when there is interference in the amount of blood flowing to the brain. Such interference can be due to blockage or rupture of an artery supplying blood to the brain. This causes some brain cells to lack adequate oxygen and nutrients.

Symptoms of stroke

Symptoms of a stroke include sudden numbness or weakness especially on one side of the body, sudden confusion or trouble in understanding or speaking and sudden poor vision in one 01 both eyes. The patient also experiences sudden dizziness, loss of balance, trouble when walking 01 lack of coordination, and sudden severe headaches

Effects of a stroke

A stroke has severe effects on the victim such as weakness or paralysis on one side of the body, leading to difficulties in movement and coordination. It also causes lack of feeling on one side of the body, speech or language problem; and loss of memory. Other effects are behaviour changes, difficulty when swallowing and exhaustion.

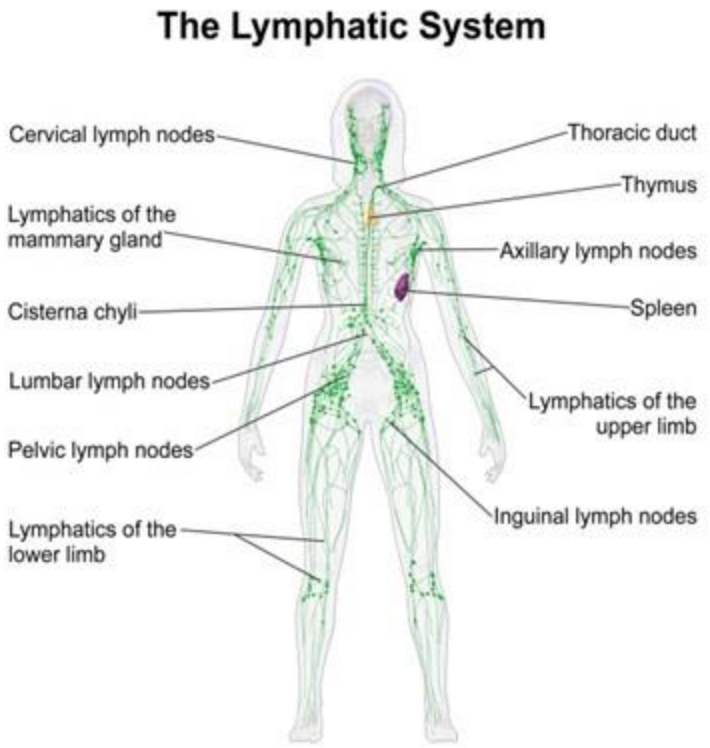
Prevention and treatment of a stroke

A stroke can be avoided by avoiding drinking and smoking, ensuring your blood pressure remains it the normal range and exercising regularly. Eating a low-fat, low-salt diet can also prevent a stroke Medication can help in the treatment of a stroke.

The Lymphatic system

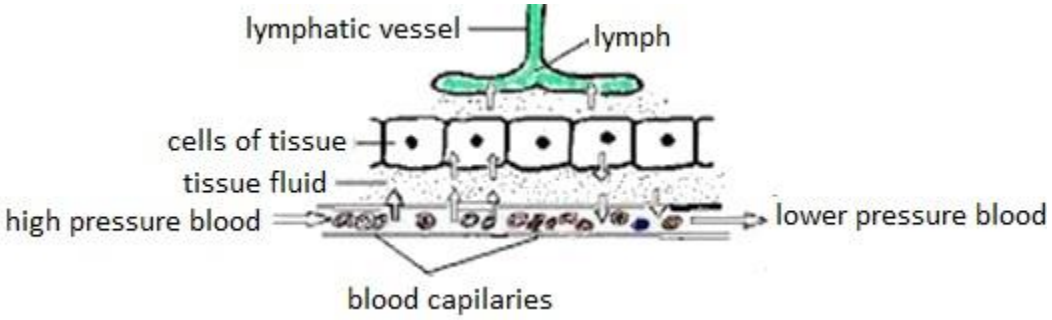
The lymphatic system closely resembles the blood circulatory system. It consists of lymph, lymph vessels through which lymph travels, and lymphoid organs and tissues such as **thymus**, **adenoids**, **tonsils**, **lymph nodes** and **spleen**.

Lymphatic system connects with the blood circulatory system at the **superior vena cava**



After cells get their requirements from tissue fluid, not all the fluid flows back into the capillaries, Part of it flows into **lymph vessels**. Once in these vessels, the fluid is called **lymph**. Lymph is a pale yellow fluid. It has the same components as tissue fluid, but more fatty substances.

Lymph vessels unite to form larger vessels called **lymph ducts**. There are two main lymphatic ducts; **the right lymphatic duct** empties into the right **subclavian vein** while **the left lymphatic duct** drains into the left **subclavian vein.** The two veins join to form the superior vena cava. In this way, the contents of lymph enter the blood circulation system



Formation of lymph

Lymphatic ducts form nodule-like structures called **lymph nodes**. These nodes are found in the abdomen, groin, armpits and neck. Lymph nodes are important sites for the production of white

blood cells. They also filter out foreign materials such as bacteria and dead tissue before they enter the bloodstream.

The flow of lymph depends greatly on the squeezing of lymph vessels by breathing movements, intestinal movements and muscular movements. The lymph vessels have valves to prevent back flow of lymph.

Importance of the lymphatic system

1. Lymph nodes produce lymphocytes (white blood cells) which help the body to fight diseases.
2. Lacteals enable absorption of fatty acids after digestion.
3. It provides a way of getting tissue fluid back to the circulatory system.
4. The spleen destroys worn out red blood cells.
5. The spleen, the adenoids and the tonsils produce antibodies which help in fighting disease-causing microorganisms

Disorders and diseases of the lymphatic system

There are many diseases and disorders that affect the lymphatic system. Some of these diseases and disorders are explained below.

Elephantiasis

This is a disease that is caused by worms (filaria) that block the lymph vessels causing accumulation of lymph which leads to swelling of the arms or legs

Filaria worms are transmitted by mosquitoes. Elephantiasis is treated by destroying the parasites. One way of preventing it is by eliminating breeding areas of mosquitoes, for instance bushes and stagnant water.

Oedema

This is the swelling of body tissues due to excessive lymph. It is caused by increased blood pressure in the capillaries, causing the production of large amounts of lymph that the lymphatic system cannot transport efficiently, pregnancy, obesity and protein deficiency.

Oedema can be controlled by taking measures to reduce blood pressure, pregnant women keeping the feet slightly raised when sitting or lying down eating a well-balanced diet and taking measures to reduce body weight, for example by exercising and avoiding eating excessive amounts of food.

Lymphoma

Lymphoma is the term used to refer to cancers that affect the lymphatic system. These cancers cause abnormal growth or functioning of the components of the lymphatic system. The result is weakened immune response in the body.

Symptoms of lymphoma include swollen and painful lymph nodes, fatigue, weight loss, night sweats and itching.

Lymphomas are treated using chemotherapy and radiation therapy. Severe cases may call for bone marrow transplants

Tonsillitis

This is an infection and swelling of the tonsils. It is caused by bacteria or viruses that enter the body through the mouth or sinuses.

Symptoms include red and swollen tonsils, sore throat, fever or chills, muscle ache and tiredness.

Mild cases of tonsillitis are treated by having adequate rest and taking plenty of fluids. More severe cases may require medical treatment; frequent tonsillitis is sometimes solved by tonsillectomy (surgical removal of the tonsils).

Summary:

1. The mammalian heart is responsible for pumping blood to all parts of the body. It has four chambers: two auricles (or atria) and two ventricles.
2. Valves in the heart and veins prevent the back flow of blood.
3. The flow of blood in the heart is as follows

(a) Deoxygenated blood from the body enters the right auricle through the vena cava

(b) The right auricle pumps blood to the right ventricle.

(c) The right ventricle pumps blood to the lungs through the pulmonary artery.

(d) Oxygenated blood from the lungs enters the left auricle through the pulmonary vein.

(e) The left auricle pumps blood to the left ventricle.

(f) The left ventricle pumps blood to all parts of the body through the aorta.

4.The main blood vessels are arteries, veins and capillaries.

5. Arteries are muscular vessels that transport blood away from the heart. Arteries contract and relax, creating a pulse.

6. Veins are less muscular than arteries. They transport blood towards the heart.

7. Capillaries are very small vessels whose walls are one cell thick. They are in direct contact with the body tissues.
8. Blood is a fluid tissue consisting of plasma, red blood cells, white blood cells and platelets
9. Plasma is the fluid part of blood. It transports dissolved substances, helps to regulate body temperature and pH and acts as a site for the exchange of nutrients and waste products.

10. Red blood cells are biconcave in shape, lack a nucleus and contain haemoglobin. Their function is to transport oxygen and carbon dioxide.

11. White blood cells are irregularly shaped. They are important for immunity.

12. Platelets are fragments of cells. They help in blood clotting.

13. Grouping of human blood is done according to the ABO system and the Rhesus factor.
14. Blood transfusion is the transfer of blood from a donor to a recipient.
15. Agglutination occurs if transfused blood is incompatible with the recipient's blood.
16. Blood circulation is the movement of bloodfrom the heart to all parts of the body. Blood circulation in humans involves a double circulation system where there are two cycles:
- Pulmonary cycle (from the heart to the lungs and back).
- Systemic cycle (from the heart to all parts of the body and back)

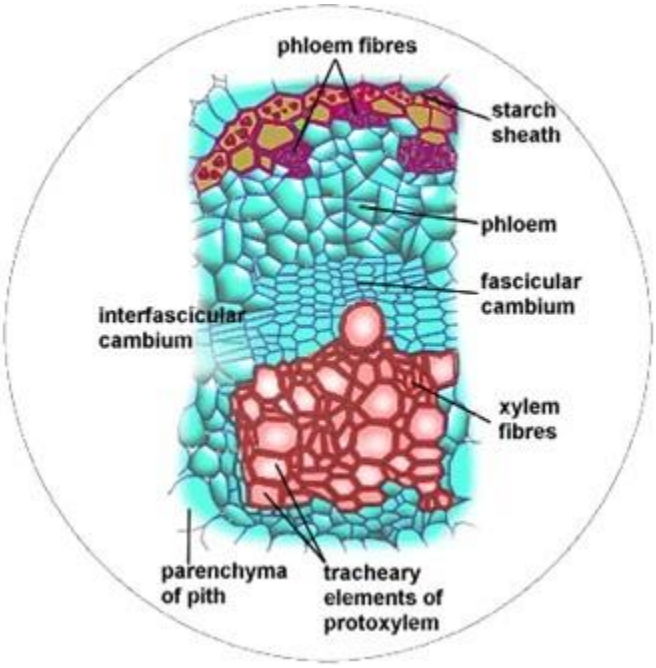
17. Diseases and disorders of the human circulatory system include high blood pressure, arteriosclerosis, sickle-cell anaemia and leukaemia.
18. Blood pressure is measured by considering the pressure when the ventricles contract (systole) and the pressure when the auricles contract (diastole).
19. Lymph is formed from tissue fluid that does not flow back into the capillaries.
20. Disorders of the lymphatic system include oedema, lymphoma, tonsillitis and elephantiasis.

TRANSPORTATION OF LIVING MATERIALS -2

TRANSPORT IN PLANT

Introduction:

The transport system in plants is not as complex as that of animals. Materials are transported by vascular bundles made up of **xylem and phloem** tissues. Xylem tissue transports water and mineral salts from the soil to all parts of the plant. Phloem tissue transports manufactured food from the sites of photosynthesis to all parts of the plant. In between the xylem and phloem is **cambium.** The cambium divides to form newxylem and phloem

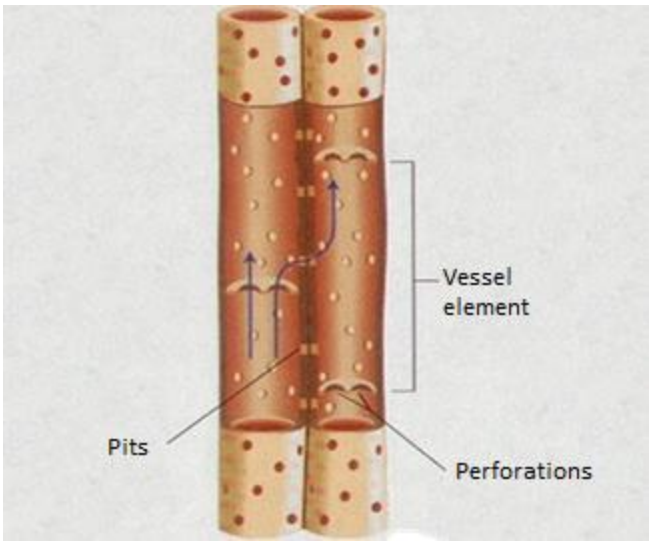


Vascular bundle in a stem showing the position of cambium

Components of the vascular system

Xylem

Xylem tissue is made up of the xylem vessels and the tracheids. Mature xylem vessels and tracheids are made up of hollow and dead cells. Their walls are made **of cellulose** and **lignin.** Lignin strengthens the cell walls and makes them rigid. Therefore, xylem has an additional function of giving support to the plant.

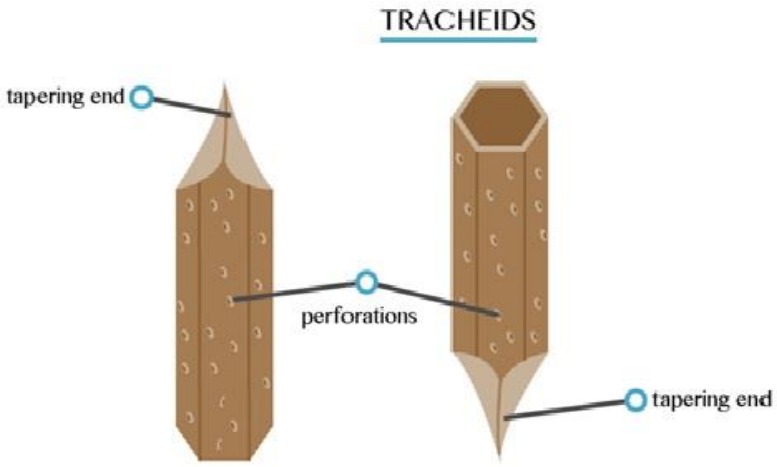


Xylem vessels

The movement of substances in the xylem is always upward and is by **conduction. A xylem vessel** is made of hollow cells without end walls. These cells are joined end to end to form a pipe-like structure. See above Xylem vessels begin in the roots, go up through the stem and branch into every leaf of the plant.

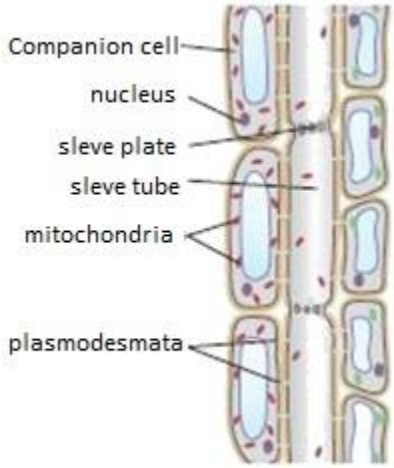
Xylem vessels have no cytoplasm and nuclei. This enables them to transport a larger volume of water and mineral salts.

Tracheid elements are elongated with pointed (tapering) ends (Figure. below) they are also laid end to end to enable continuous flow of water. Their end walls have perforations (pits) unlike in xylem where end walls are missing. This makes them less efficient in conduction of water.



Phloem

The phloem tissue is made up of sieve-tube elements and companion cells.



Phloem tissue

Like xylem vessels, sieve-tube elements are made of cells that are joined end to end. However, the end walls of these cells are not completely broken down. They have perforations or pores that form **sieve plates.** These cells contain cytoplasm but they have no nucleus. Fibres run through the pores thereby connecting adjacent sieve-tube cells.

Each sieve-tube element has a companion **cell;** they are separated by a thin wall made up of parenchyma cells with pores called **plasmodesmata** which allow exchange of materials between them.

Companion cells have a high concentration of mitochondria. They provide the sieve-tube elements with energy.

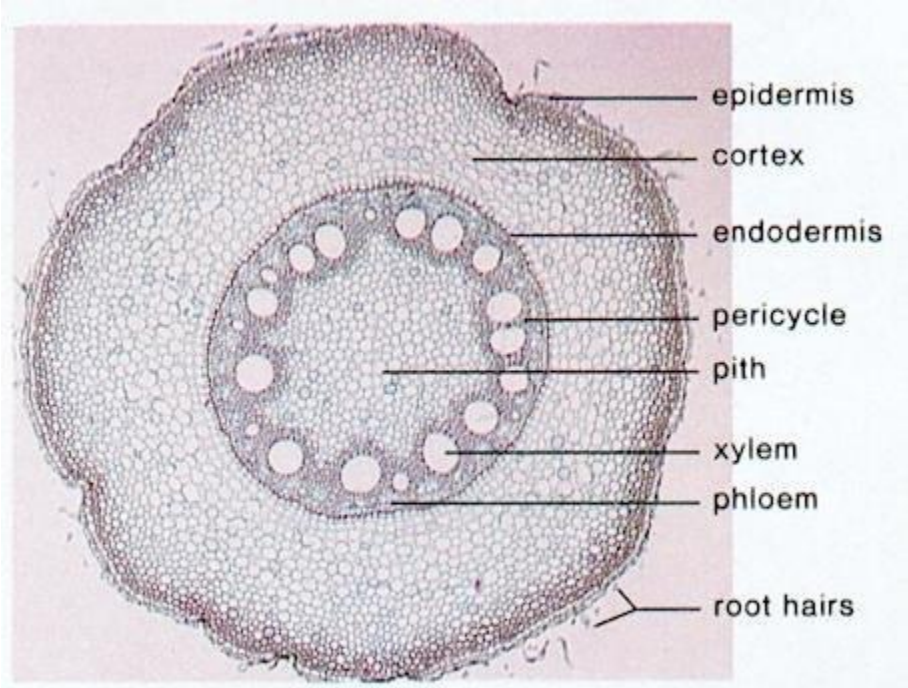
The movement of substances in the phloem is by **translocation.** It can be in any direction.

The distribution of vascular bundles in plants

The way the vascular bundles are arranged in the roots, stems and leaves of monocots and dicots differ. This arrangement also differs in the roots and stems of the two categories of plants.

Monocotyledonous root

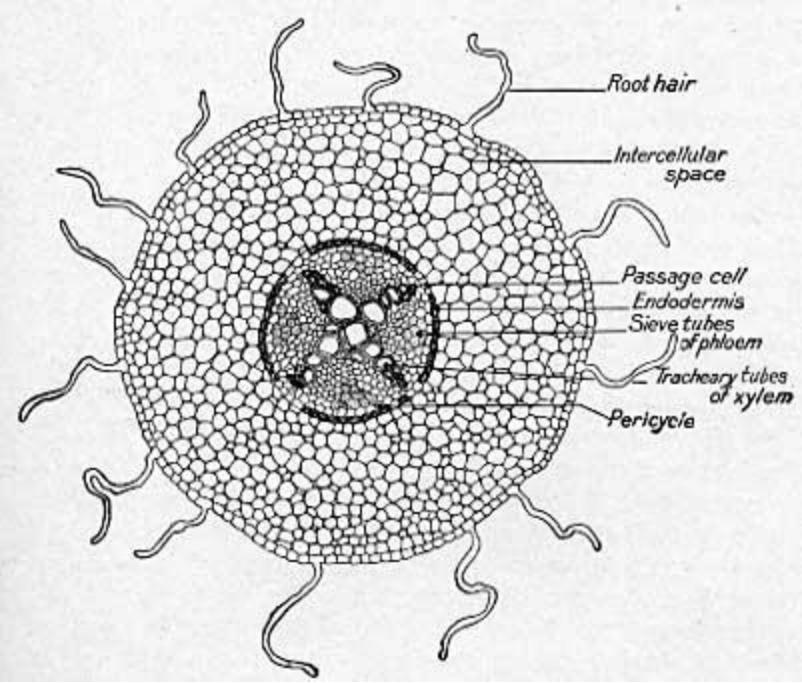
The arrangement of vascular bundles is as shown:



Cross Section of Monocot Root

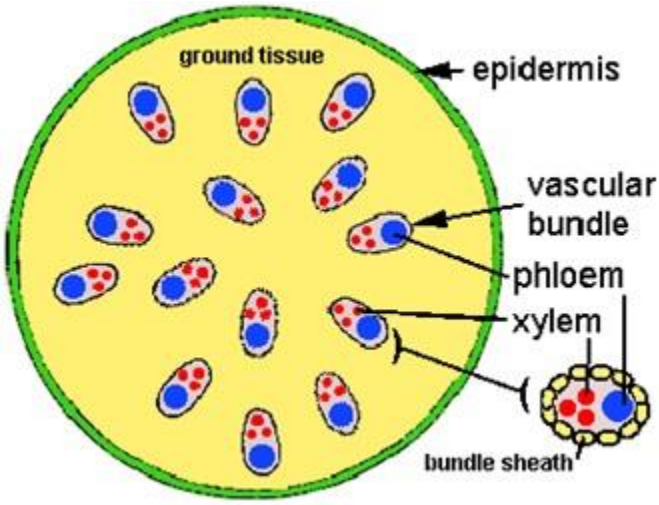
Dicotyledonous root

The xylem is centrally positioned and star-shaped. The phloem is found between the extensions of the xylem as shown in Figure below



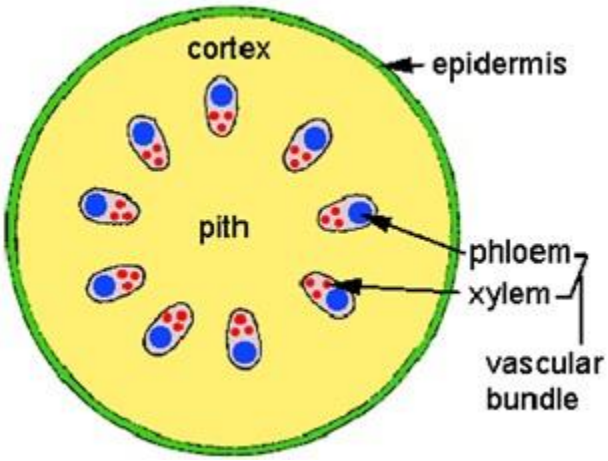
Monocotyledonous stem

The arrangement of vascular bundles is random. See Figure below



Dicotyledonous stem

The vascular bundles are arranged around the central pith, See Figure below

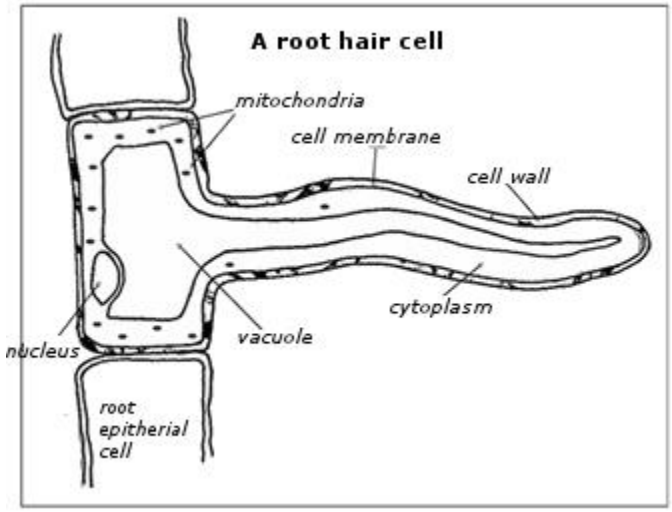


Absorption and movement of water and mineral salts

Plants absorb water and mineral salts from the soil through root hairs.

Structure and functions of root hairs

Root hairs are extensions of the epidermal cells of the root. Figure below shows the structure of a root hair.



Structure of root hair

Root hairs are long and slender to provide a large surface area for the absorption of water and mineral salts from the soil. The large number of root hairs also increases the total surface area of the roots.

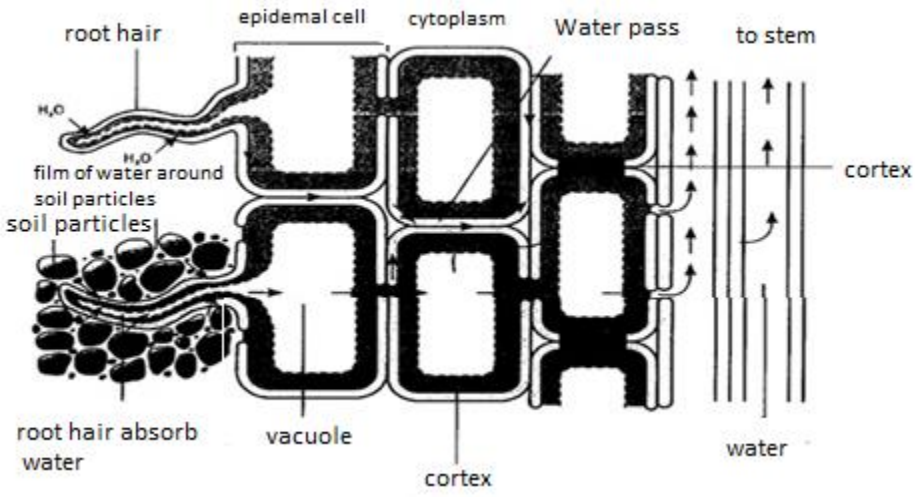
The root hair cell sap is usually hypertonic to the surrounding. Hence, water enters the cell by osmosis.

Root hair cells have a higher concentration of minerals than the surrounding. Mineral salts are therefore absorbed by active transport.

The root hairs are very thin in order to provide a short distance over which absorption of water and mineral salts takes place.

Movement of water and dissolved mineral salts

When water is absorbed by the root hair, it dilutes the contents of the cell sap vacuole. As a result, the cells of the cortex, which are adjacent to the epidermis, have less water than the root hair cells. Water moves from the root hair cells to the cortex cells by **osmosis.** It moves the same way into the cells of the endodermis, then into the **pericycle** and then into the xylem.



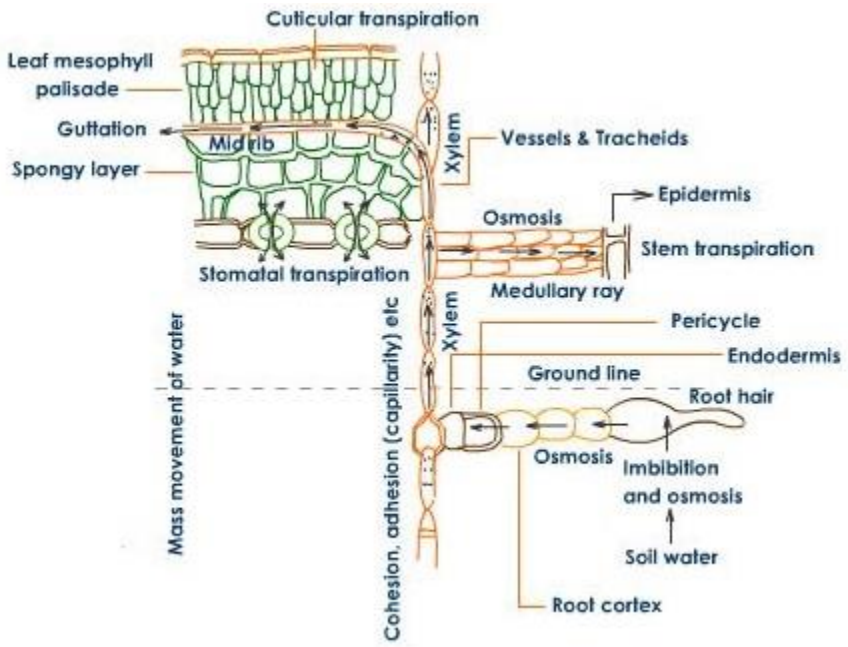
Movement of water from root hair xylem

Once in the xylem, the water and the mineral salts dissolved in it move up the xylem vessel by transpirational pull, capillarity and root pressure.

Transpirational pull

Transpiration occurs when water evaporates from the plant through the stomata in the leaves. As the water is lost, the mesophyll cells draw water from the xylem in the leaf which hi turn draws water from the xylem in the stem. This creates a tension called **transpirational pull** which draws water from the roots.

This results in a continuous column of water from the roots, through the xylem to the leaves. This column of water is called **transpirational stream**



Transpirational stream

Capillarity

Capillarity is the action that causes water to rise in narrow tubes. Xylem vessels have a narrow lumen which makes it possible for water to rise in them by capillarity.

Capillarity is made possible by **cohesion** and **adhesion** forces. Cohesion is the attraction between like molecules. It makes the water molecules Stick to each other. Adhesion is attraction between different molecules. It causes water molecules to adhere to the xylem vessels.

Root pressure

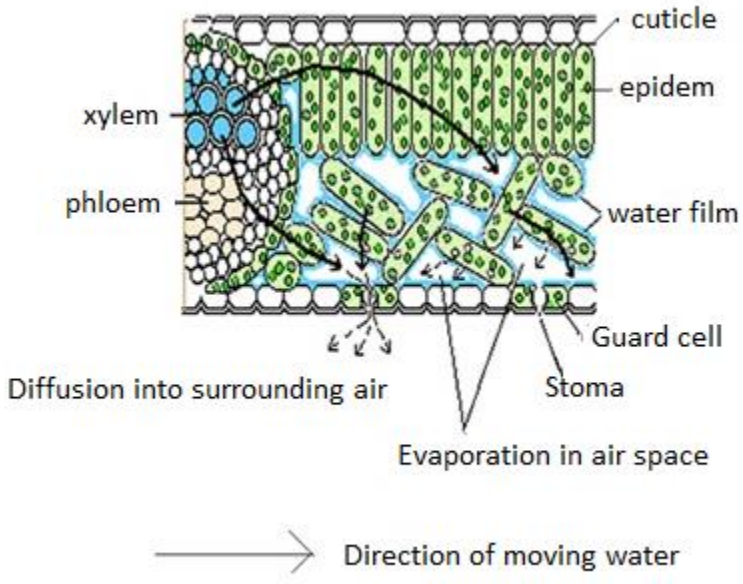
Root pressure pushes water and dissolved mineral salts upwards from the root. This happens because the cells of the endodermis push mineral It's into the xylem. This increases osmotic pressure in the xylem thereby creating a force that moves the water and dissolved minerals up the xylem vessel. When a plant is cut, fluid oozes out the remaining stem (Stump). This is proof of root pressure in plant.

stump oozing sap

TRANSIPIRATION

Transpiration is the process by which plants lose water through the stomata in the leaves.

Water flows from the roots to the leaves through the xylem vessels. It enters the spongy mesophyll by osmosis. The spongy mesophyll has substomatal air spaces where water enters as water vapor. As a result, the concentration of water vapor in the substomatal air spaces becomes higher than the concentration of water vapor in the air. This causes water to diffuse into the atmosphere through the stomata.



Movement of water through leaves

Note: Another process known as **guttation** also occurs in plants. It is the process by which plants lose water as droplets through special glands found where veins are in contact with the leaf margin. Guttation is different from transpiration in that transpiration is the loss of water vapor mainly through the plant's stomata. Guttation occurs mostly at night or in plants growing in wet areas

Types of transpiration

There are three types of transpiration:

1. **Stomatal transpiration** occurs through the stomata on the leaves. It accounts for approximately 90% of the water lost by plants.
2. **Cuticular transpiration** happens through the cuticle of leaves. The cuticle is a waxy layer that covers the surface of leaves. A thick cuticle prevents excessive loss of water.
3. **Lenticular transpiration** takes place through the lenticels. Lenticels are pores found on the bark of stems or roots in woody plant

Factors affecting the rate of transpiration

The rate of transpiration is affected by plant features as well as environmental factors.

Plant features

Plant features include the following:

(a) **The size of leaves***;* a large leaf has more stomata than a small leaf. Therefore, plants with large leaves lose more water than those with smaller leaves,

(b) **An extensive root system:**Plants that have extensive roots absorb more water and can therefore lose more water than those with few roots.

(c) **Leaf cuticle***:* A thick cuticle resists water loss by transpiration while a thin cuticle makes water loss by transpiration easier.

(d) **Number of stomata***:* The more stomata a leaf have, the faster the rate of transpiration and vice versa.

(e) **Position of stomata*:***Stomata on the upper surface of the leaf lose water more easily than those on the lower surface. If a plant has leaves with more stomata on the upper surface, the rate of transpiration is faster than in a plant that has Leaves with more stomata on the lower leaf surface.

(f) **Size of substomatal air spaces***:* Larger air spaces allow for a faster rate of transpiration because the leaves can hold more water vapor. Smaller substomatal air spaces slow down the rate of transpiration.

(g) **Sunken stomata***:* Sunken stomata occur in pits. They are not exposed to moving air so they slow down transpiration rate.

(h) "**Epidermal hairs***:* Epidermal hairs trap water on the surface of the leaves, thus preventing water

Environmental factors

(a) **Temperature***:* Transpiration rates go up as the temperature goes up. Higher temperatures cause the stomata to open and release water into [the atmosphere. Lower temperatures cause the stomata to close.

(b) **Relative humidity:**As the relative humidity of the surrounding air rises, the transpiration rate falls. It is easier for water to evaporate into dry air than into air saturated with moisture.

(c) **Wind and air movement***:* Increased movement of the air around a plant results in a higher transpiration rate. As water transpires from a leaf, the water saturates the air surrounding the leaf. If there is no wind, the air does not move, thus 11raising the humidity of the air around the leaf. Wind moves the air causing the more saturated air close to the leaf to be replaced by drier air.

(d) **Availability of soil moisture**:When moisture is lacking in the soil, plants begin to senesce (age prematurely) resulting in leaf loss and reduced transpiration. Also, less water is absorbed by the roots when the soil is dry.

(e) **Light***:* Increased sunlight increases the rate of photosynthesis in the guard cells, causing them to become turgid and open the stomata. Higher light intensity also increases the plant's internal temperature and hence increases the rate of transpiration.

(f) **Atmospheric pressure***:* When atmospheric pressure is low, for example at high altitudes, plants lose water more easily. The rate of transpiration is reduced in areas with high atmospheric pressure.

Significance of transpiration

1. It helps to maintain transpirational pull which is important for maintaining a constant stream of water between the roots and the leaves.
2. Transpiration enables the loss of excess water from the plant,

3. It helps to cool the plant and enables absorption and distribution of water and mineral salts.

Summary:

1. The vascular system in plants is made up of xylem and phloem tissues.
2. Xylem transports water and" mineral salts from the roots to all parts of the plant.
3. Phloem transports manufactured food from the site of photosynthesis to all parts of the plant.
4. The distribution of vascular bundles is different in roots and stems and in dicotyledonous and monocotyledonous plants.
5. Root hairs are extensions of the epidermal cells of the root. They absorb water and mineral salts from the soil.
6. Water is absorbed from the soil by osmosis.
7. Mineral salts are absorbed from the soil by active transport.
8. Water and dissolved minerals move up thexylem by transpiration pull, capillarity and root pressure.
9. Transpiration is the process by which plants lose excess water through their leaves. Transpiration is important because it:

- Helps to maintain the transpirational stream.
- Enables the loss of excess water.
- Enables absorption and distribution of water and mineral salts in a plant.
- Helps to cool the plant.

1. Transpiration is affected by the features ofthe plant and environmental factors. The features of the plant include: leaf size, size of root system, size of leaf cuticle, size of air spaces, number and position of stomata and whether the stomata are sunken or not, and the presence of epidermal hairs.
2. Environmental factors include the amounts of moisture in air, temperature, and air movement, availability of soil moisture, light and atmospheric pressure.

GASEOUS EXCHANGE AND RESPIRATION

Gaseous exchange

Gaseous exchange is the movement of oxygen and carbon dioxide across a respiratory surface. Unicellular organisms carry out gaseous exchange by diffusion across the cell membrane. Large organisms cannot carry out diffusion efficiently so they have developed specialized organs for gaseous exchange. These are called respiratory surfaces.

Table below shows examples of respiratory surfaces in various organisms. **Respiratory surfaces in various organisms**

Organism	**Respiratory surface**
Amoeba	Cell membrane
Insects	Tracheal system
Spider	Book lung
Fish	Gills
Plants	Leaves, stems, roots
Amphibians	Skin, gills and lungs
mammals	Lungs
Birds	Lungs
Reptiles	Lungs

Characteristics of respiratory surfaces

1. They are thin to reduce the diffusion distance.

2. They are moist to dissolve gases so that they diffuse in solution form.

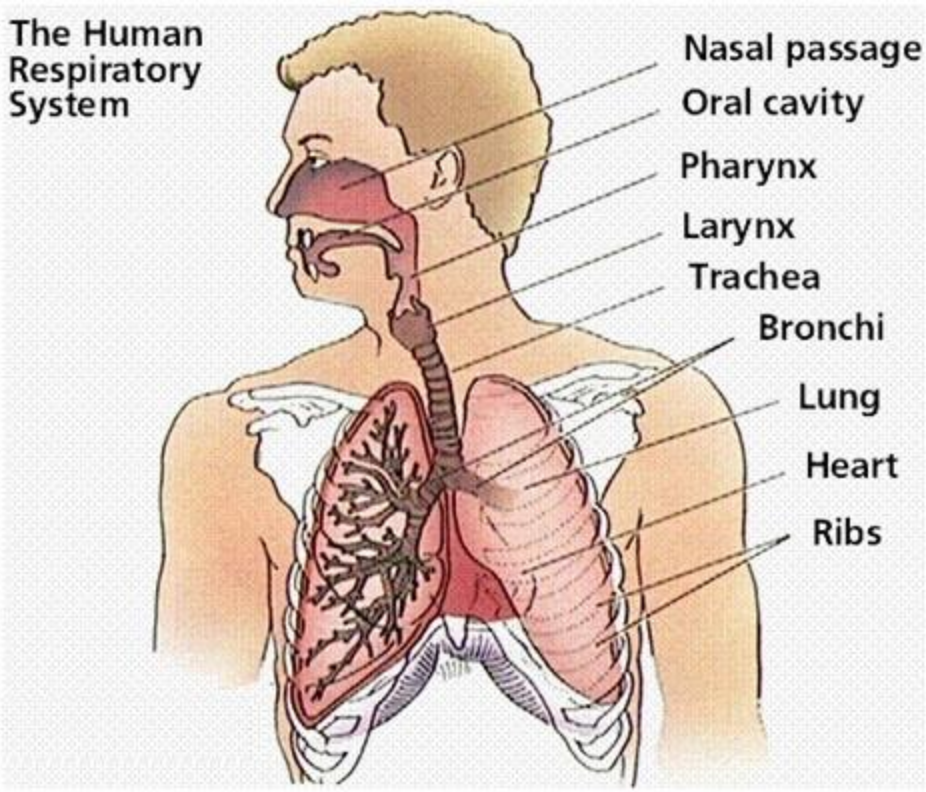
3. They are highly branched, folded or flattened in order to increase the surface area for gaseous exchange,

4. They are close to an efficient transport and exchange system so that gases can be taken to and from the cells easily.

5. They are well ventilated so that gases can pass through them easily

GASEOUS EXCHANGE IN MAMMALS

The components of the gaseous exchange system in mammals include the nostril, trachea, lungs, intercostals muscles, diaphragm and ribs.



The adaptations and functions of parts of the mammalian respiratory system

Part	Adaptive features	Functions
Nose and nasal cavity	Mucus lining and hairs (cilia)	Trap dust and microorganisms
Glottis	Presence of epiglottis	Closes the trachea during swallowing to prevent food from entering the respiratory system
Trachea, bronchus and bronchioles	Blood vessels near the surface	Warm the air
	Have rings of cartilage tissue along their length	Prevent collapse of the respiratory tract
	Mucus lining and cilia	Trap and filter dust and microorganisms
Lungs	Spongy with air spaces (alveoli)	Main organ of mammalian gaseous exchange Airspaces hold inhaled air

Alveoli (singular: alveolus)	Numerous in number	Provide large surface area for gaseous exchange
	Thin membranes	Reduce distance for diffusion of gases
	Moist surface	Enables gases to dissolve into solutions before diffusing
	Has dense network of capillaries	Transport oxygen from the alveoli to the tissues and carbon dioxide from the tissues to the alveoli
	Constantly contain air	Maintain shape to avoid collapsing
Pleural membrane	Contain pleural fluid	Lubricates the membranes so that the lungs can slide smoothly over the thoracic cavity during breathing
Ribs	Are made of hard bone tissue	Protect the lungs from injury
Intercostal muscles	Move antagonistically: when one muscle contracts the other relaxes and vice versa	Allow expansion and contraction of the thoracic cavity
Diaphragm,	Muscular sheet of tissue	Separates the thorax from the abdomen. Allows for gaseous exchange by becoming dome-shaped or flattens.

The mechanism of gaseous exchange in mammals

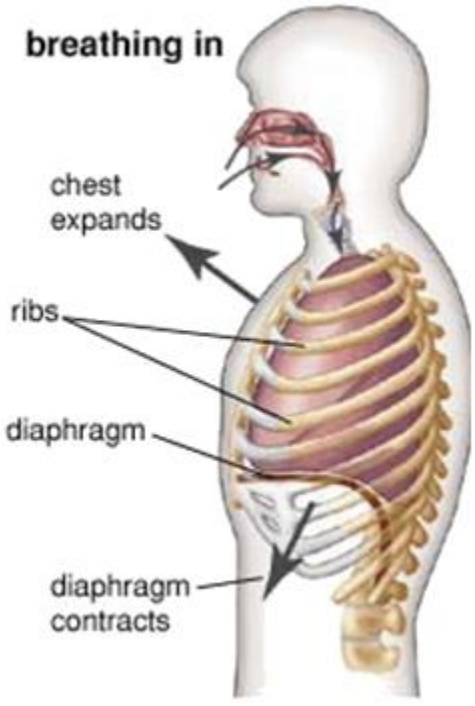
Gaseous exchange in mammals happens as a result of **inhalation** (or **inspiration) and exhalation** (or exp**iration).** Inhalation is breathing in air into the lungs. Exhalation is breathing out air from the lungs

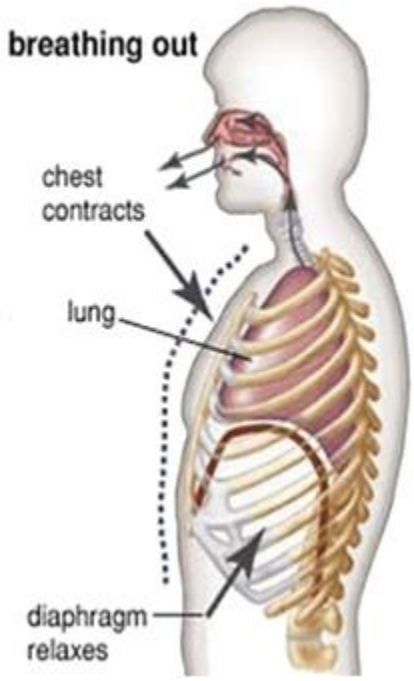
During inhalation the muscles of the diaphragm Contract, pulling the diaphragm downwards; As this happens, the external intercostal muscles contract and pull the ribcage upwards and outwards. The result of these movements is an increase in the volume and a decrease in the air pressure of the thorax. This makes air rush into the lungs through the nostrils, trachea and bronchioles.

During exhalation, the muscles of the diaphragm relax and the diaphragm resumes its dome shape. The external intercostal muscles relax, pulling the ribcage inwards and downwards. As a

result, the volume of the thorax decreases and the pressure inside it increases. This forces air out through the bronchioles, trachea and nostrils

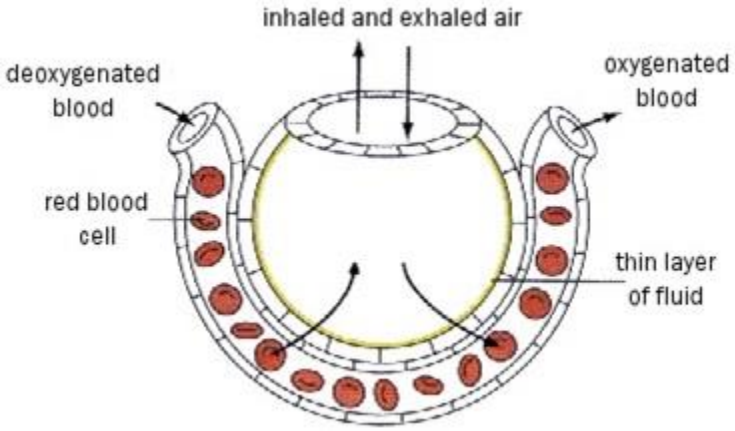
	Breathing in (inhalation)		**Breathing out (exhalation)**
	External intercostal muscles contract		The external intercostal muscles relax
	Internal intercostal muscles relax		The internal intercostal muscle contract
	The ribcage is lifted outward and upward		The ribcage move inward and downward
	The diaphragm contracts and flattens		The diaphragm relaxes and become dome-shaped
5	The volume of thoracic cavity increase as pressure decrease This allows air to enter the thoracic cavity	5	The volume of thoracic cavity decrease as pressure increase
6	Air enter the alveoli through the nostrils, pharynx, glottis, trachea, bronchioles and finally alveoli	6	Air leaves the alveoli through the bronchioles, trachea, glottis, pharynx and finally nostrils





Gaseous exchange across the alveolus

The actual exchange of oxygen and carbon dioxide takes place in the alveoli. One mammalian lung has millions of alveoli. The alveoli are surrounded by network of capillaries.



Gases exchange across alveolus

When we breathe in, air accumulates in the alveoli. There is a higher concentration of oxygen in the air in the alveoli than in the bloodstream.

Therefore, oxygen diffuses out the alveoli into the blood in the capillaries. It combines with haemoglobin to form **oxyhaemoglobin**

The oxygen is then transported to the tissues. Once in the tissues, the oxyhaemoglobin breaks down to release oxygen and haemoglobin. The tissues use released oxygen and release carbon dioxide.

This causes the levels of carbon dioxide to become higher in the tissues than in the blood. Carbon dioxide therefore diffuses into the blood in the capillaries and combines with haemoglobin to form carbaminohaemoglobin. The capillaries transport carbon dioxide in this form to the alveoli.

The concentration of carbon dioxide is higher in lie blood in the capillaries than in the air in the

alveoli. Carbon dioxide therefore diffuses from the Capillaries into the alveoli. It is then transported through the bronchioles, trachea, glottis, pharynx and finally nostrils into the atmosphere

Composition of inspired and expired air

gas	**Inspired air**	**Expired air**
Oxygen	20.95%	16.40%

Carbon dioxide	0.03%	4.00%

Factors affecting the rate of gaseous exchange

1. **Concentration of carbon dioxide**

High concentration of carbon dioxide in the blood increases the rate of gaseous exchange. This provides the tissues with adequate amounts of oxygen and lower carbon dioxide concentration in the blood.

2. **Concentration of haemoglobin**

Haemoglobin is responsible for the transportation of gases from the lungs to the tissues and back. Efficient transportation of gases takes place when the body has adequate amounts of haemoglobin.

When a person is anaemic, the body has a low concentration of haemoglobin. Only small amounts of oxygen can be transported at a time. As a result, the rate of gaseous exchange has to increase so that the tissues get adequate amounts of oxygen.

3. **Physical activity**

A more active body requires more oxygen than a less active body. As a result, gaseous exchange takes place faster when there is increased body activity.

4. **Health status of the body**

Generally, the rate of gaseous exchange increases when somebody is sick. This is as a result of increased metabolism by the liver in order to remove the toxins released by disease-causing microorganisms or break down the drugs taken. Certain diseases also make the body weak and cause slowing down of the breathing process.

5. **Altitude**

Altitude is the height above sea level. At high altitudes, the concentration of oxygen is lower compared to low altitudes. Breathing is therefore faster at high altitudes. At high altitudes, there is also decreased atmospheric pressure. This makes breathing difficult. Organisms therefore have to breathe in faster in order to get enough oxygen.

6. **Age**

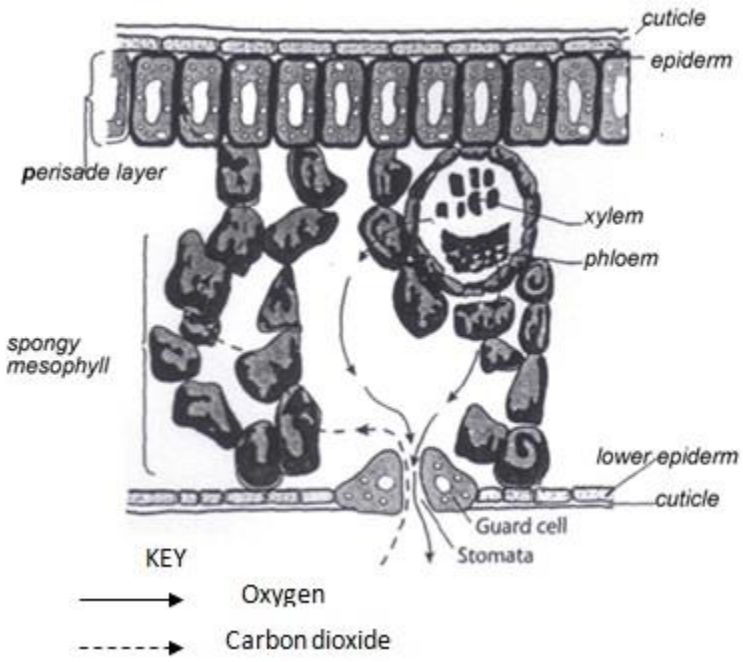
Young people are generally more active than old people. Also, a lot of growth processes take place in the bodies of young people. This increases the demand for oxygen and therefore increases the breathing rate.

Gaseous exchange in plants

In plants, gaseous exchange mostly takes place through the stomata on the leaves and lenticels on the stem. Some plants such as mangrove and ficus also carry out gaseous exchange through breathing roots.

Gaseous exchange in the leaves

Atmospheric air moves into and out of the leaf through the stomata. Gaseous exchange mostly takes place in the air spaces in the spongy mesophyll.



During the day, guard cells that surround the stomata absorb water by osmosis.As a result, the cell sap of guard cells becomes hypertonic and draws in water from the neighbouring cells by osmosis.

The guard cells become turgid and the stomata open. Air from the atmosphere enters into the air spaces in the spongy mesophyll. The cells next to the air spaces have more oxygen (produced by the cells during photosynthesis) but less carbon dioxide (used up during photosynthesis).

On the other hand, carbon dioxide is more in the air within the air spaces but oxygen is less. Carbondioxide and oxygen diffuse in opposite directions depending on their concentration gradients. The carbon dioxide diffuses to neighbouring cells until it reaches the site for photosynthesis. Oxygen moves out through the open stomata into the atmosphere.

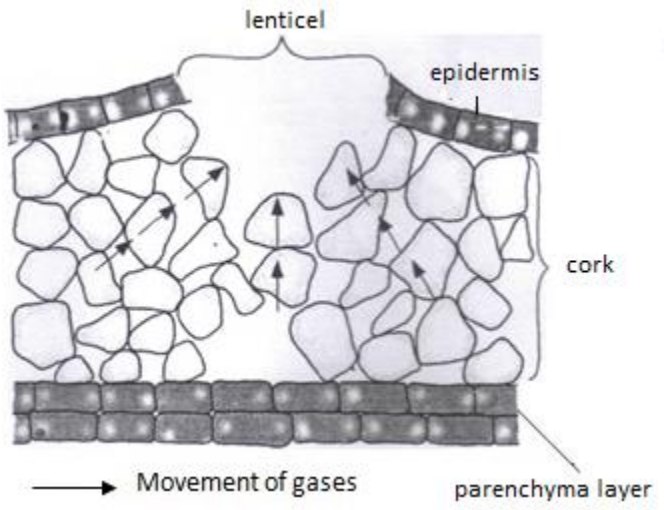
At night, there is no light, therefore photosynthesis ceases. No glucose is produced therefore the guard cells do not absorb water by osmosis. Hence, the stomata remain partially closed.

However, respiration takes place in plants at night. The partially open stomata allow in small amount of air which accumulate in the air spaces. There is more oxygen and less carbon dioxide in the air spaces compared to the plant cells.

Oxygen moves into the plant cells while carbon dioxide moves into the air spaces and eventually into the atmosphere through the partially open stomata. This explains why plants produce carbon dioxide at night and oxygen during the day.

Gaseous exchange through the lenticels

Lenticels made up of loosely packed cork cells located on the bark of woody stems and roots. They are small pores through which gaseous exchange occurs.



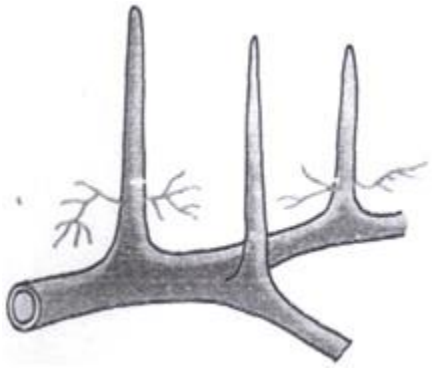
Gaseous exchange in the lenticels

The loose arrangement of the cells facilitates the movement of gases between them. The cells have a thin layer of moisture so that gases diffuse in and out while in solution form

At night, there is a higher concentration of oxygen in the air spaces between the cork cells than in the ells themselves. Oxygen therefore diffuses into the cells surrounding the lenticels. The cells use oxygen far respiration and release carbon dioxide in the process. Thus, the concentration of carbon dioxide in the cells becomes higher than in the air spaces. Carbon dioxide therefore diffuses out through the cells into the air spaces and then out through the lenticel. The opposite happens during the day.

Gaseous exchange through the roots

This occurs through breathing roots. Plants with breathing roots have a very thin epidermal layer which enables the root to carry out gaseous exchange.



Breathing roots

Oxygen is at a higher concentration in the atmosphere than in the root cells. Therefore, oxygen diffuses into the root cells through the epidermis.

During respiration, the plant uses oxygen and releases carbon dioxide. This causes the concentration of carbon dioxide in the root cells to be higher than in the atmosphere. Carbon dioxide diffuses from the root cells into the atmosphere through the epidermis.

Importance of gaseous exchange in plants

1. It Enables plants to obtain carbon dioxide, which is one of the raw materials necessary for photosynthesis.
2. Plants obtain oxygen which is necessary for the production of energy. Energy is produced during respiration.
3. It enables the plant to eliminate excess carbon dioxide at night of which if left, will harm the plant.

Respiration

Respiration is the process by which food substances are broken down to provide energy. It is controlled by enzymes. Enzymes are substances that affect the rate at which a reaction occurs but are not used up in the reaction themselves. Respiration takes place in the mitochondria of the plant cells.

There are two types of respiration: aerobic respiration and anaerobic respiration.

Aerobic respiration

This is a type of respiration whereby oxygen is used to break down glucose, releasing energy, carbon dioxide and water. The chemical reaction for aerobic respiration is:

$$C_6H_{12}O_6 + 6\,O_2 \longrightarrow 6\,CO_2 + 6\,H_2O + \text{Energy}$$

Glucose oxygen carbon dioxide water

The energy produced is in the form of ATP (adenosine triphosphate). Thirty-eight molecules of ATP are produced at the end of the aerobic respiration.

Aerobic respiration takes place in two stages**: glycolysis** and **Kreb's cycle.**

Glycolysis takes place in the cytoplasm. It does not require oxygen so it is a phase that is common for both aerobic and anaerobic respiration.

During glycolysis, enzymes break down glucose into a three carbon compound called **pyruvic acid**. Glycolysis produces 2 molecules of ATP per molecule of glucose.

The pyruvic acid can further be broken down in the presence or absence of oxygen. If there is oxygen, the pyruvic acid proceeds to the next stage of aerobic respiration, which is Kreb's cycle. If there is no oxygen, anaerobic respiration occurs.

Note that pyruvic acid passes through a stage where it is **decarboxylated** (one carbon dioxide molecule removed from it) before going through the Kreb's cycle.

Kreb's cycle is also called the citric acid cycle. It involves the formation of citric acid molecule (a six carbon) from the two carbon molecule by addition of a four carbon molecule, i.e. **oxaloacetic acid in a cyclic process.**

Kreb's cycle takes place inside the cristae of the **mitochondria**.

Anaerobic respiration

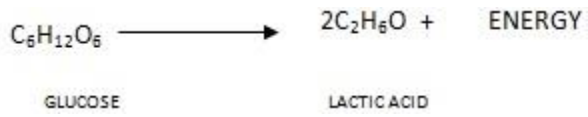
Anaerobic respiration takes place in the absence of [oxygen.

In plants, anaerobic respiration is also called fermentation. It involves the breaking down of glucose by bacteria or fungi to form alcohol, carbon dioxide and energy. This is represented by the following equation:

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + \text{ENERGY}$$

GLUCOSE ETHANOL CARBON DIOXIDE

In animals, anaerobic respiration leads to the formation of lactic acid and energy. This is written as



In animals anaerobic respiration takes place during strenuous activity, for example during sports. It leads to the accumulation of lactic acid in the muscles. Lactic acid is toxic.

Anaerobic respiration occurs when the body's oxygen supply does not meet the body's needs. Therefore, an oxygen debt or oxygen deficit occurs. This causes the animal to breathe fast and deeply in order to get enough oxygen to convert the lactic acid to carbon dioxide and water. Some of the lactic acid is converted to glucose. Breathing goes back to normal when the acid has been broken down.

Anaerobes are organisms that respire anaerobically. They include bacteria, yeast and fungi. There are two types of anaerobes:

Obligate anaerobes which can only live and respire in the absence of oxygen. They die in the presence of oxygen.

Facultative anaerobes; which respire both in the presence and in the absence of oxygen

Differences between aerobic and anaerobic respiration

Aerobic respiration	Anaerobic respiration
1. Oxygen is used	1. Oxygen is not used
2. Large amounts of energy are produced	2. Small amount of energy are produced
3. Water molecules are produced	3. Water is not produced
4. Food substances are completely broken down	4.Food substances are not completely broken down
5. Takes place in the mitochondria and cell membrane	5.Takes place in the cytoplasm
6. Carbon dioxide and water are the end-products	6. Lactic acid is produced in animals and alcohol is produced in plants

Factors affecting the rate of respiration

The rate at which respiration takes place varies depending on the state of an organism. Hence, respiration is sometimes fast and at other times slow. The following factors affect the rate of respiration:

Temperature

Respiration is controlled by enzymes. The functioning of enzymes is affected by temperature. The rate of respiration is slow at low temperatures and increases with increase in temperature until the optimal temperature. Optimal temperature is the temperature at which the enzymes function best. If the temperature is raised above optimal temperature, the enzymes are denatured and the rate of respiration reduces.

Activity

When an organism is involved in a vigorous activity, it requires more energy than when it is at rest. For example, a human being requires less energy when sitting than when taking part in arace. Therefore, the rate of respiration changes to suit the needs of the organism's physical activity.

Size

Small organisms lose heat faster than big organisms. This is because small organisms have a larger surface area to volume ratio. Heat is a form of energy. Therefore, small organisms need to respire faster than large organisms to replace the energy lost through heat.

Age

Generally, young organisms respire faster than older organisms. This is because they need energy to grow. In addition, young organisms are more active than old organisms.

Health

When we are sick, the rate of respiration increases so as to remove the toxic materials produced by the pathogens in our bodies.

Infections and diseases of the respiratory system

There are several airborne infections which affect the human respiratory system. The common ones are influenza, pneumonia, common cold and tuberculosis.

Most of the airborne infections are as a result of close contact with an infected person. When the sick person breathes out, coughs or sneezes, the pathogens are released into the air. Hence, a person who is close by may catch the infection. Sometimes, droplets may infect bedding, clothes and surfaces used by the sick person.

Airborne infections can be controlled by isolation of the infected patient, proper disposal of infected secretions such as sputum, living in a well-ventilated house and avoiding overcrowding, especially in bedrooms.

Pneumonia

Pneumonia is inflammation of the lungs. It is caused by bacteria, viruses, fungi or by inhaling chemical toxins or irritants. Pneumonia is normally followed by other illnesses such as cold or flu.

Signs and symptoms of pneumonia

- Fever
- Chills
- Shortness of breath associated with pain
- Increased mucus production
- Cough

Prevention and treatment of pneumonia

- Staying warm
- Avoiding overcrowded areas
- Avoiding cold food or drinks. Hot drinks are preferred more as they loosen secretions
- Get treatment as early as possible since it is curable by antibiotics

Bronchitis

Bacteria, viruses and inhaling of irritating substances can cause the lining of the respiratory system to become inflamed. This causes an infection called bronchitis. Bronchitis can be acute or chronic.

Acute bronchitis

This is caused by whooping cough or recurrent attacks of influenza. Smoking can also cause acute bronchitis.

Signs and symptoms of acute bronchitis

- Pain in the chest
- Rapid breathing
- Fever
- Coughing
- Headaches

Prevention and treatment of acute bronchitis

- Staying warm. Cold temperatures make the body more susceptible to bacterial infections
- Get treatment for all infections as fast as possible

Chronic bronchitis

Chronic bronchitis is caused by heavy smoking and recurrent acute bronchitis.

Signs and symptoms of chronic bronchitis

- Coughing, with the production of thick sputum
- Breathing difficulties

Prevention and treatment of chronic bronchitis

- Avoid smoking
- Avoid very smoky or dusty areas
- Live in a well-ventilated house
- Keep your body warm
- Seek medical help

Asthma

Asthma can be caused by:

- Allergic reactions to dust, pollen, spores oranimal fur
- Hereditary diseases of the respiratory system
- Extremely cold weather
- Frequent viral or bacterial lung infections

Signs ***and symptoms of asthma***

- Narrowing of bronchioles resulting in breathing difficulties and a wheezing or hissing sound when breathing
- Excessive production of mucus
- Dilation of blood vessels, leading to low bloodpressure. Low blood pressure can be fatal

Prevention and treatment of asthma

- Avoid allergens (things that cause allergicreactions)
- Get treatment for respiratory infections asearly as possible
- Keep the body warm
- Muscle relaxants in the form of sprays, pills and injections are used to prevent the narrowing of the bronchioles.

Lung cancer

The main cause of lung cancer is smoking. The nicotine in cigarette smoke stops the cilia in the trachea from expelling foreign materials leading to respiratory infection.

Signs and symptoms of lung cancer

- Chest pain
- Breathing difficulty
- Weight loss
- Persistent cough
- Abnormal production of mucus

Prevention and treatment of lung cancer

- Stop smoking
- There is no cure for cancer. However, chemotherapy and physiotherapy are used to control the disease

Emphysema

This is a lung disease which results from destruction of the structures supporting the alveoli leading to their collapse. This significantly reduces the surface area available for gaseous exchange.

Causes of emphysema

- Mainly cigarette smoke
- Air pollution
    - Hereditary
    - Old age

Signs and symptoms of emphysema

- Shortness of breath
- Coughing
- Obstructive lung disease
- Difficulties when breathing, especially duringexercise
- Wheezing during breathing

Prevention and treatment of emphysema

- Avoid cigarette smoking and exposure to smoke
- Lung surgery is usually done to relieve thesymptoms
- Use of medical drugs
- In severe cases, lung transplant is necessary

Chapter Summary:

1. Gaseous exchange is the exchange of oxygen and carbon dioxide through a respiratory surface.
    2.
    - thin membrane
    - large surface area
    - moist lining
    - Dense network of capillaries.Features of a gaseous exchange surface are:
3. The structures involved in gaseous exchange in mammals are the nose, mouth, pharynx, glottis, trachea, lungs, bronchioles, alveoli, ribs, pleural membranes and diaphragm.
4. Gaseous exchange is affected by the amount of haemoglobin in the blood and carbon dioxide concentration.
5. In plants, gaseous exchange can take place through the stomata in the leaves, lenticels in woody stems or in breathing roots.
6. Respiration is the process by which food substances are broken down to release energy.

7. Aerobic respiration takes place in the mitochondria in the presence of oxygen
8. Aerobic respiration involves two stages: glycolysis and Kreb's cycle.
9. Anaerobic respiration takes place in the cytoplasm in the absence of oxygen.
10. Diseases and infections that affect the respiratory system include bronchitis, asthma, pneumonia, tuberculosis, and emphysema and j influenza.