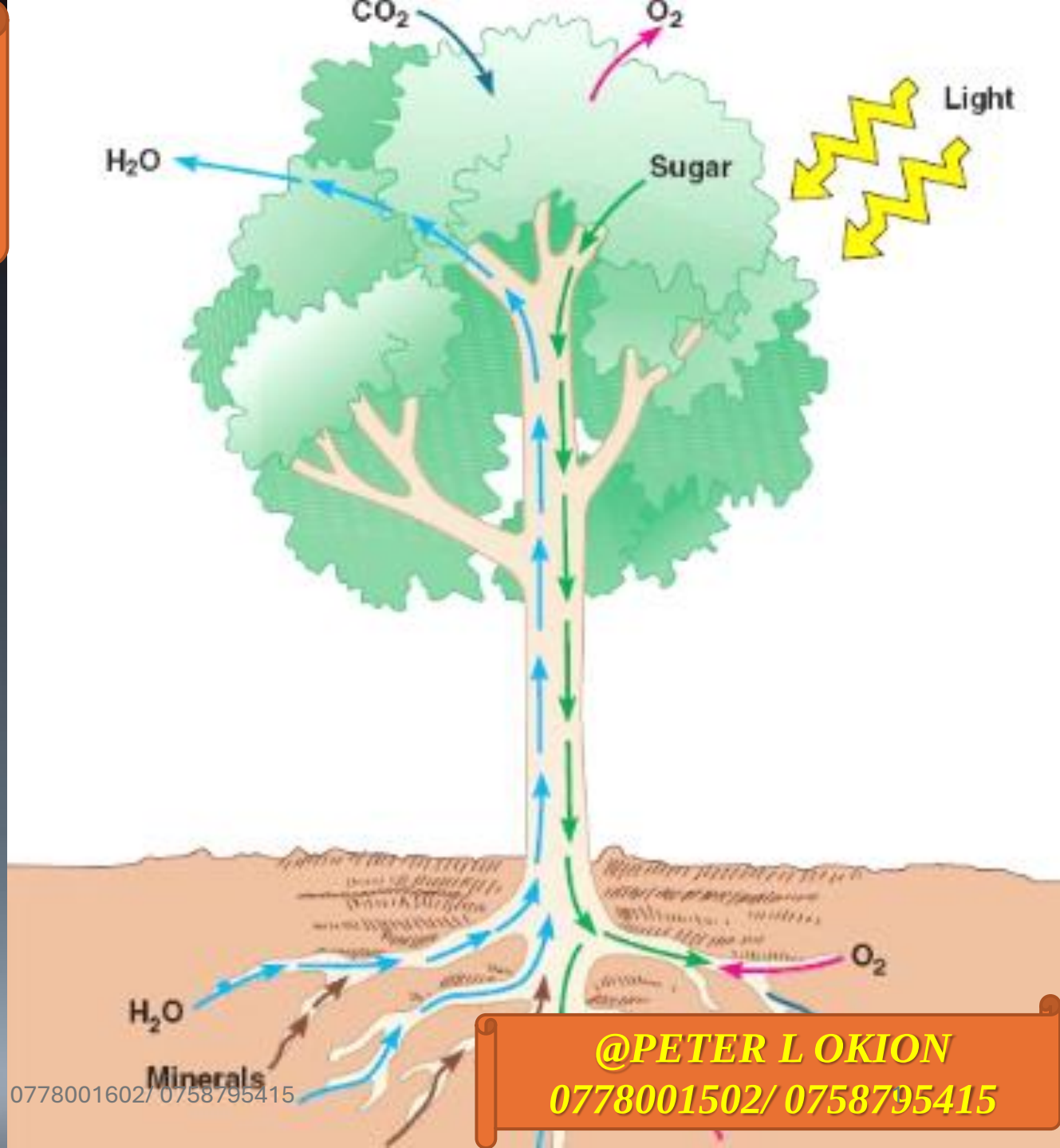
TRANSPORT



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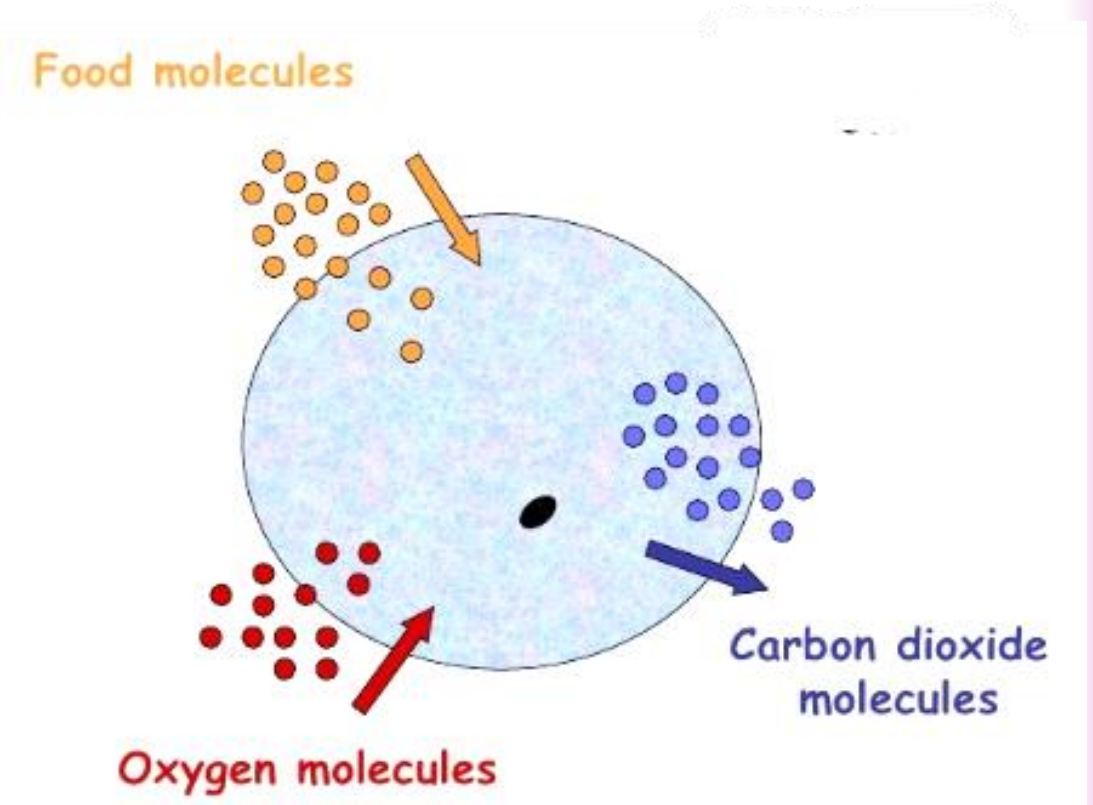
Movement of materials in and out of cells

The functional unit of all living organisms is known as a **Cell**.

For life of a cell to be maintained, the cell takes in essential substances called **Metabolites** to carry out metabolism and also takes out waste materials of metabolism.

This exchange of materials occurs by different mechanisms.



Mechanisms by which cells of organisms exchange materials

Materials move in and out of cells in two ways;

By active transport.

Involves use of Energy to move materials against their concentration gradient (from a region of Low concentration to a region of a High concentration)

By Passive transport i.e. osmosis and diffusion.

Involve No use of energy to move materials since they are moved down a gradient (from a region of a High concentration to a region of a Low concentration)

Diffusion

This is the net movement of substances from a region where their concentration is high to a region where their concentration is low.

Diffusion is only used during movement of small molecules of gases and liquids and some charged particles known as ions and only takes place where there is a difference in concentration of a substance/material.

This is known as concentration gradient.

Therefore, during Diffusion, molecules move along/down a concentration gradient

For-example consider a **Tea bag** placed into warm water as shown below

It will be observed that the water after some time turns brown.

Explanation

The tea molecules moved by diffusion from the tea bag, where they are at a high concentration into the warm water where they are at a low concentration hence making the water brown.

Factors which affect the process of diffusion

Temperature

Increase in temperature increase the rate of diffusion due to an increase in the Kinetic energy of the diffusing molecules making them to move faster.

Size of diffusing molecules

The smaller the molecules, the faster the rate of diffusion.

The larger the diffusing particles, the slower the rate of diffusion.

For example, molecules of glucose (monosaccharide) diffuse faster than those of starch (polysaccharide).

Distance over which diffusion occurs

The Shorter the distance between two regions over which diffusion has to occur, the faster the rate of diffusion.

This explains why leaves have thin laminas and also walls of villi are thin.

Surface area over which diffusion occurs

The Larger the surface area over which diffusion is to take place, the faster the rate of diffusion.

Concentration gradient

Concentration gradient is the difference in concentration between the two regions where diffusion is to take place.

The higher the concentration gradient between two regions, the faster is the rate of diffusion.

Importance or significance of diffusion in living organisms

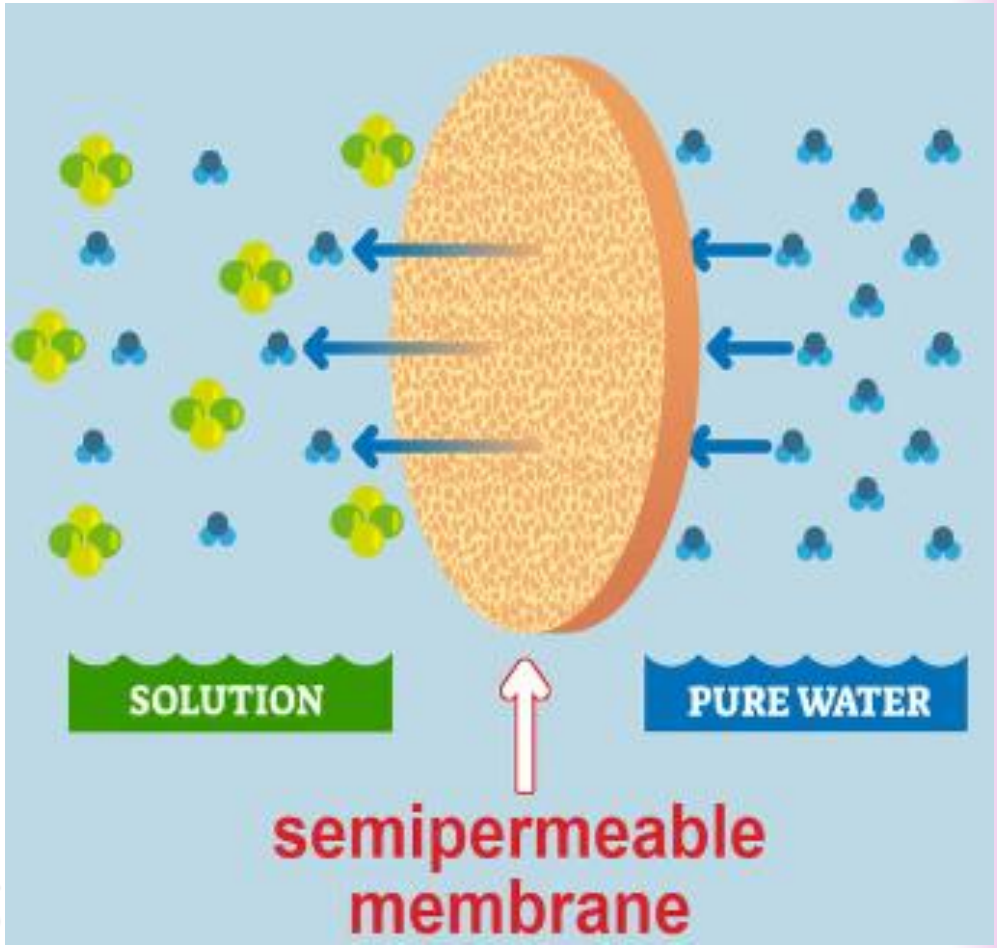
- ✓ Root hair cells of plants absorb mineral salts from the soil by diffusion.
- ✓ Unicellular organisms like an amoeba exchange gas with the surrounding water across the cell membrane by diffusion.
- ✓ Digested food such as glucose, vitamins enter the blood from the ileum by diffusion.
- ✓ Gaseous exchange in lungs of mammals and gills of fish occurs by diffusion.
- ✓ Waste products of metabolism such as urea, carbon dioxide diffuse out of animal cells into blood by diffusion.

Osmosis

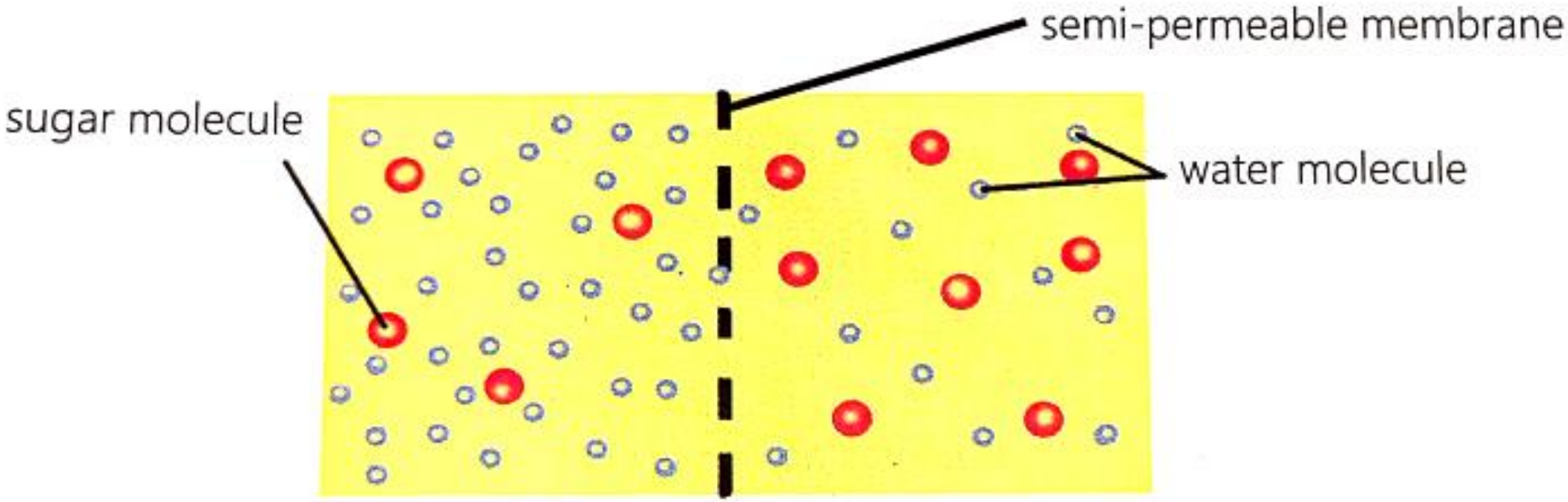
Osmosis is the Net movement of Water molecules from a region of their High concentration to a region of their Low concentration across a **Semi permeable membrane.**

In simple terms, osmosis refers to the diffusion of water molecules.

NB: Semi/partially/selectively permeable membrane is one which allows passage of some molecules and prevents passage of other molecules for example Visking tubing



Illustration



Solution A

- less concentrated
- more water molecules
- hypotonic

Solution B

- more concentrated
- less water molecules
- hypertonic

water moves in this direction

Definitions of terms related to osmosis

Hypotonic solution.

This is a solution with a Higher concentration of water molecules than another solution. It is also referred to as a Dilute solution or one having more water molecules than solute molecules.

Hypertonic solution.

This is a solution with a Lower concentration of water molecules than another solution. It is also referred to as a Concentrated solution or one having more solute molecules than water molecules

Isotonic solution.

Is one with the Same solute concentration as another solution.

An experiment to investigate the effect of solutions A, B and C on the length or texture of tissues from an Irish potato

List of requirements

Cork borer
large Irish potato,
Knife/Razor blade,
Ruler
Stop clock
Boiling/Test tubes/petri dishes,
Labels
Beakers
solutions A, B and C

Procedure

i. Using a cork borer, 3 tissues cylinders are obtained from the Irish potato and then trimmed using a razor blade and a ruler to a length of 3cm.

ii. Three test tubes are labelled A, B and C respectively then a cylinder is then added to each of the test tubes labelled A, B and C.

iii. $6cm^3$ of solutions A, B and C was then added to the corresponding test tubes labelled A, B and C respectively.

iv. The cylinders are left to stand in the solutions for 40 minutes

v. After 40 minutes, the cylinders are removed from the solutions and then their New length measured using a ruler. The cylinders are also felt between fingers to determine their Texture.

Observation and results

Solution	Initial length (cm)	Final length (cm)	Difference in length (cm)	Texture
A				
B				
C				

Explanation or Discussion or Interpretation of results

Significance/importance of osmosis

In Plants

- ✓ Facilitates absorption of water by **Root hair cells** from the soil.
- ✓ **Imbibition**/uptake of water through the **Testa** by germinating seeds.
- ✓ Facilitates opening and closing of **Stomata** of some species. When the guard cells taken in water by osmosis, they expand and become turgid hence opening the stomata.
- ✓ Facilitates opening of **Flowers** of some species when the cells in the flower taken in water by osmosis and become turgid.
- ✓ Uptake of water by osmosis into the cells in the stem results into **Support** in non-woody or herbaceous plants such as tomatoes, Amaranthus.

In Animals

- ✓ Reabsorption of water into the blood stream across the **Kidney tubules.**
- ✓ Enables absorption of water from the **Gut** into the blood stream.

Active transport

This is the Net movement of materials/substances from a region of their Low concentration to a region of a High concentration using Energy from a cell.

During active transport, materials are moved Against their concentration gradient.

This process therefore will involve use of energy derived from Respiration and Transport proteins within the cell membrane.

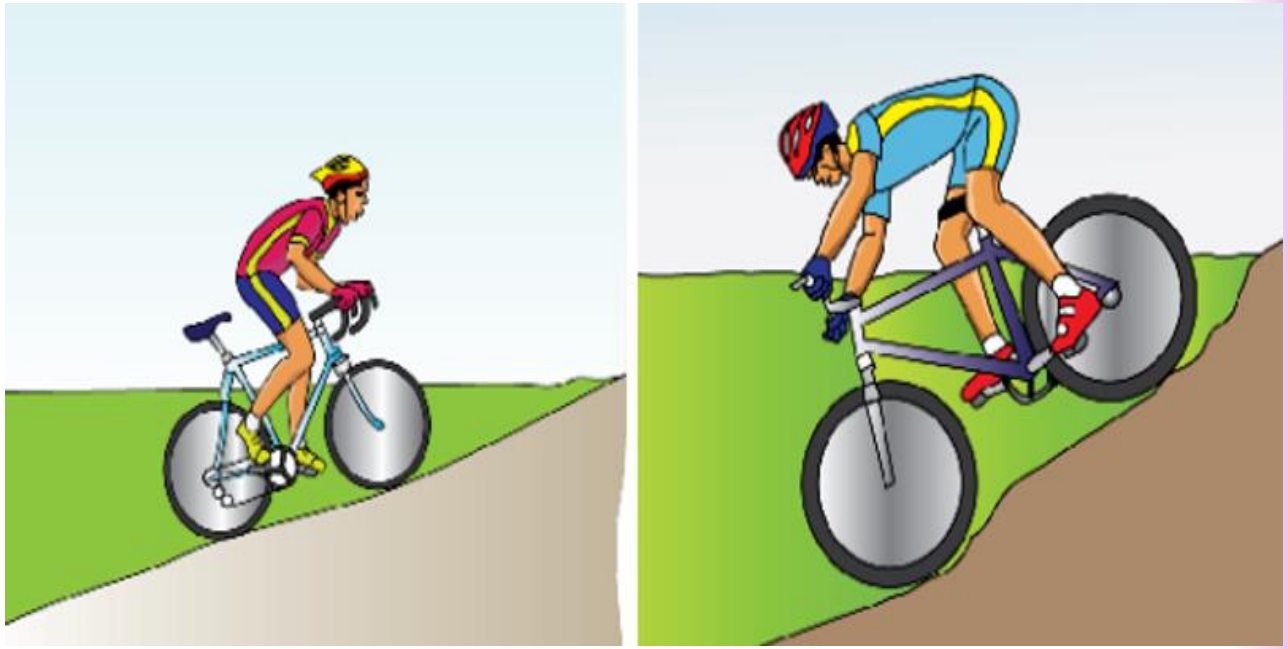
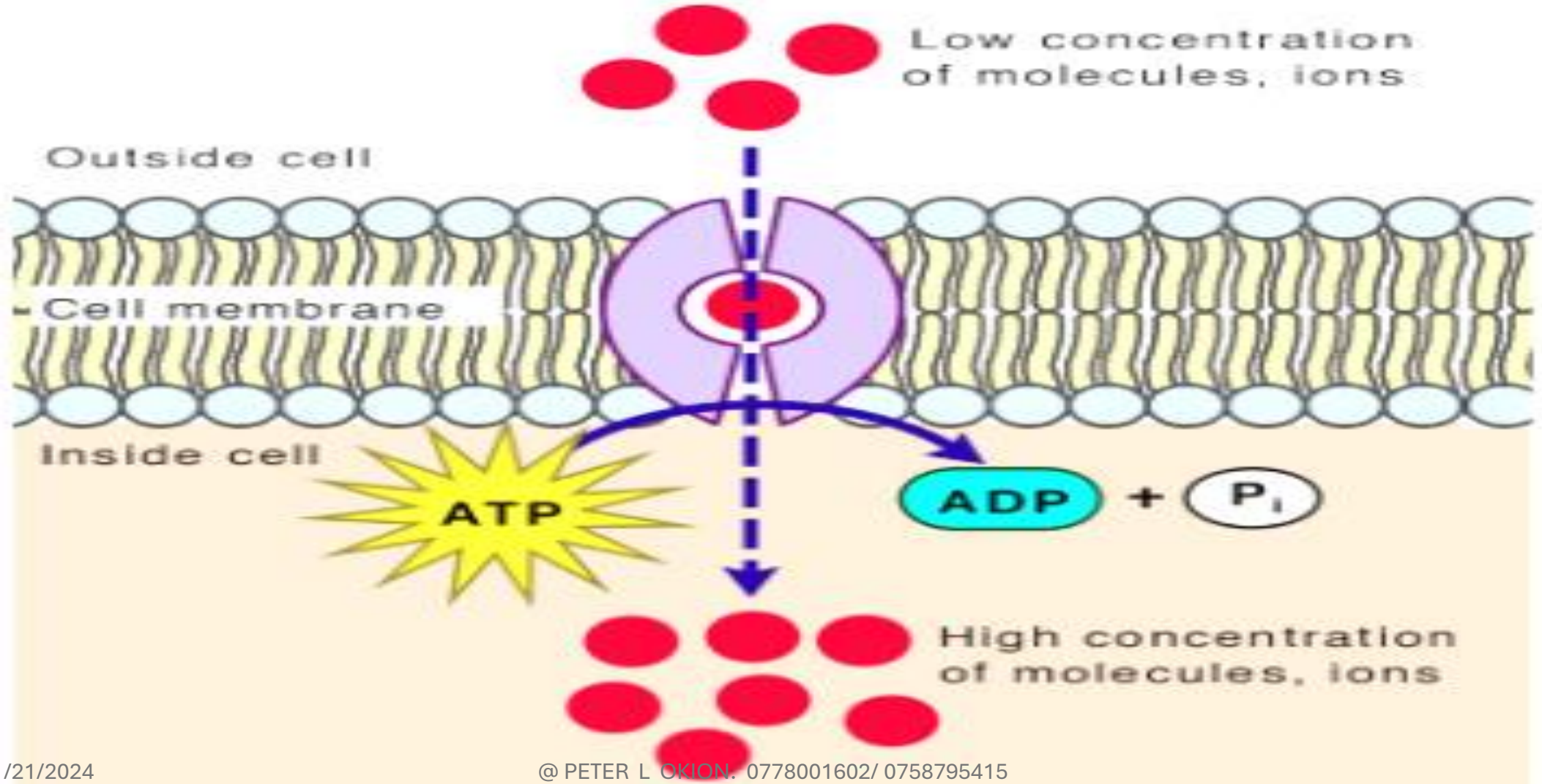
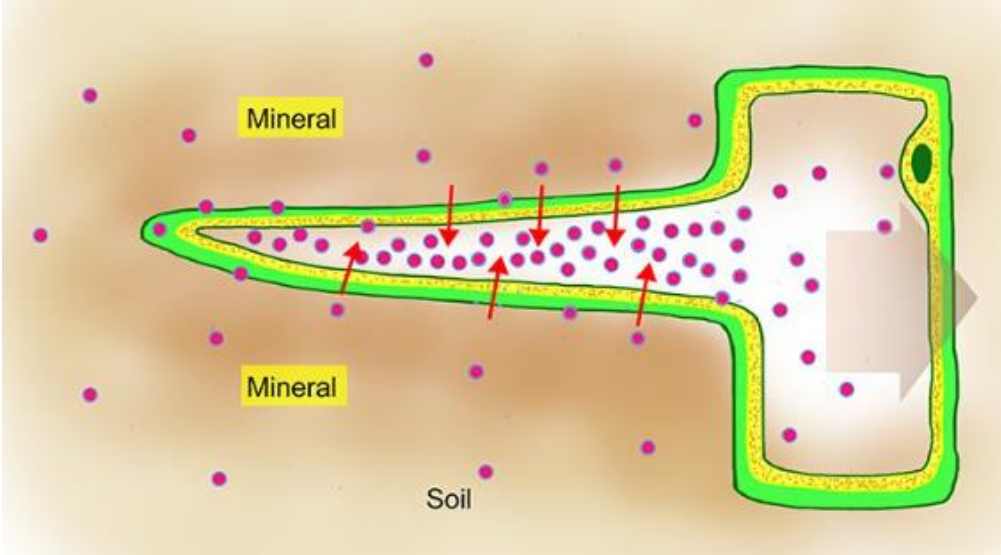


Illustration of the process of Active Transport



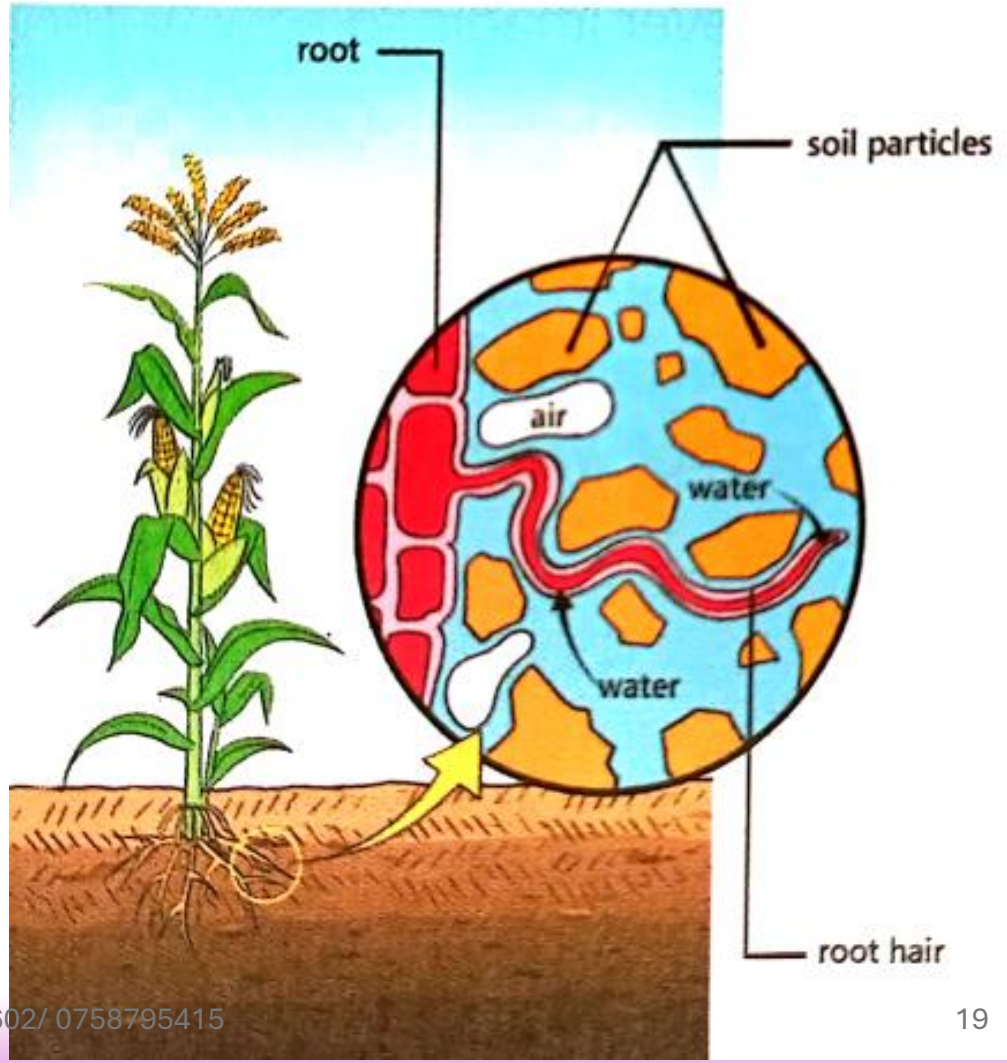
Importance of active transport in living organisms

- ✓ Facilitates absorption of mineral salts by root hair cells from the soil.
- ✓ Enables absorption of glucose from the ileum into blood
- ✓ Reabsorption of useful substances such as glucose, amino acids, salts from the kidney nephron back into blood
- ✓ Exchange of ions during transmission of nerve impulses.
- ✓ Secretion of hormones from glands into blood stream

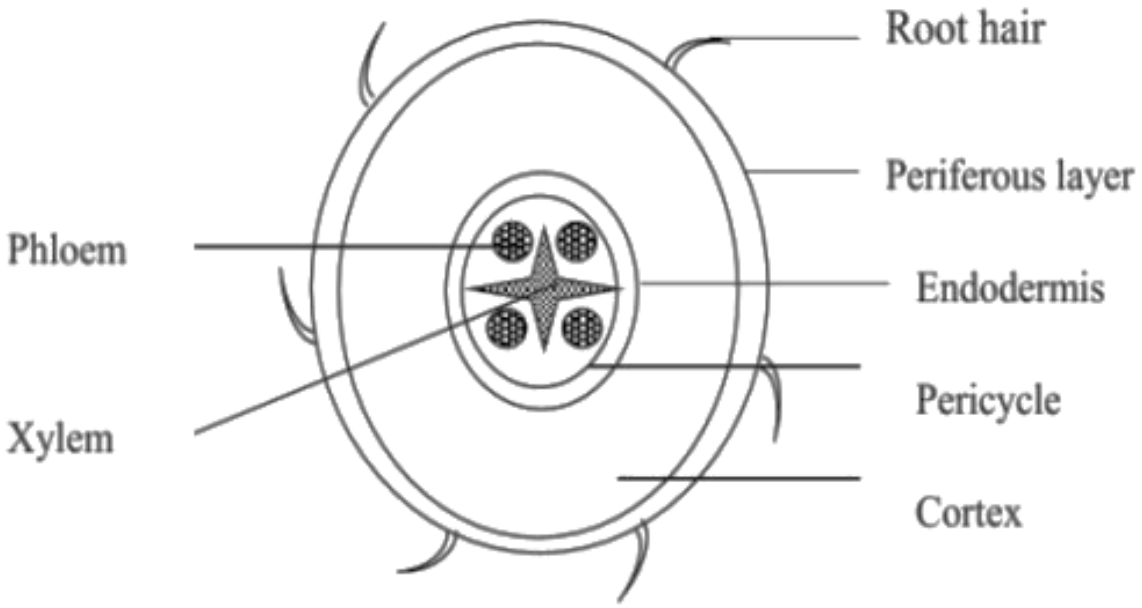


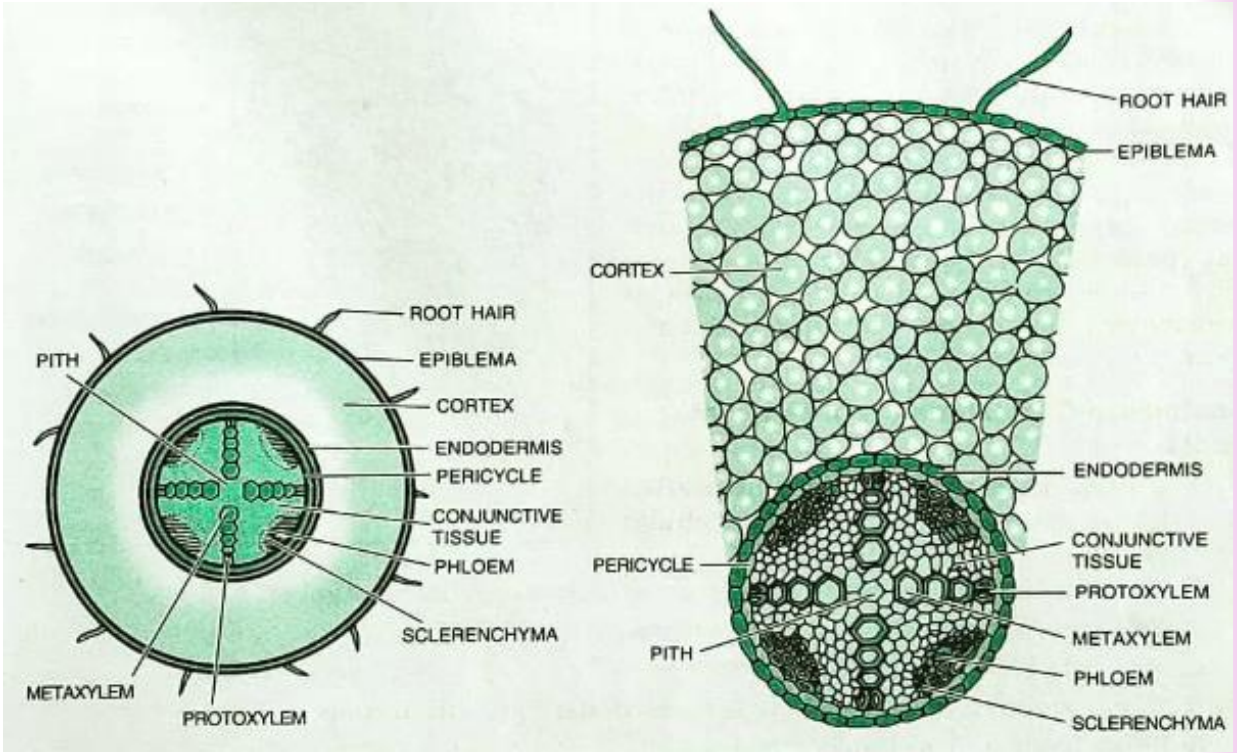
Absorption and Translocation of water and mineral salts in a plant

Plants absorb water and dissolved mineral salts from the soil by osmosis using their Root hair cells.



Drawing showing the transverse section of a dicot root



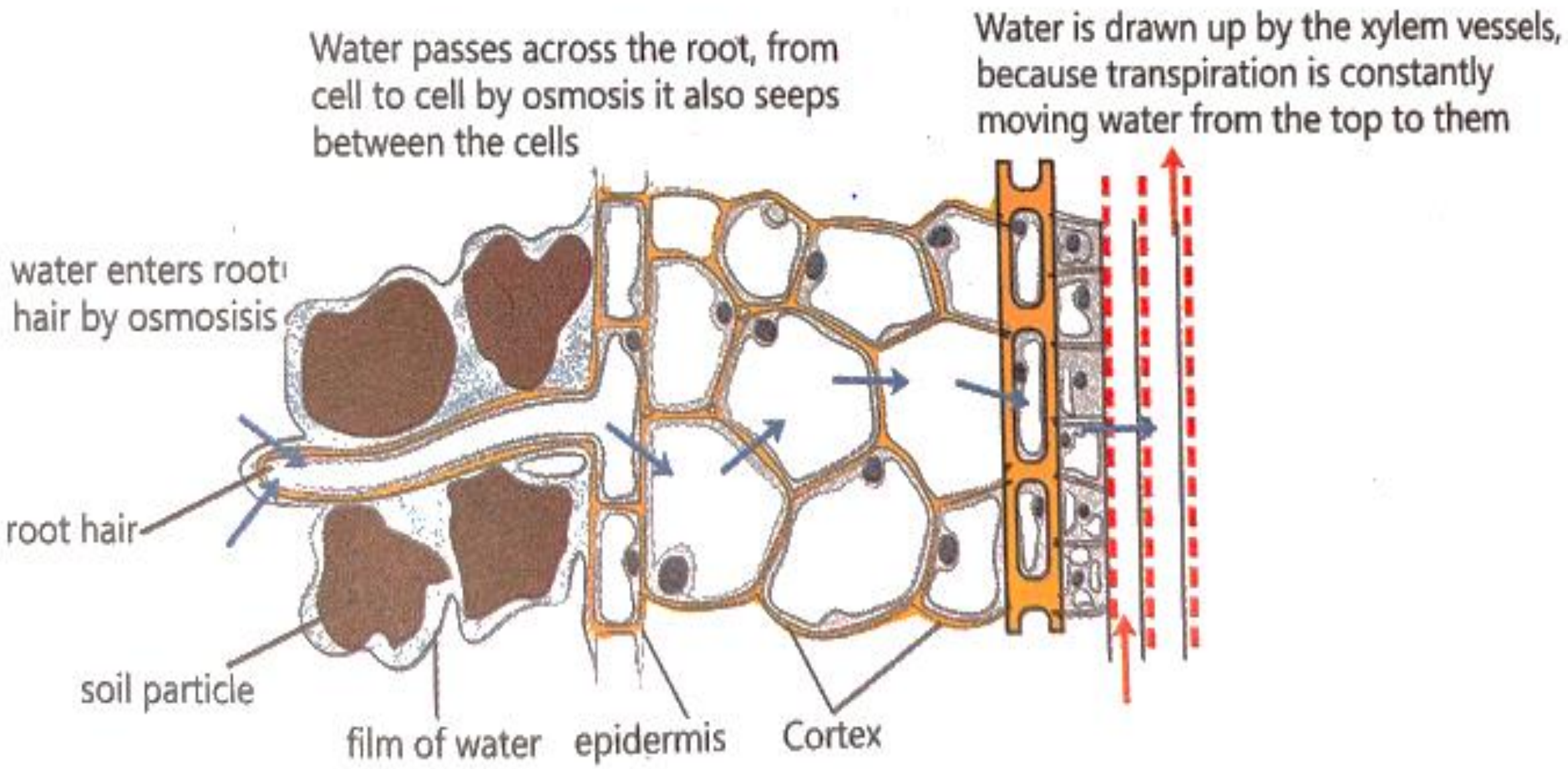


Movement of water from the soil into the root cells and its movement up the Stem of a plant

The Cell sap of the root hair cells has is more concentrated than the soil solution that surrounds the root hair cells. This allows water to move from the soil into the root hair cells by Osmosis.

Entry of water into the root hair cells increases their concentration of water molecules above that of the neighbouring cells in the Cortex of the roots. This facilitates movement of the water by osmosis from the root hair cells into the cortex cells

Water then leaves the cortex cells and enters the cells of the Endodermis by osmosis, and then into the Xylem vessels by osmosis.


Water passes across the root, from cell to cell by osmosis it also seeps between the cells
Water is drawn up by the xylem vessels, because transpiration is constantly moving water from the top to them
water enters root hair by osmosisis
root hair
soil particle
film of water
epidermis
Cortex

From the xylem vessels, water moves the stem of a plant to the leaves as a result of three forces.

Transpiration pull

Evaporation of water from the leaves of a plant by transpiration exerts a Pulling force that moves water from the xylem of the roots up the stem to replace the lost water.

Cohesion

These are forces of attraction between molecules of the same substance. The strong forces of cohesion between water molecules enables water to move within the xylem vessels in a continuous column.

Adhesion

Forces of attraction between water molecules and the xylem vessels. It enables water molecules to move up the stem along the walls of the xylem vessels.

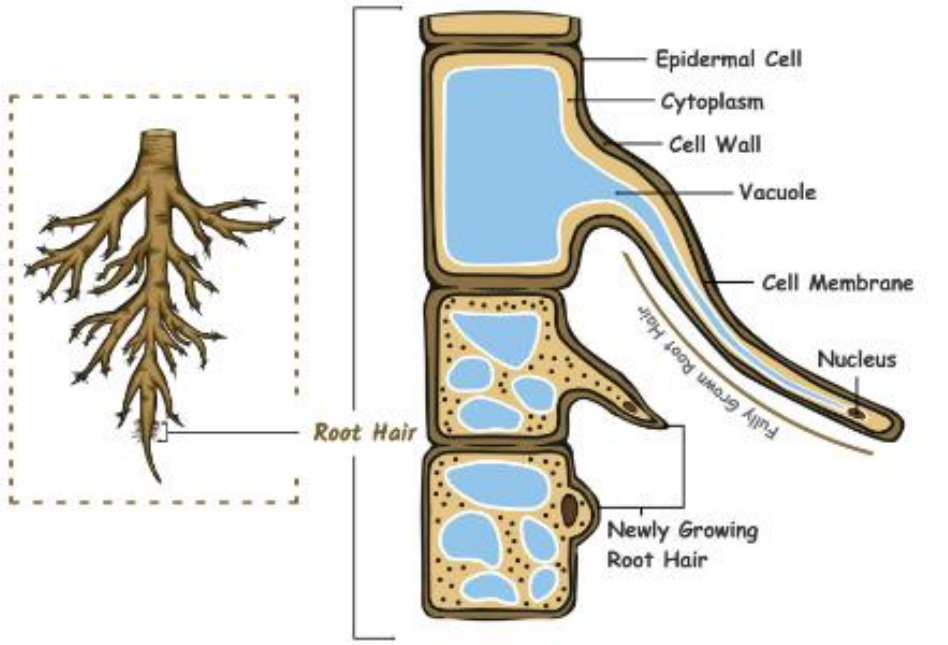
Capillarity

This is the ability of water to move up a fine/narrow tube.

Xylem vessels are very fine tubes which allows water molecules to move up the stem by forces of capillarity

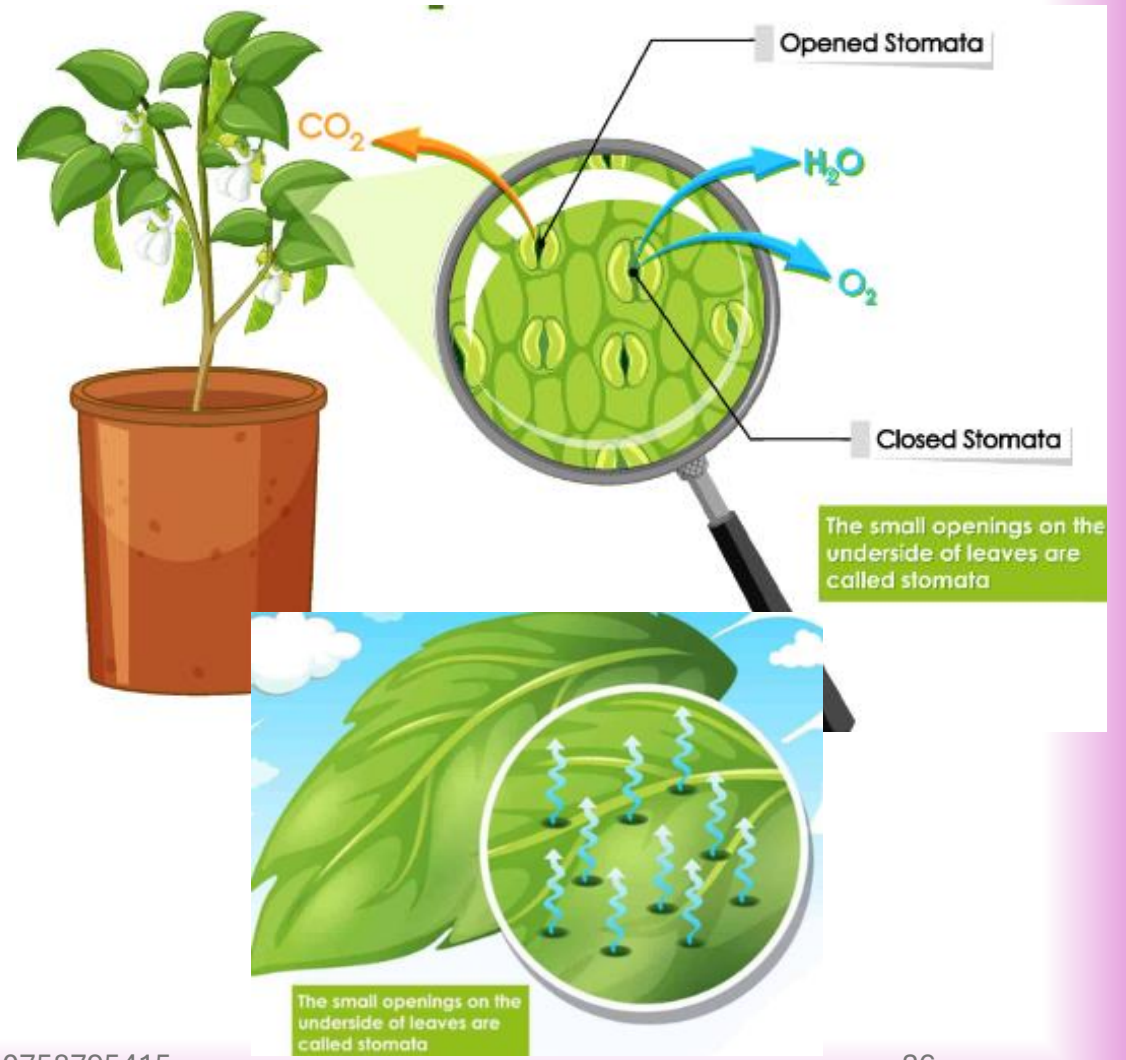
Adaptations of the root hairs for absorption of water and mineral salts from the soil

- ✓ Root hairs are **slender** and **flexible** hence easily penetrate between the soil particles to absorb the water from the spaces.
- ✓ They are **numerous** (**many**) presenting a large surface area over which water absorption takes place.
- ✓ **Long** to absorb water from deeper soil layers
- ✓ **Lack a cuticle** hence are freely permeable to water molecules.
- ✓ Have a **Thin** membrane to reduce the distance for entry of water by osmosis



Transpiration

This is the evaporation of water from the aerial parts (shoot) of the plant to the atmosphere.



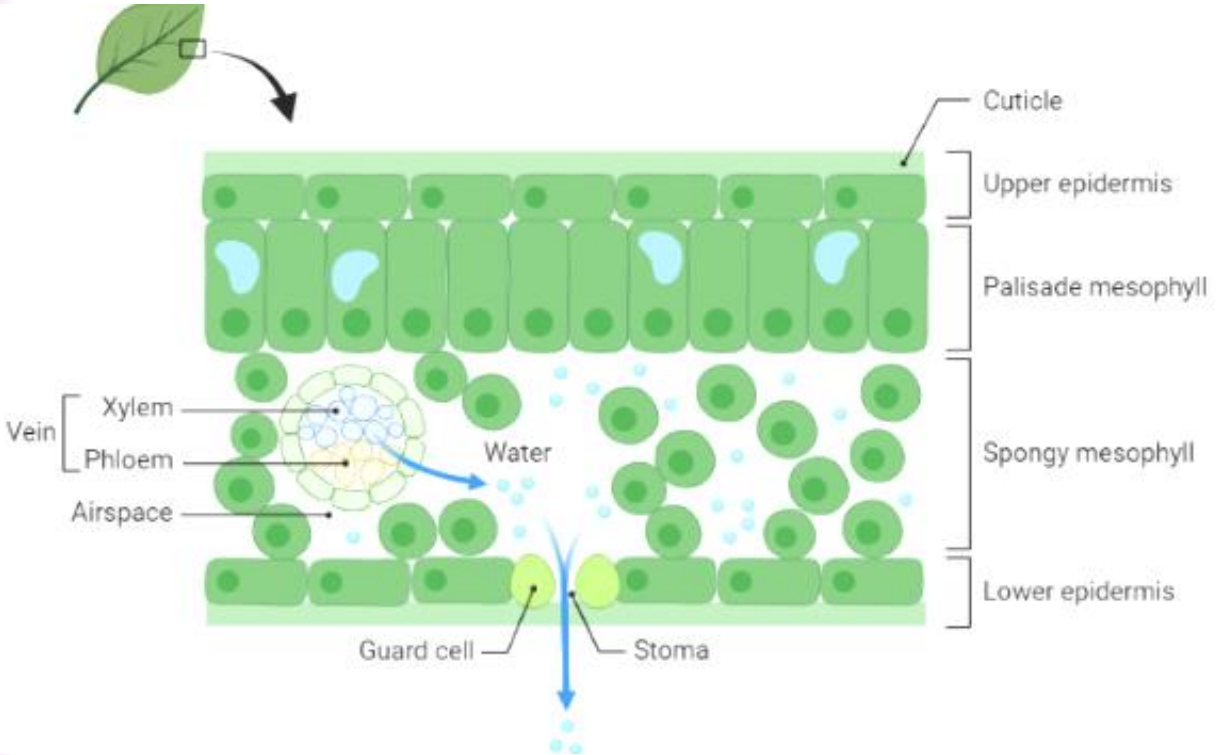
Types of transpiration

Stomatal transpiration.

This is the evaporation of water through stomata found in the epidermis of leaves.

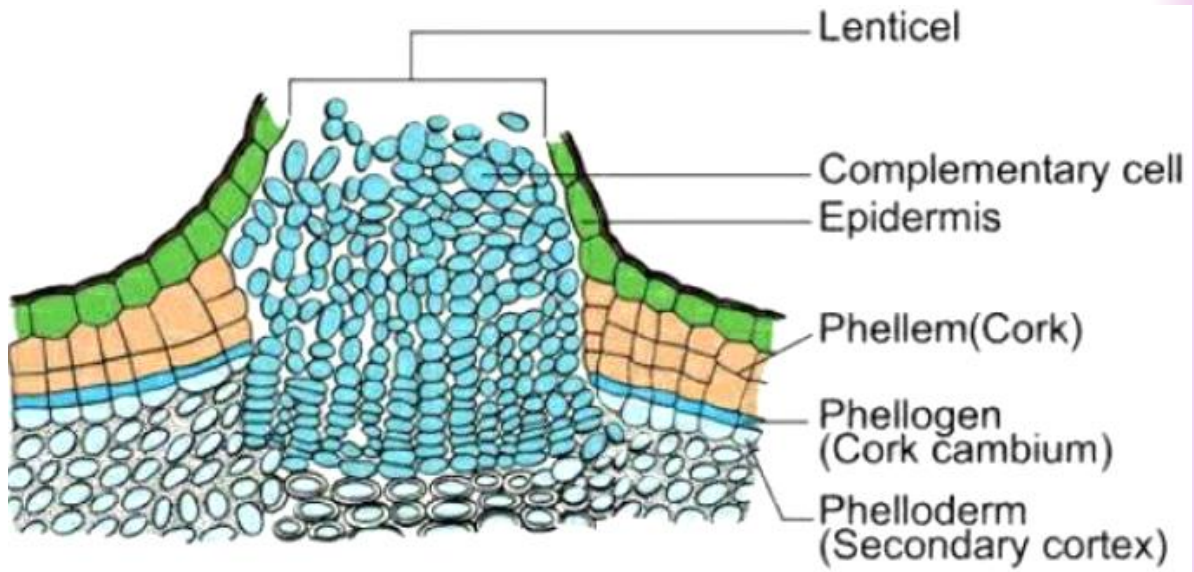
Cuticular transpiration.

The loss of water by evaporation through the cuticle of the leaf or stem epidermis



Lenticular transpiration.

Water is lost by evaporation through small slits called lenticels which are found in the bark of stems of woody trees



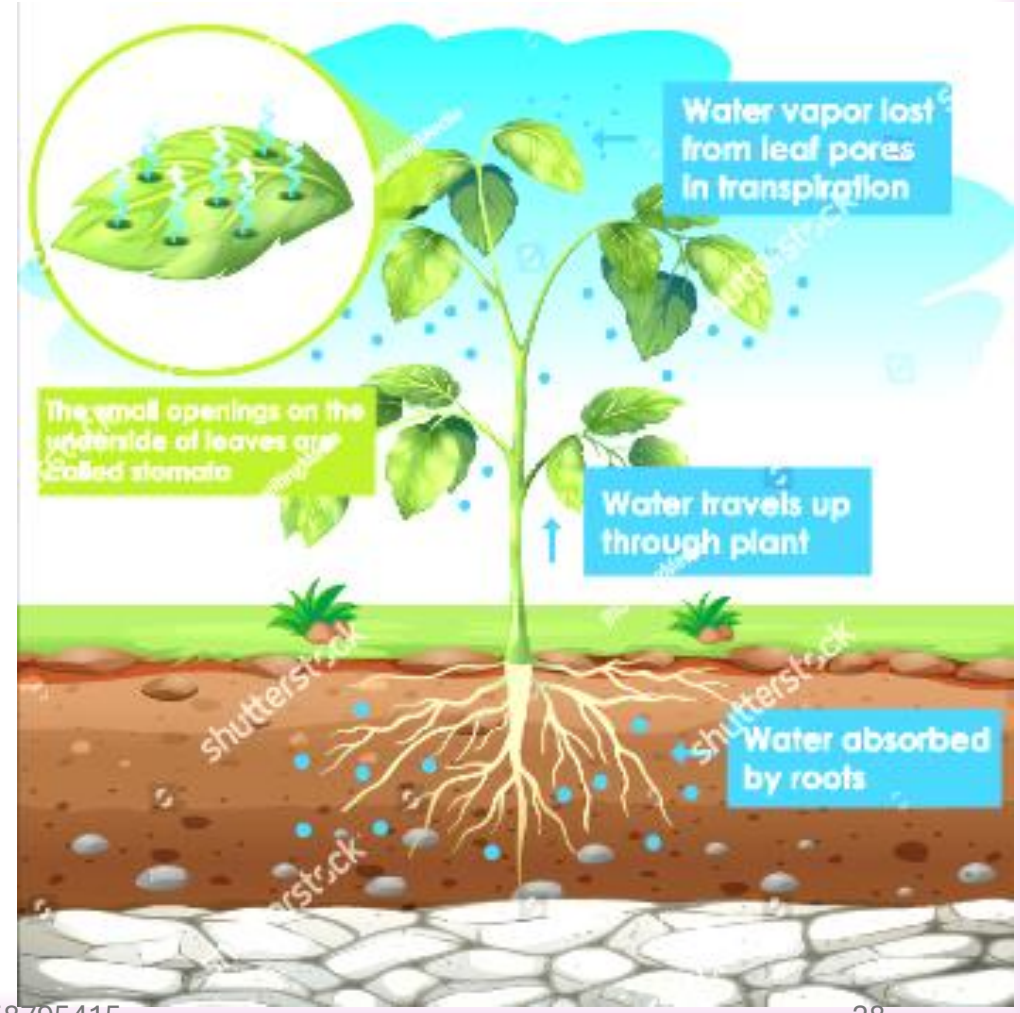
The process of transpiration

Water loss by transpiration occurs in following stages;

i. Water from the roots is brought up to the leaf mesophyll cells through the xylem vessels.

ii. The Heat from the surrounding makes water molecules to evaporate from the moist mesophyll cells into the intercellular spaces of spongy mesophyll cells.

iii. The water vapor then diffuses from the intercellular spaces, through the stomata then into the atmosphere



An Experiment To Show That Water Is Lost During Transpiration

Apparatus

Potted plant,

Polythene bag,

String,

Cobalt (II) chloride paper or Anhydrous Copper (II) Sulphate.

Procedure

Tie polythene around the tin of the potted plant, using a string to avoid evaporation of water from the soil surface.

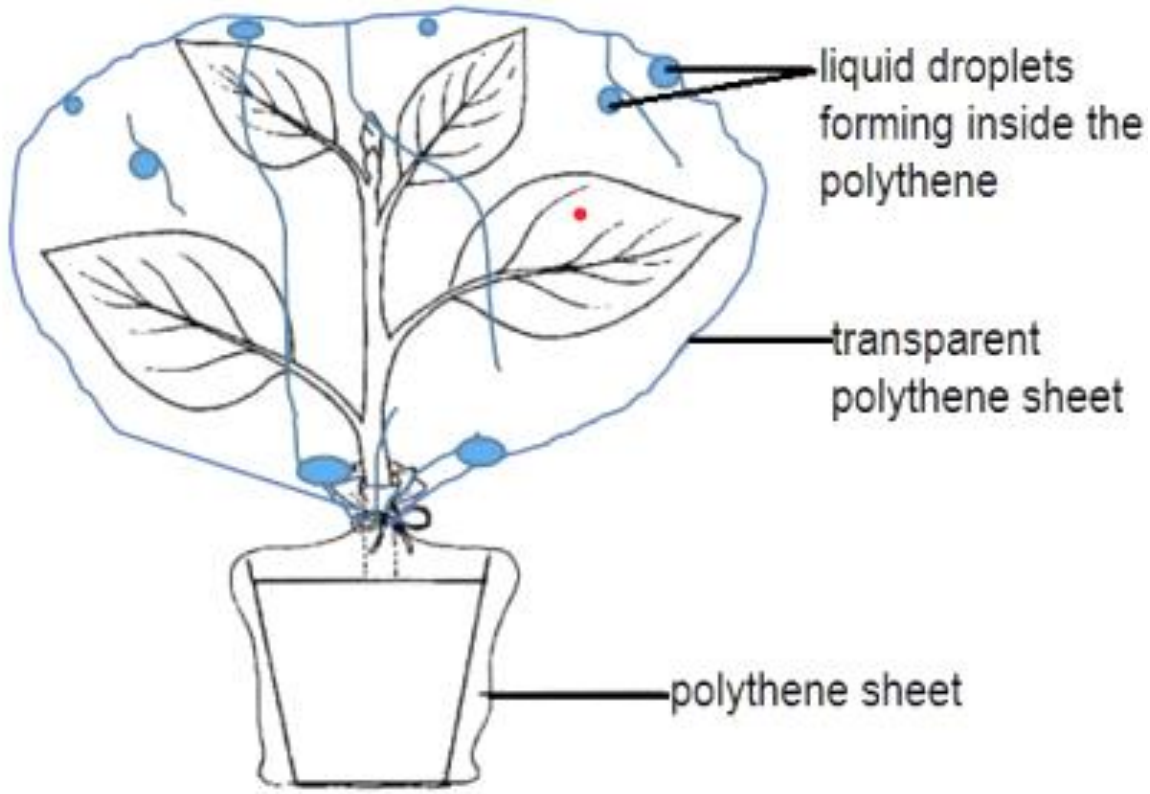
Tie transparent polythene around the leafy shoot of the plant.

Set up another similar control experiment but with leaves removed and dry plant.

Leave the experiment to settle for 3 hours in bright sunlight.

Remove the polythene around the leafy shoot and test the drops of liquid inside the polythene using anhydrous copper (II) sulphate / cobalt (II) chloride paper.

Illustration



Observation

Colorless droplets form inside the polythene which turn anhydrous copper (II) sulphate from White to Blue or Blue cobalt (II) chloride paper to Pink.

No vapor is observed from experiment with no leaves / dry plant.

Conclusion

Water is given off during Transpiration

Factors affecting the rate of transpiration

Temperature

Increase in temperature increases the rate of transpiration due to an increase in the Kinetic energy of water molecules resulting into rapid evaporation of water from the leaf mesophyll cells.

An increase in temperature also reduces the amount of water vapor around the leaf surface and the stomata. This results into rapid evaporation of water from the leaf.

Light intensity

An increase in light intensity increases the rate of transpiration due to increased opening of stomata which provide a large surface area for water loss by transpiration.

Wind speed/velocity

In still air (low wind speed) rate of transpiration Reduces.

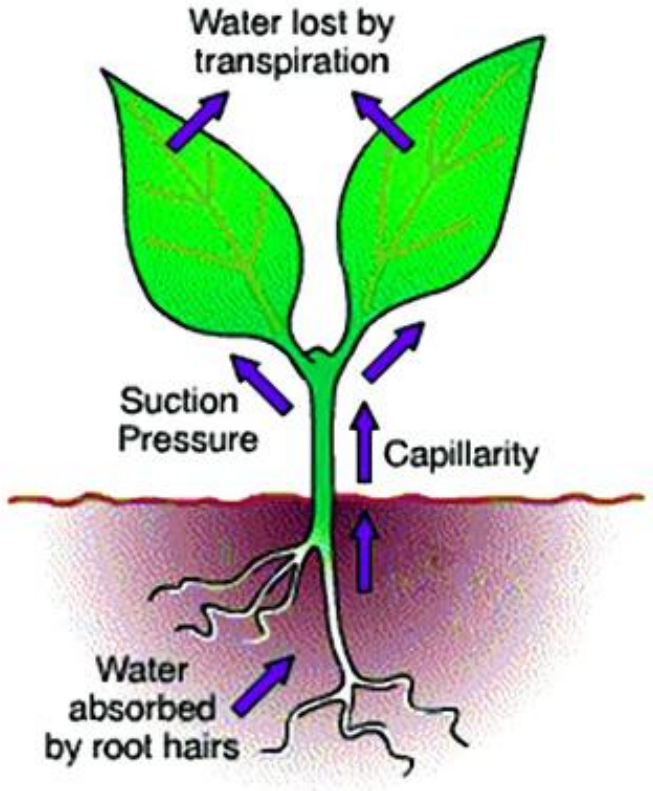
This is because water vapor accumulates onto the surface of the leaf and onto the stomata which reduces the rate of evaporation of water from the leaf.

Under windy conditions, rate of transpiration Increases.

This is because the wind blows away water molecules from the leaf surface. This creates a steep diffusion gradient for water molecules to move from the leaf into the atmosphere.

Importance of transpiration to plants

- ✓ Heat is lost along with the water vapor hence cooling the plant during high environmental temperatures.
- ✓ Transpiration pull facilitates absorption of water and mineral salts from the soil and their movement up the stem of a plant to the leaves.
- ✓ Transported water keeps all plant cells turgid. This keeps leaves, stems in erect positions.



Disadvantages or dangers of transpiration

- ✓ Results into shading of leaves in some plants thus reducing surface area for photosynthesis
- ✓ Excessive water loss from the plant may lead to wilting, drying and even death of the plant. Wilting results into drooping of the plant shoot and closure of stomata.

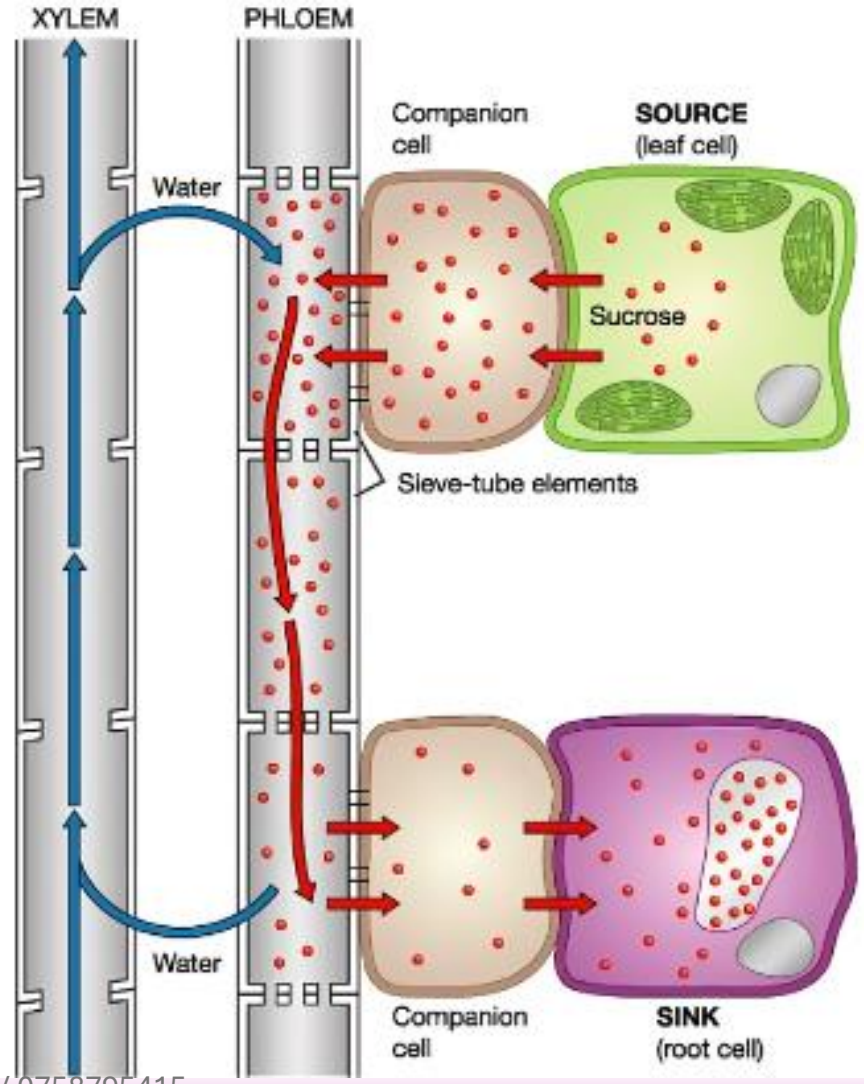
NB:

Wilting results from loss of turgor by cells in the plant body due to excessive loss of water by transpiration.

The drooping of leaves during wilting reduces surface area for trapping sunlight by chlorophyll and also reduces uptake of carbon dioxide a raw material for photosynthesis due to closure of stomata

Translocation of food in plants

This is the process by which food materials synthesized during the process of photosynthesis are transported from the leaves through the **Phloem** to other plant parts for Utilization or Storage.



Fate of translocated food

Food materials translocated to actively growing parts of the plant such as shoot apex, root apex are broken down during the process of respiration to produce energy for growth.

Some food materials are stored within storage organs as starch such as in fruits, root tubers like cassava, stem tubers like Irish potatoes, in leaves for example in leaves of an onion bulb.

Structures involved in translocation

Leaves (source)

These are the source of the food materials.

Transport channels

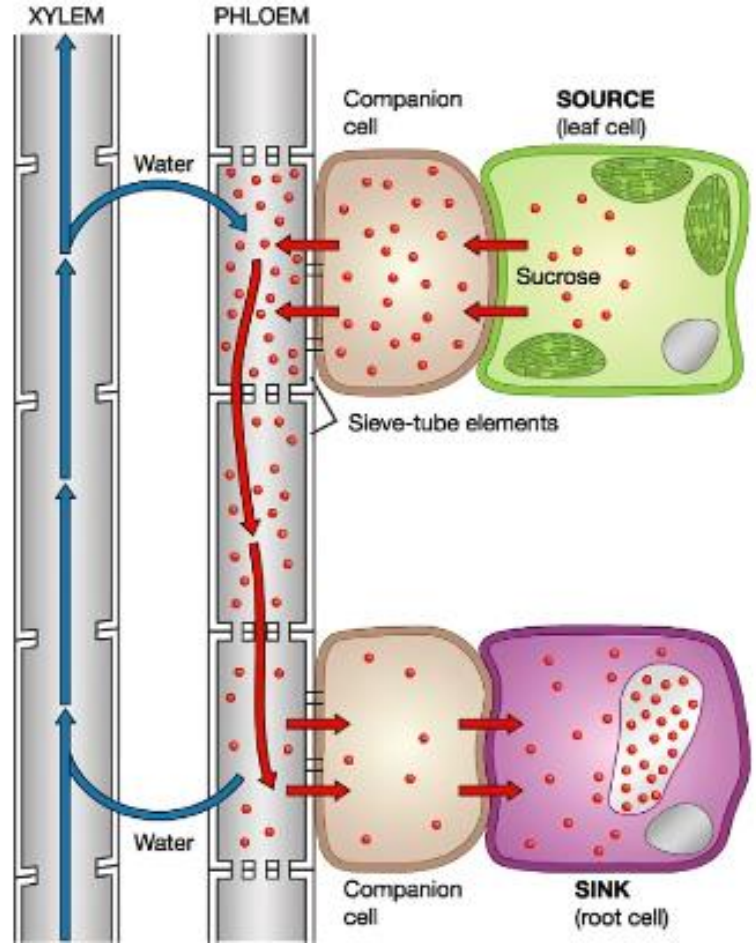
These are the phloem vessels.

Sinks

These are storage organs (stems, roots and some leaves) and points of utilization for the food materials for example actively growing points like shoot apex.

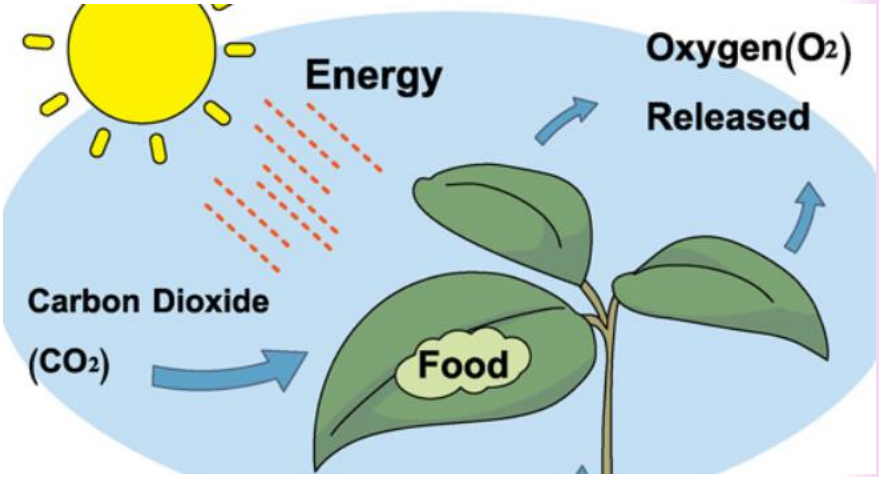
The xylem vessels

The food materials are transported as dissolved solutes in water supplied by the xylem vessels.



Importance or significance of translocation in plants

- ✓ Provides actively growing points such as the shoot apex with food materials that are respired to provide energy for their growth.
- ✓ Manufactured food materials are stored within storage organs for use during adverse/harsh conditions.
- ✓ Water translocated to leaves is used as a raw material for photosynthesis.
- ✓ Mineral nutrients are used for growth of the plant

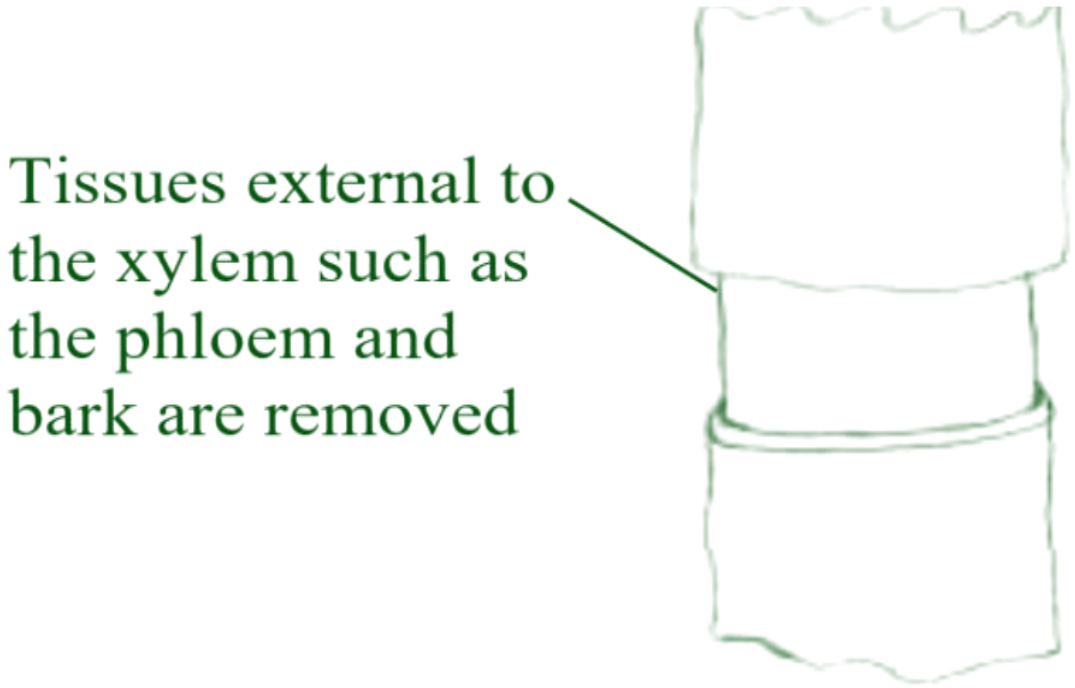


Debarking

This is the process that involves removal of tissues external to the xylem of the stem.

These include the Phloem and Bark.

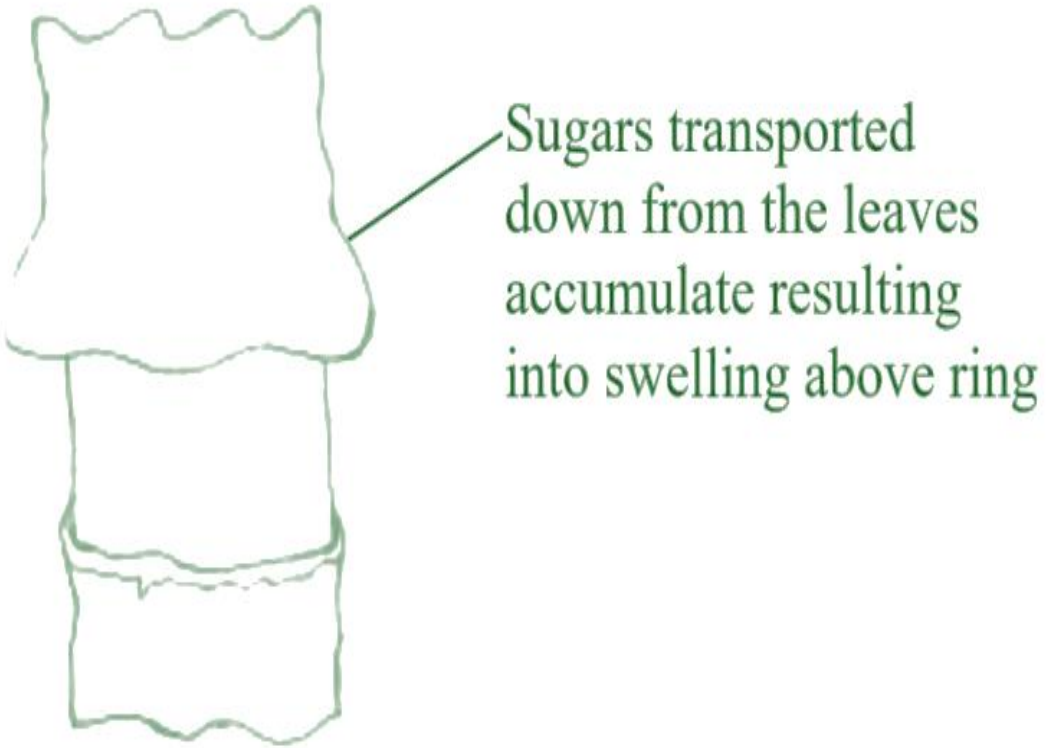
This activity is mainly practiced by herbalists in communities who use certain plants as herbs.



Effects of debarking on translocation

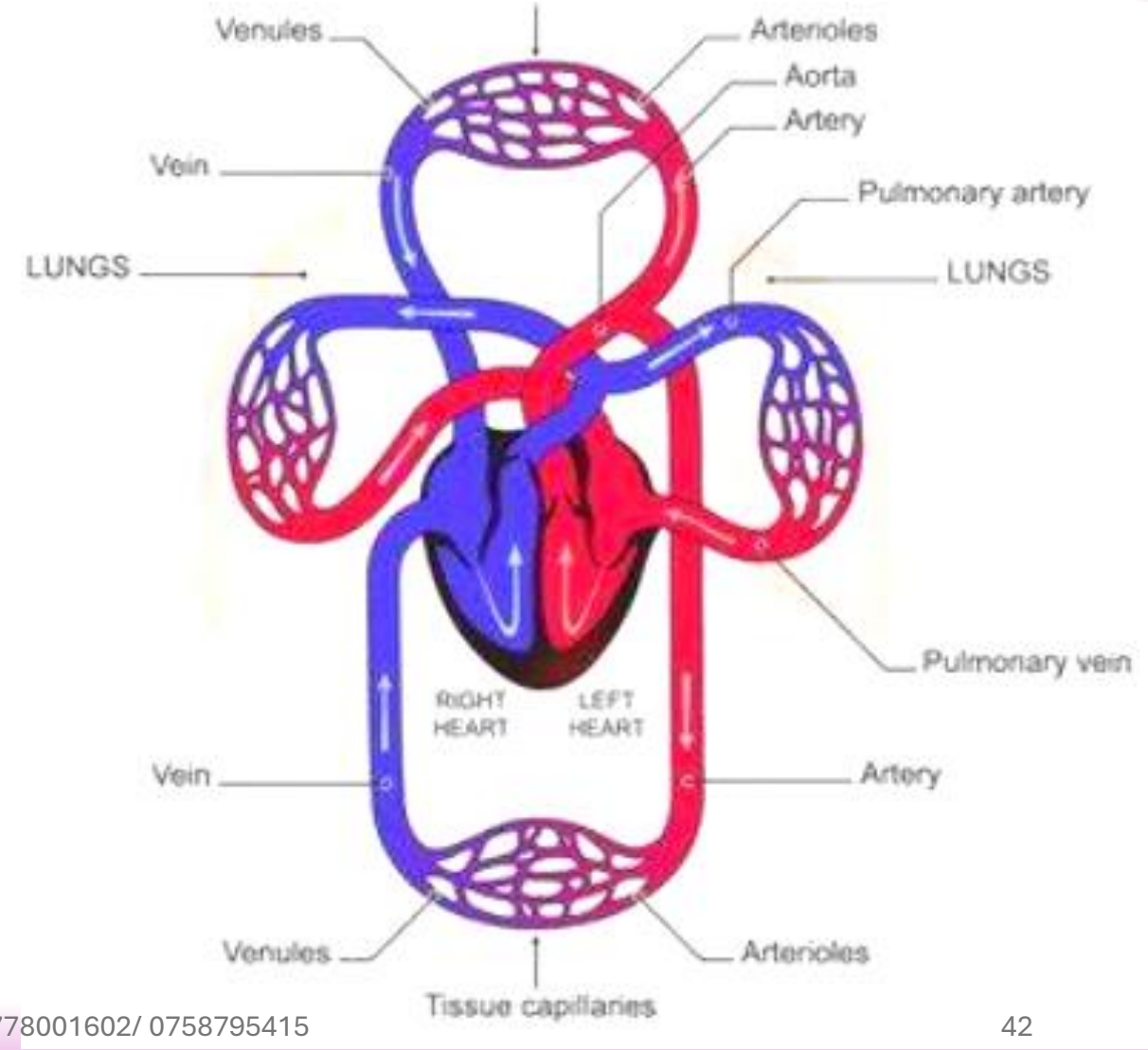
Damages the phloem tissue which prevents translocation of manufactured food from the leaves to the roots. This is evidenced by a swelling above the ring, as a result of accumulation of sugars due to disruption to their transport

Debarking also exposes the xylem tissues causing drying and infection of the stem. This reduces rate of translocation of water and mineral salts from roots to the aerial parts of the shoot



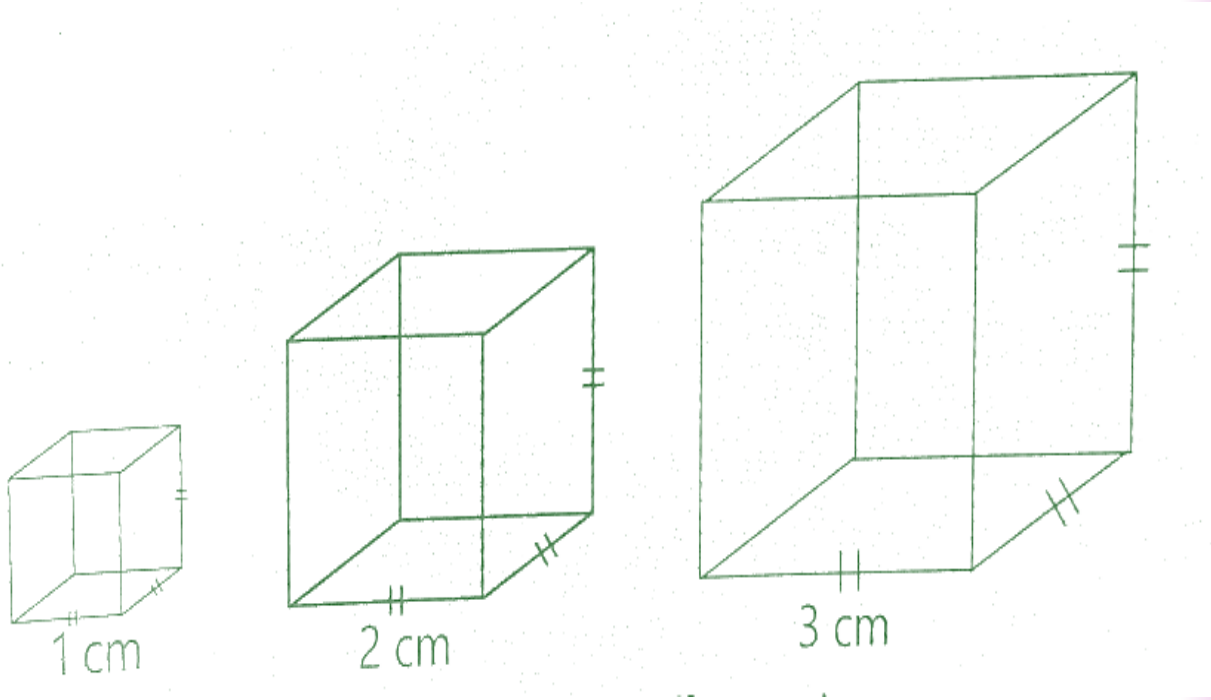
TRANSPORT IN ANIMALS

In animals, transport involves the movement of materials from one part of an organism to another for example; Glucose derived from digestion of carbohydrates is transported by blood to the muscles of legs, where it is broken down to release energy for use during locomotion in the process of respiration



The principle of Surface Area to Volume Ratio

Consider cube A of unit length 1cm representing a small unicellular organism like; Amoeba, cube B of unit length 2cm representing a medium multicellular organism like a Rat and cube C of unit length 3cm representing a large multicellular organism like Man.



Cube size	Surface Area (cm^2) ($SA = 6S^2$)	Volume (cm^3) ($v = S^3$)	Surface Area to Volume ratio
1cm			
2cm			
3cm			

Explanation

Cube A has a Larger surface area to volume ratio than **cube B and C**. therefore, Smaller organisms for example the single celled Amoeba have a larger surface area to volume ratio than larger organisms such as a rat and man who are multicellular.

The implication is that, a small sized organism like an amoeba can efficiently and rapidly exchange materials with its surrounding by diffusion alone due to its large ratio of surface area to volume, therefore such an organism does **not need a specialized system** for transporting materials in its body.

However, due to their small ratio of surface area to volume, diffusion alone would be so **Slow** to effectively move materials with-in the body of a Large sized and multicellular organisms like **Rat** and **Man**.

Therefore, multicellular organisms have evolved specialized systems such as the **Blood circulatory system** to ensure rapid transport of materials within their bodies since body organs lie deep into the body away from the external environment.

Specialized Transport systems in mammals

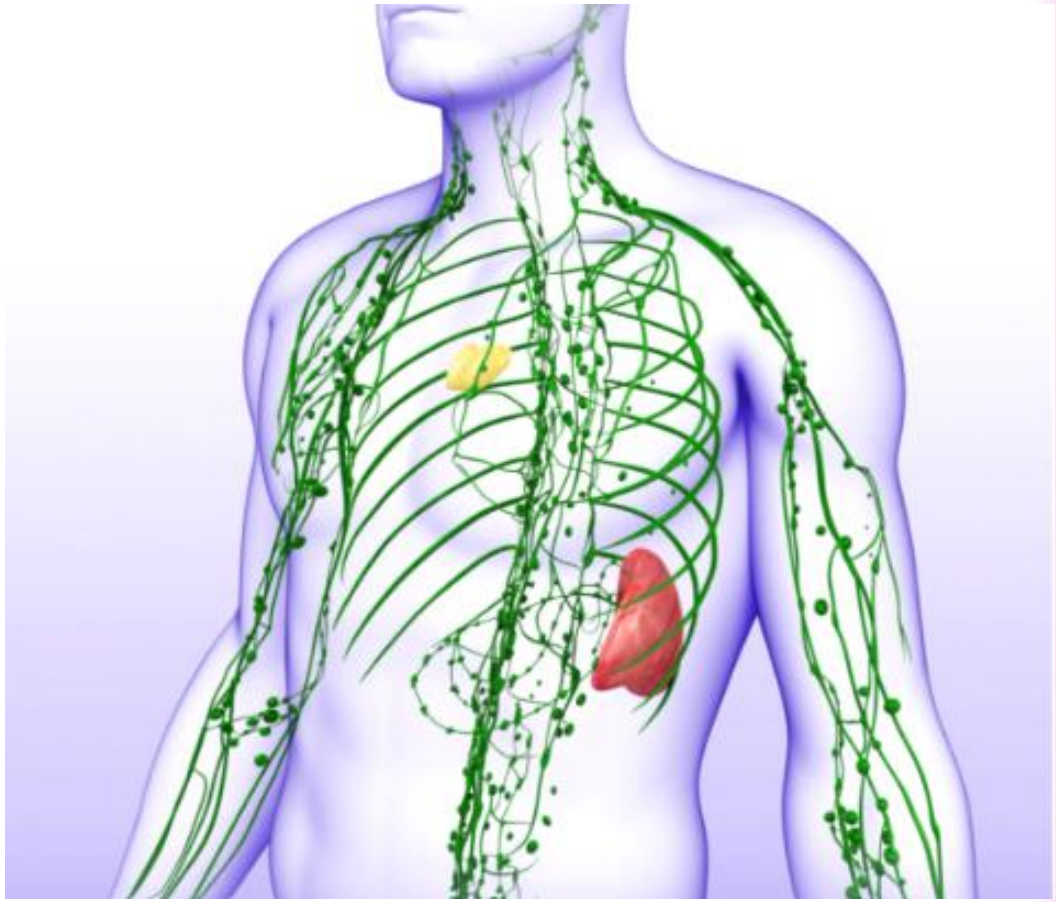
In mammals, there are two transport systems namely;

The blood vascular system or the circulatory system.

This transports materials around the body by blood.

The lymphatic system.

This transports materials in a fluid called lymph.



Components of the transport system

The blood circulatory system is made up of different components that perform different function. These include;

Heart

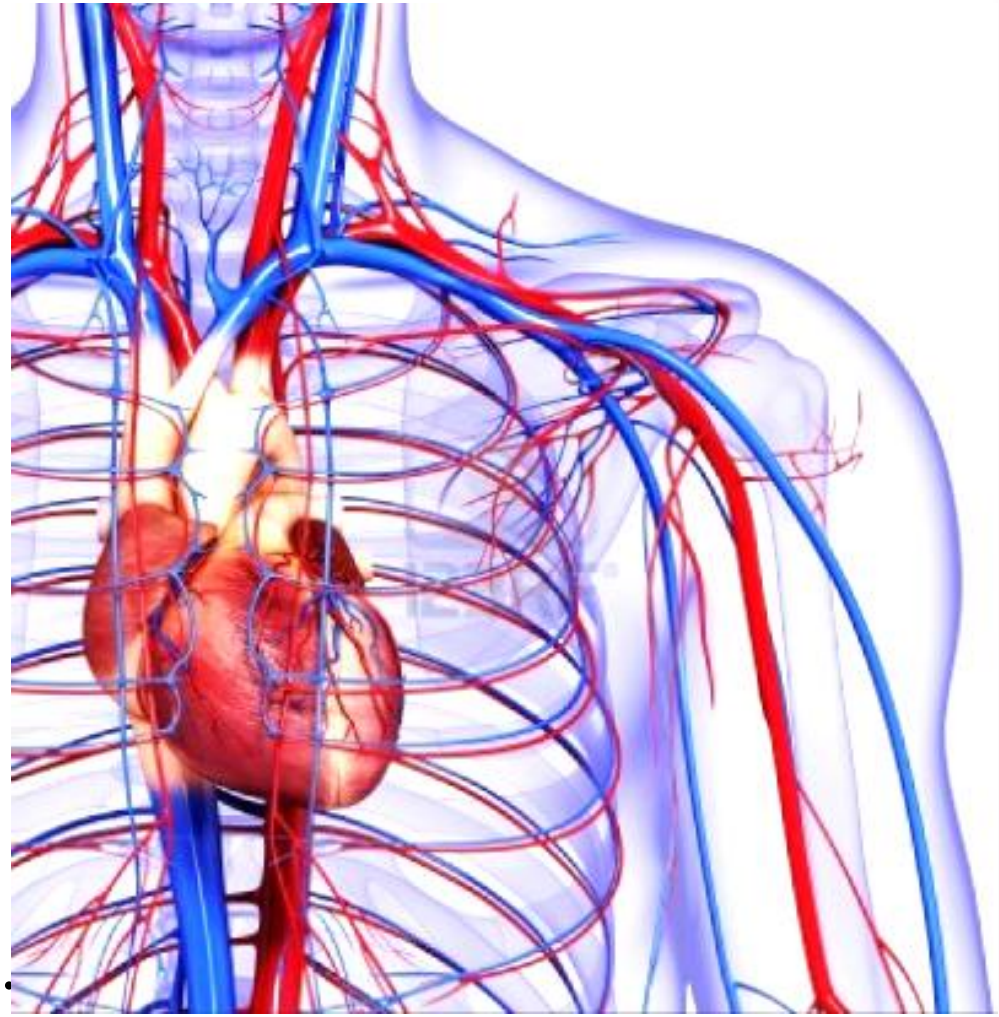
This is an organ that contracts to generate pressure required to pump blood around the body.

Blood

This is the circulatory fluid that transports materials such as respiratory gases and food materials to different parts of the body.

Blood vessels

These are tubes through which blood circulates.

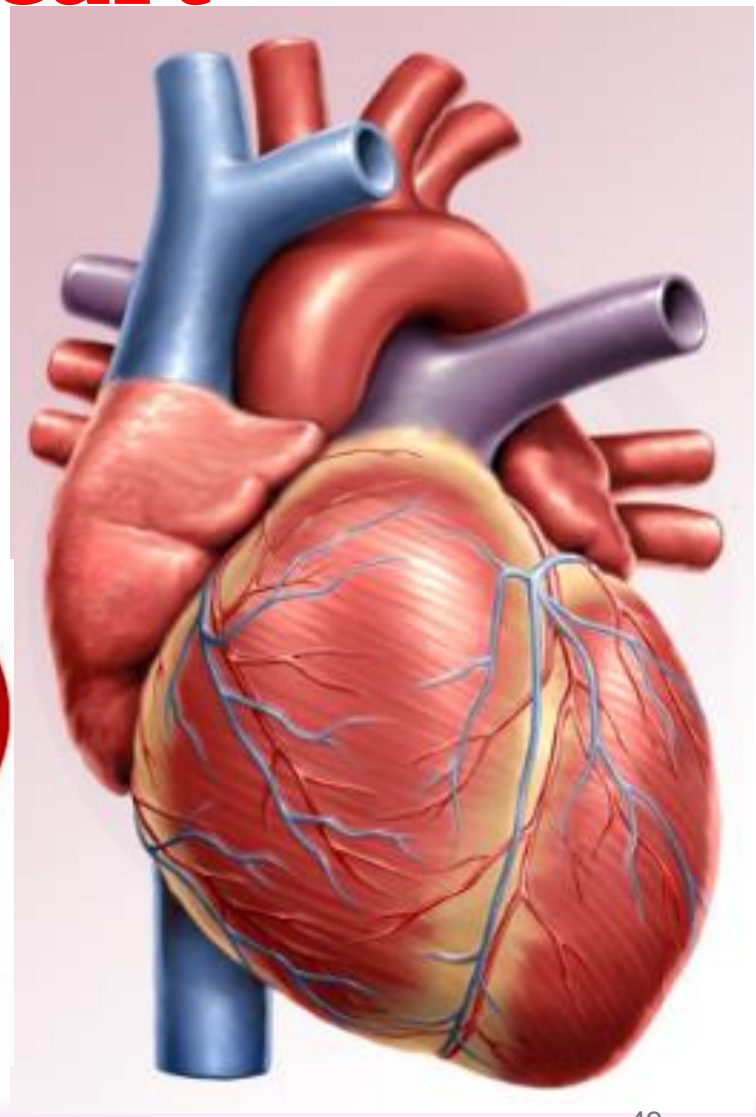


The Mammalian Heart

The heart is the organ whose muscles continuously contract generating a force that pumps blood across the entire body.

It is found in the chest cavity

The whole heart is surrounded by a tissue called **pericardium** which has two layers. The **pericardial fluid** between the layers of pericardium reduce **friction** between them during the pumping action of the heart.

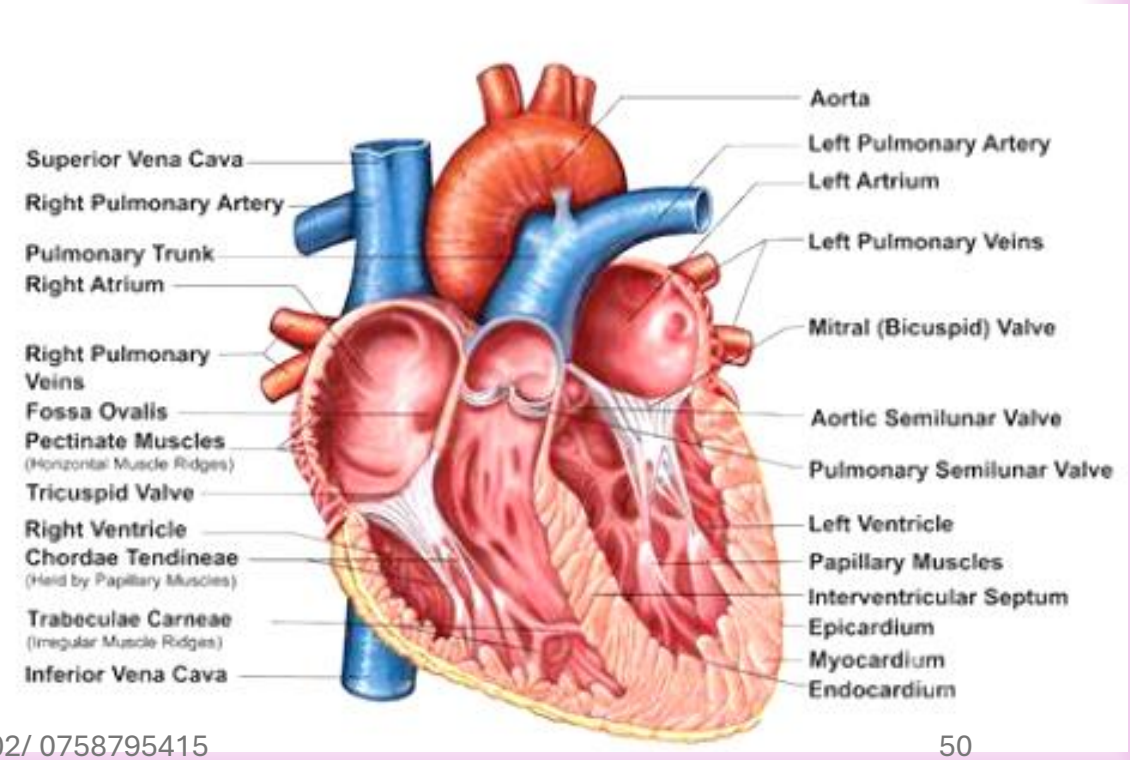


Description of the internal structure of the heart

The mammalian heart is divided into Four chambers; the two upper chambers are called **Atria**, and the two lower chambers are called **Ventricles**.

The Right side of the heart is separated from the left side by a muscular wall, known as the **Septum**. This prevents the mixing of oxygenated blood on the left side with deoxygenated blood on the right side.

Flow of blood is maintained in a single direction by **Valves** .i.e. blood flows from the Atria into the Ventricles and then from the ventricles out of the Heart



There are two sets of valves; **Atrio-ventricular** valves.

These allow blood to flow from the atria into the ventricles and also prevent backflow of blood from the ventricles into the atria.

They include; **Bicuspid/mitral valves**; separate the left atrium from the left ventricle, **Tricuspid valves**; separates the right atrium from the right ventricle, **Semilunar** or **Pocket valves**; these prevent backflow of blood from the aorta and pulmonary artery into the ventricles.

The walls of the Ventricles are **More** muscular/thicker than those of the Atria because, the atria pump blood to a Shorter distance .i.e. to the ventricles whereas the ventricles pump blood to longer distances .i.e. to the **Lungs** and **Rest** of the **Body**

The walls of the **Left ventricle** are **More muscular/thicker** than the walls of the **Right ventricle** because the **Right ventricle** pumps blood to a **Shorter distance** .i.e. to the **Lungs** whereas the **Left ventricle** pumps blood to a **Longer distance** away from the heart .i.e. to the **Rest** of the **body**.

The **walls** of the **Heart** are made up of a **unique** muscle called **Cardiac muscle** which has the **ability to contract on its own without signals** from the **Nervous system** and does not **Fatigue**.

It is thus described as being **Myogenic**.

Flow of blood through the mammalian heart

Deoxygenated blood flows into the heart from the Rest of body via the **Vena cava** into the right atrium, which then pumps it into the right ventricle.

The right ventricle then pumps the deoxygenated blood through the **Pulmonary artery** to the Lungs for Oxygenation.

Oxygenated blood flows back to the heart through the **Pulmonary vein** into the left atrium, which then pumps it into the left ventricle.

The left ventricle then pumps blood through the **Aorta** to the Rest of the body

Adaptations of the heart for carrying out its functions

- ✓ Has tricuspid and bicuspid valves to prevent back flow of blood to the atria.
- ✓ Has septum to separate deoxygenated blood on the right from oxygenated blood on the left.
- ✓ Walls of left ventricle are thick to generate sufficient pressure to pump blood to far parts of the body.
- ✓ Presence of numerous mitochondria to generate energy for the continuous contraction of the cardiac muscle.
- ✓ Its walls are lined by a layer of fat to absorb shock.

Circulation of blood in the human body

The human circulatory system is a double circulation since blood passes through the heart twice.

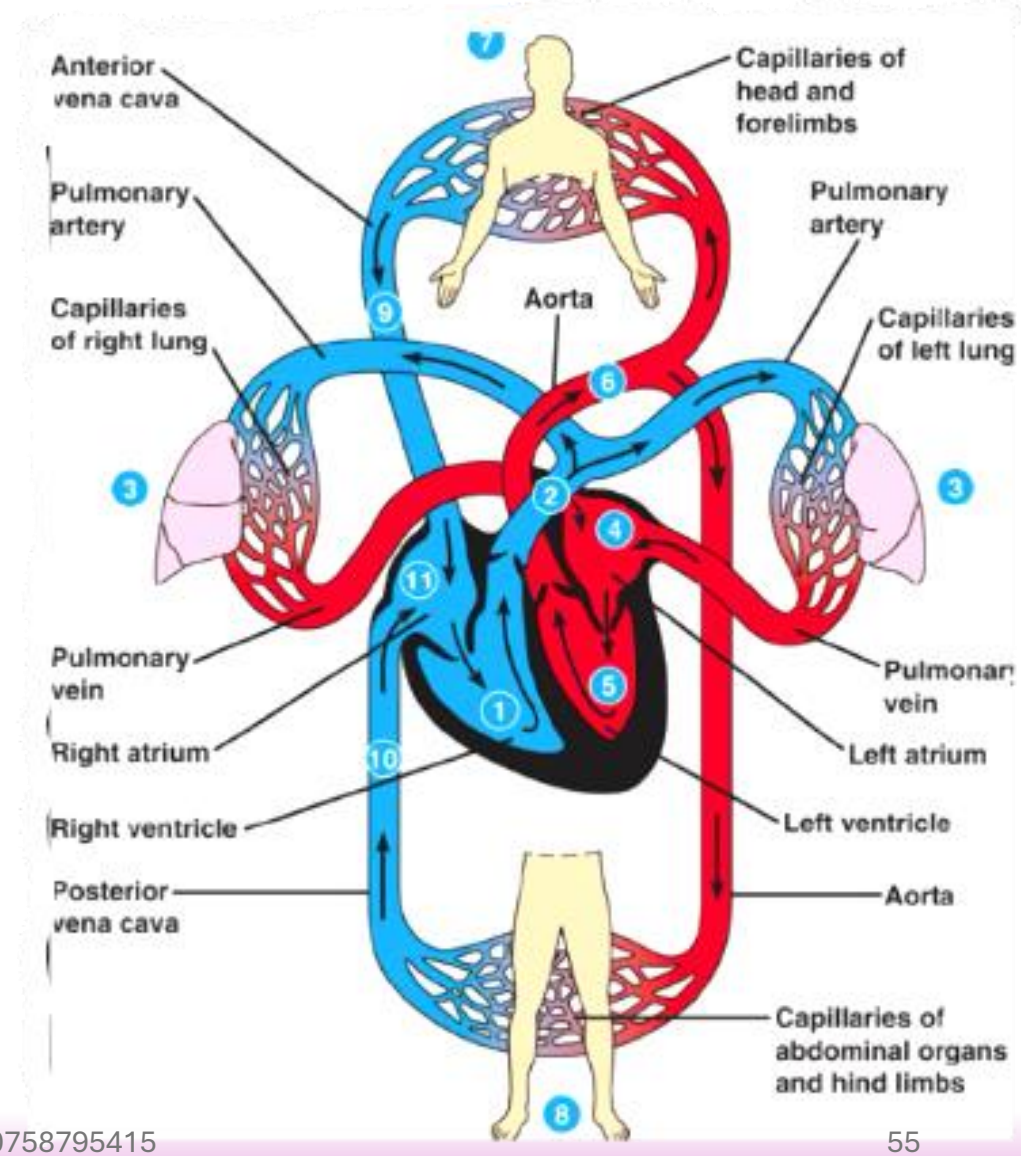
It is divided into two circulations/cycles;

Pulmonary circulation

Deoxygenated blood returning to the heart from the body is first pumped to the lungs for oxygenation and then back to the heart.

Systemic circulation

Oxygenated blood from the heart is then pumped to the rest of the body organs and tissues



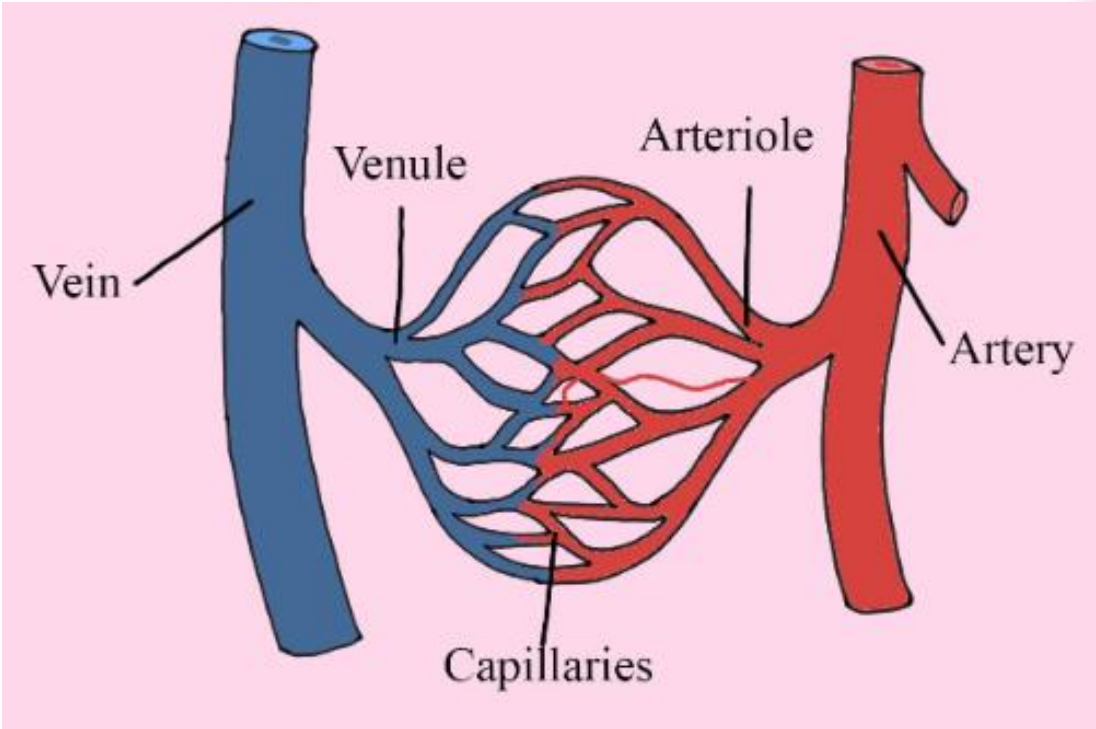
Blood vessels

These are the tube-like structures that carry blood throughout the body.

They include; Arteries, Veins, and Capillaries.

Both arteries and veins have three layers in their walls but with the elastic tissue in arteries much thicker than that in veins.

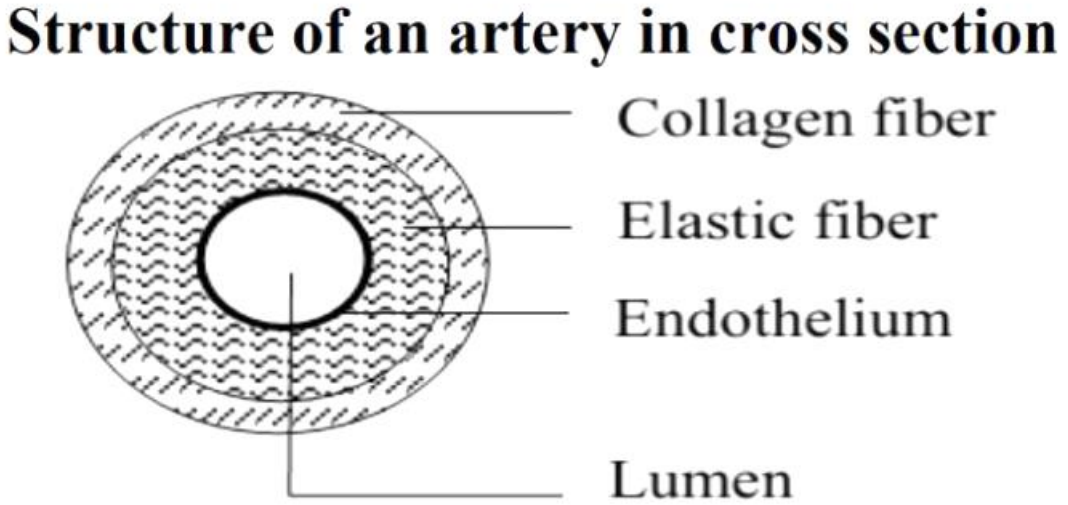
Capillaries are however only one cell thick.

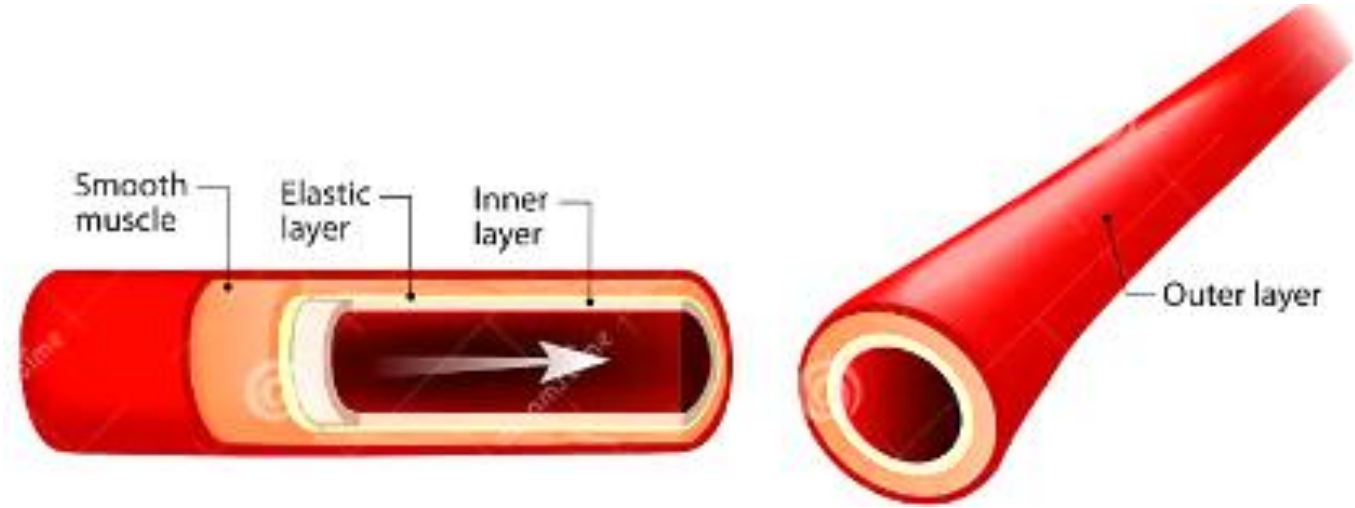


Arteries

These carry blood from the heart to the various body parts.

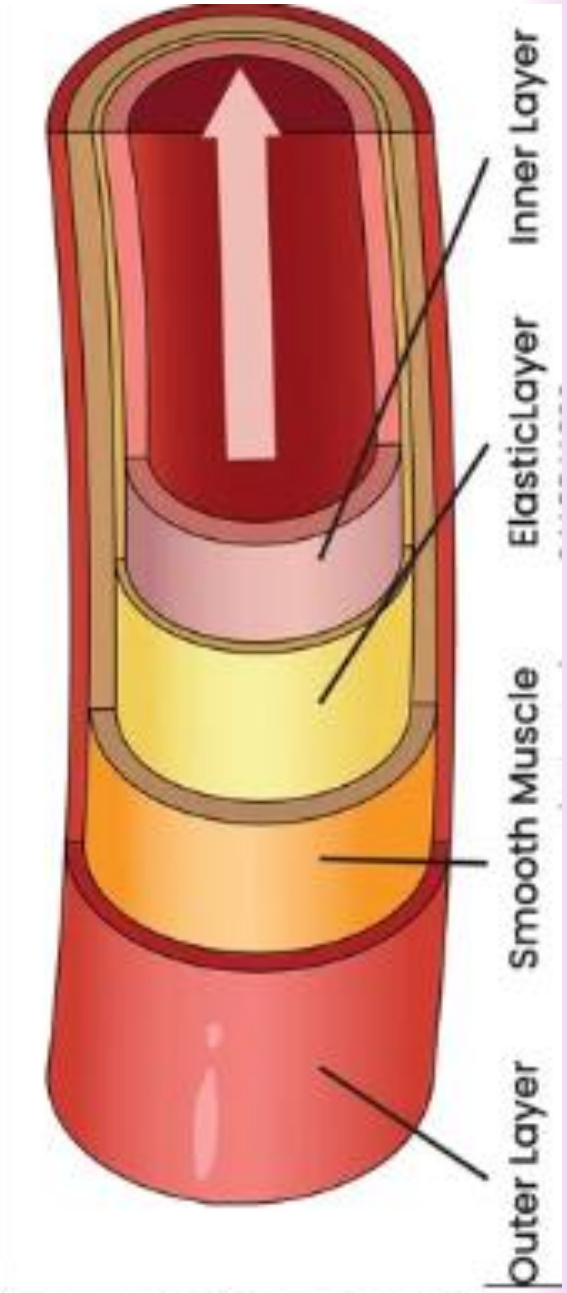
Arteries branch to form smaller vessels called Arterioles which then divide repeatedly to form capillaries with-in tissues and organs.





Characteristics of arteries

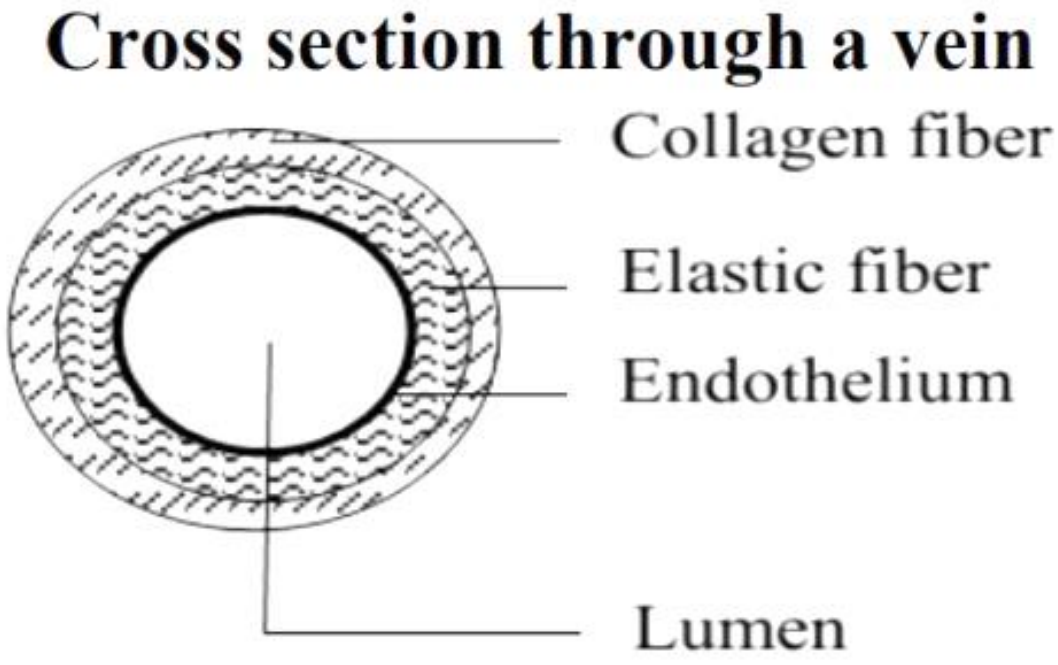
- ✓ Have a three-layered wall.
- ✓ Have a thick elastic tissue to allow stretching due to high blood pressure from pumping action of heart
- ✓ They have fibrous outer wall so as to withstand high pressure
- ✓ Blood flowing through arteries has a pulse.
- ✓ They have no valves except at the base of the pulmonary artery and aorta.
- ✓ They have narrow lumen as compared to their size and to that of veins.
- ✓ They carry oxygenated blood except the pulmonary artery and umbilical artery.

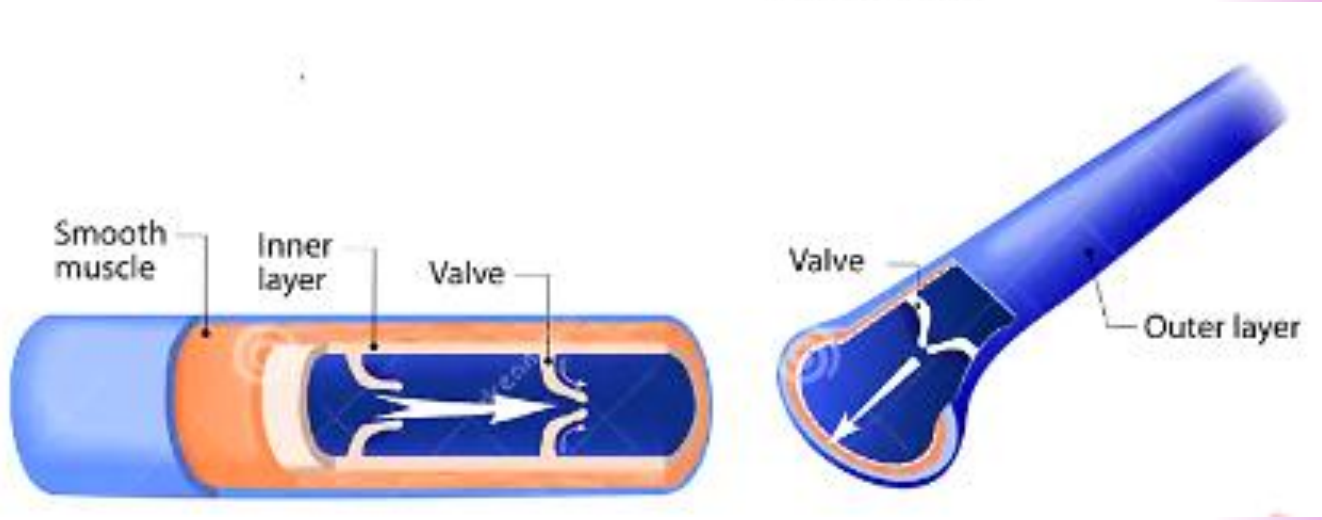


Veins

These are blood vessels that return blood to the heart from the rest of the body organs and tissues.

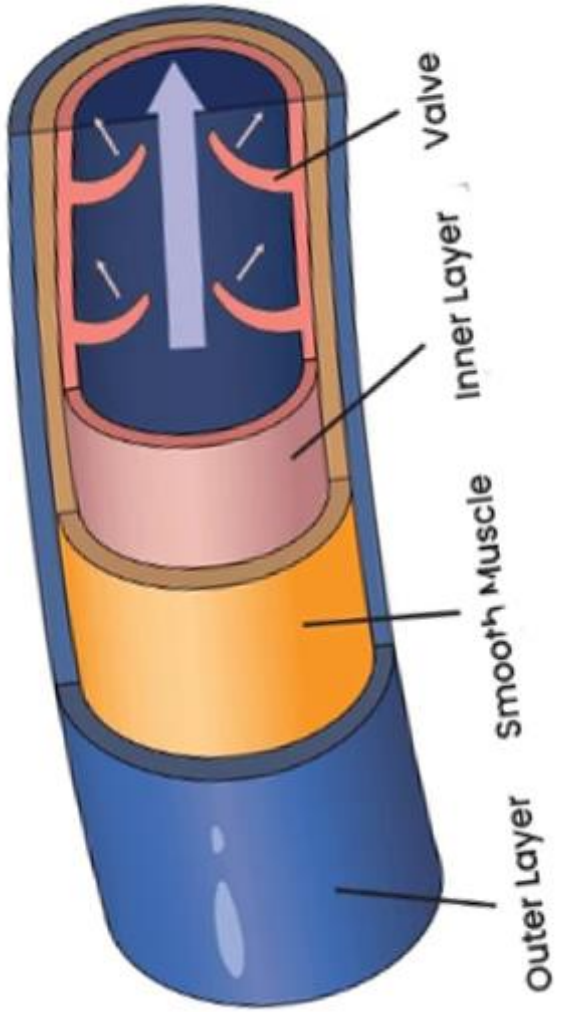
Veins branch to form smaller vessels called Venules which then divide repeatedly to form Capillaries with-in tissues and organs





Characteristics of veins

- ✓ They have wide lumen to encourage flow of blood at low pressure.
- ✓ They have thinner walls than arteries which are adequate to withstand low blood pressure.
- ✓ They have valves at intervals along their length which prevent blood from flowing backwards thus maintain blood flow in one direction.
- ✓ They transport deoxygenated blood except the pulmonary vein and umbilical vein.
- ✓ They have less elastic tissue.

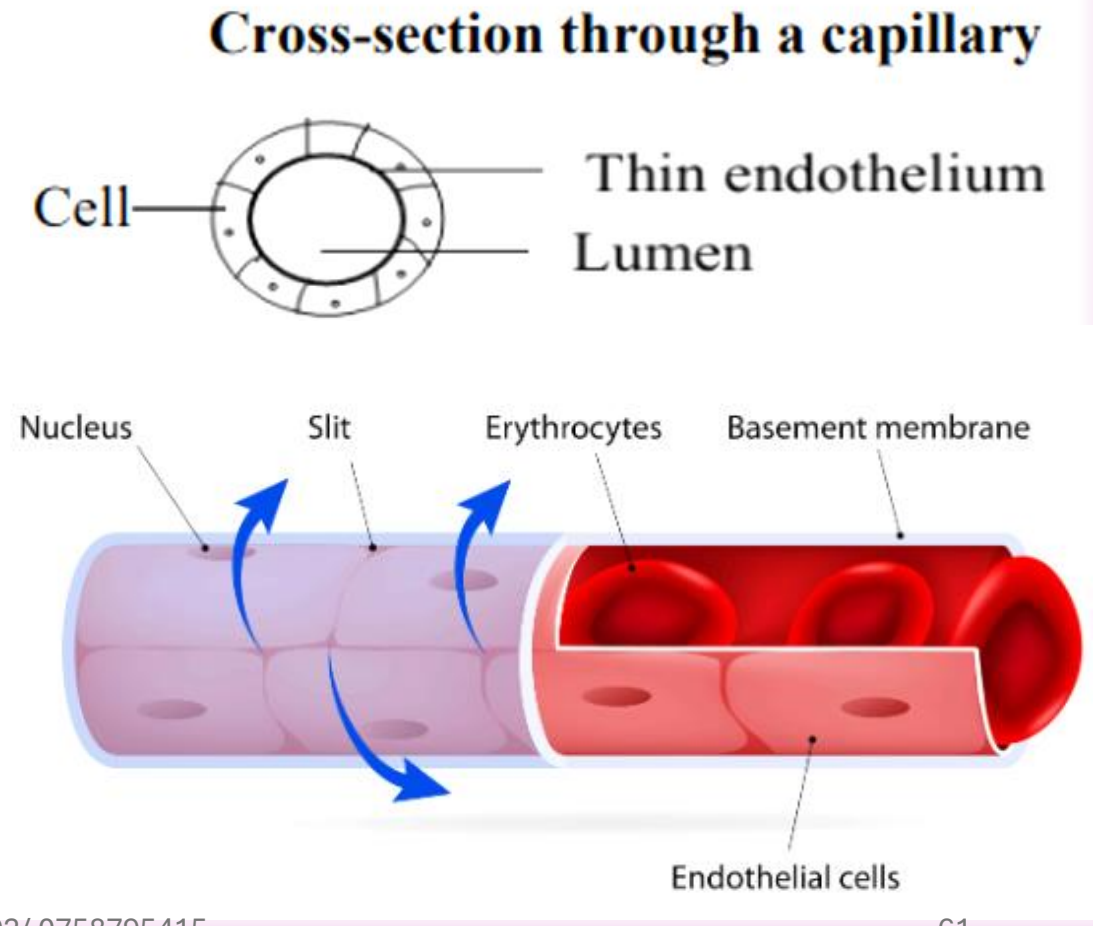


Blood capillaries

These are the smallest blood vessels in the body.

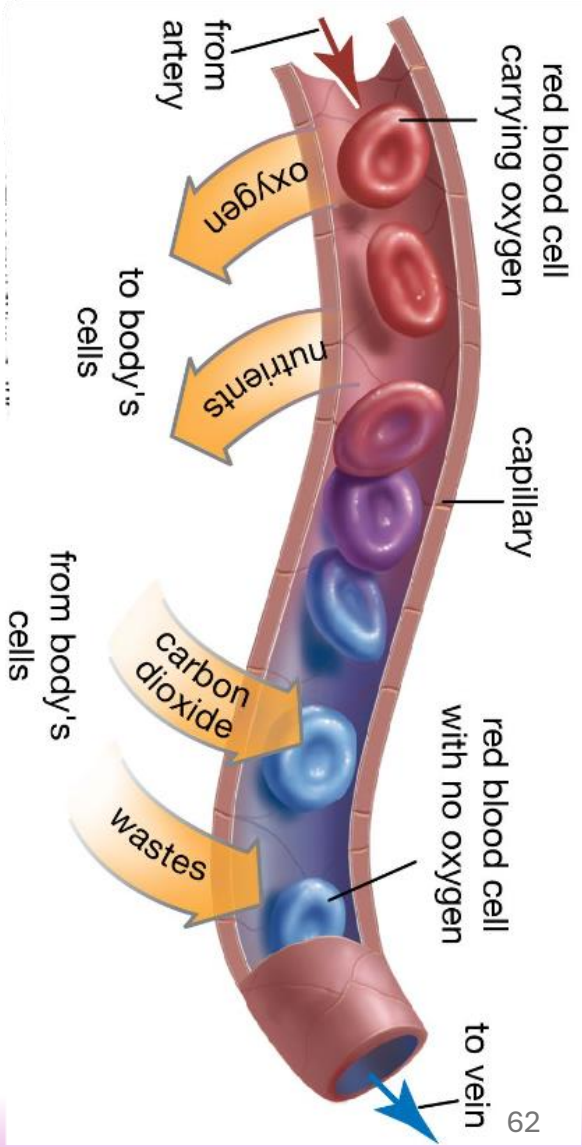
They connect arterioles to venules and form numerous interconnections (networks) in tissues and organs called capillary beds where exchange of materials between them and tissue fluid takes place.

Due to the vast branching of capillaries, blood pressure within them reduces greatly



Characteristics of blood capillaries

- ✓ Highly branched to form networks that provide a large surface area for exchange of materials.
- ✓ Have the narrowest lumen.
- ✓ They have very thin walls (one cell thick) to reduce distance for exchange of materials by diffusion.
- ✓ They have walls with tiny pores making them permeable to facilitate easy exchange of materials.
- ✓ Slow movement of blood in capillaries due to the dense capillary network ensures enough time for exchange of materials between blood and cells of tissues/organs



Structural differences between arteries, veins and capillaries

Artery	Veins	Capillaries
Have thick muscular walls	Veins have thin and less muscular walls	Have thinner walls
have more elastic fibres	Have few elastic fibres	Do not have elastic fibres
Have smaller lumen relative to diameter	Have a wider lumen relative to diameter	Have largest lumen relative diameter
Have no valves except at the base of aorta	Have valves throughout their length	Have no valves
Walls not permeable	Walls not permeable	Walls permeable
Can constrict	Can't constrict	Can't constrict

Functional differences between arteries, veins and capillaries

Artery	Veins	Capillaries
Transport blood away from the heart to organs and body tissues.	Transport blood from body tissues and organs to the heart.	They connect arteries to veins.
Transport oxygenated blood except pulmonary artery and umbilical artery	Transport deoxygenated blood except pulmonary vein and umbilical vein	Transport both oxygenated and deoxygenated blood
Blood flows rapidly at high pressure.	Blood flows slowly at low pressure	Blood flows slowly at low pressure
Blood flows in pulse	Blood flows smoothly.	Blood flows smoothly.

BLOOD

Blood is the fluid that flows in blood vessels transporting materials around the body.

Components of blood

Red Blood Cells
(Erythrocytes)

Transport oxygen from the lungs to other body organs and tissues where it is used for respiration.

Contain a red pigment called Haemoglobin that binds the oxygen and as well gives blood its color.

Transport some carbon dioxide from respiring tissues to the lungs for elimination.

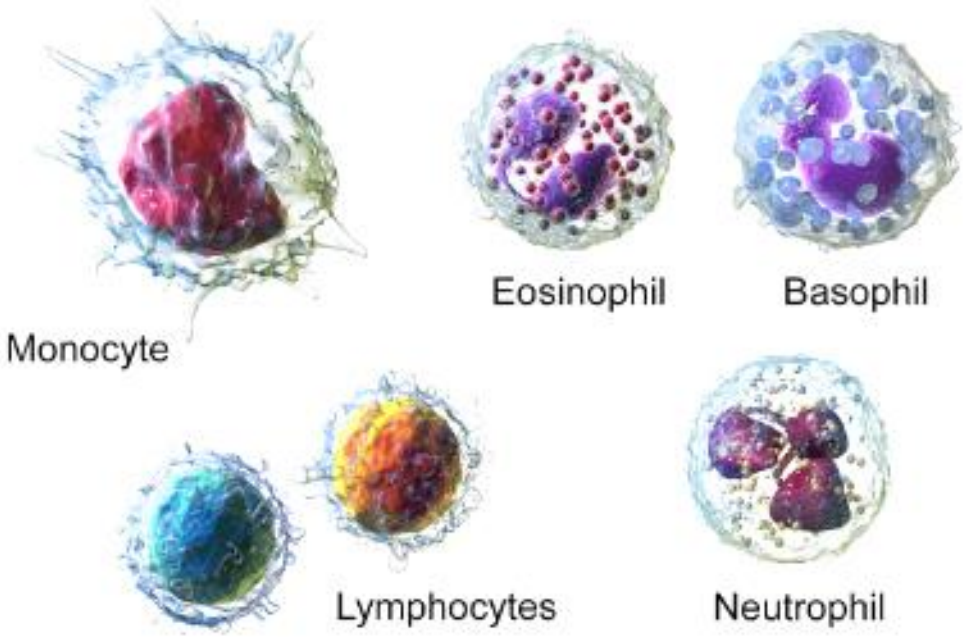
White blood cells. (leucocytes/lymphocytes)

Responsible for **defense** of the body against infections.

They achieve this by;

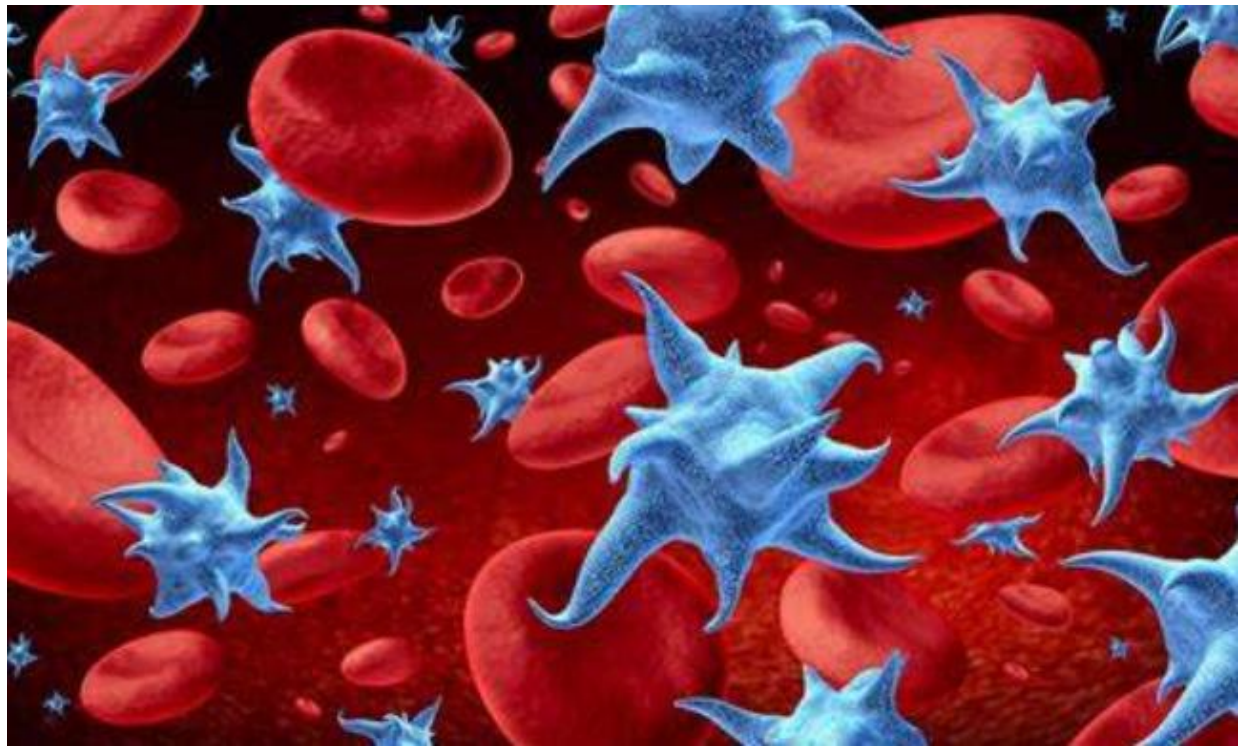
Producing substances called **Antibodies** that attack and destroy pathogens such as bacteria and any toxins they produce in the body before they cause infection.

White blood cells known as **Phagocytes** engulf then release enzymes that **digest** foreign pathogenic organisms



Platelets (thrombocytes)

They play a role in Clotting of blood, which protects the body against excessive loss of blood and entry of pathogens through the injured body parts.



Plasma

This is the Fluid part of blood.

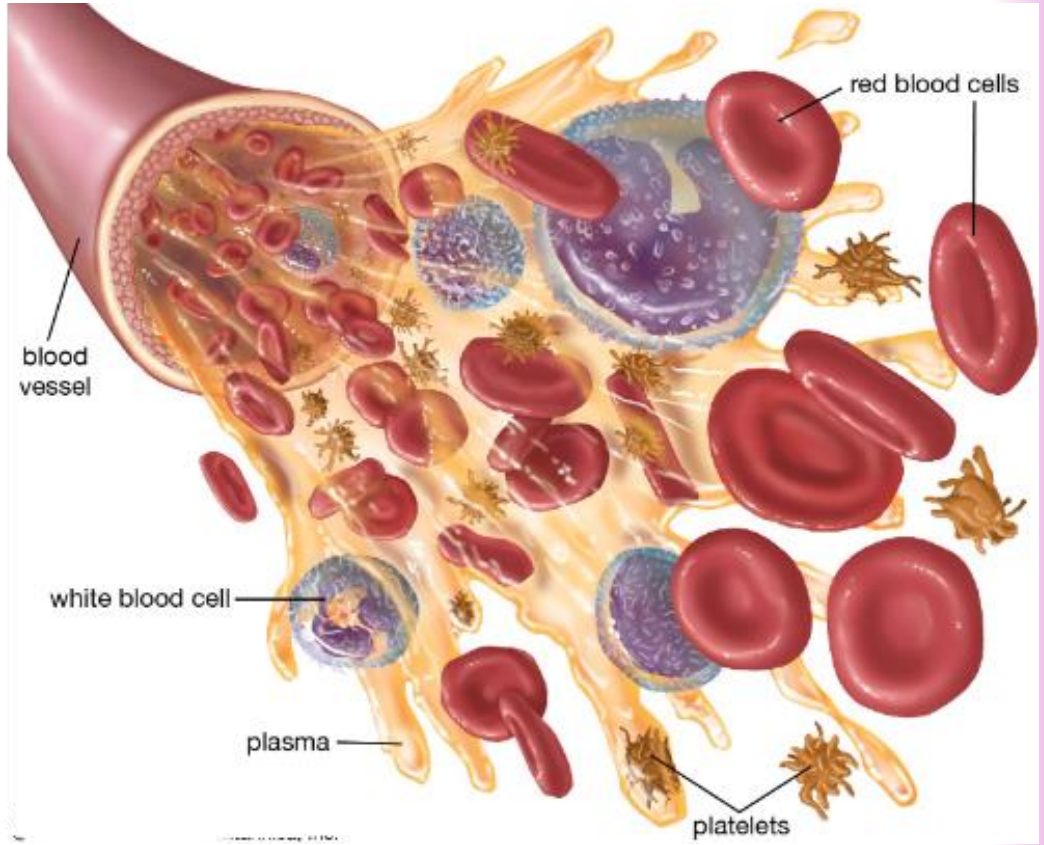
It is a medium containing blood cells, water and plasma proteins such as Fibrinogen, Prothrombin, Globulins and Albumins

Fibrinogen and prothrombin are involved in blood clotting.

Albumins make blood thick and viscous.

Generally, plasma proteins contribute to maintaining osmotic pressure of blood

Globulins form Antibodies for defense against disease.

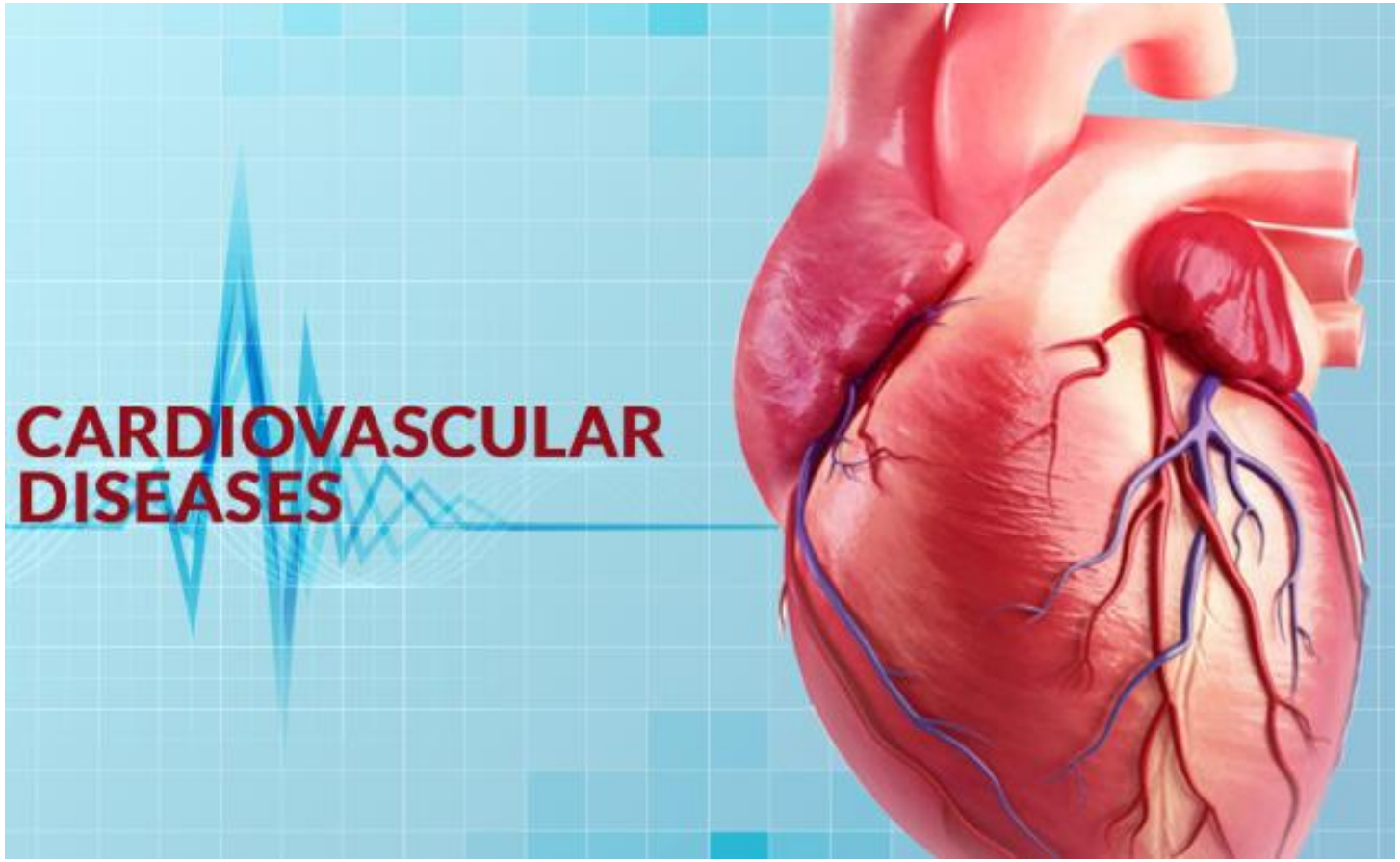


General functions of blood plasma

- ✓ Transports oxygen from the lungs to respiring tissues around the body.
- ✓ Transports products of digestion such as glucose, amino acids from the ileum to other parts of the body for use.
- ✓ Transports waste products of metabolism from site of production to excretory organs for example; carbon dioxide from respiring tissues to lungs for elimination, urea from liver cells is transported to kidneys for elimination.
- ✓ Distributes heat around the body used in regulating body temperature,
- ✓ Transports hormones from glands to target organs
- ✓ Prevents infection by transporting white blood cells to all parts of the body.
- ✓ Clotting of blood by platelets and fibrinogen prevents loss of a lot of blood from wounds and entry of pathogens into the body.

Heart diseases/ cardiovascular diseases

A heart disease is any condition that affects the structure or functioning of the heart

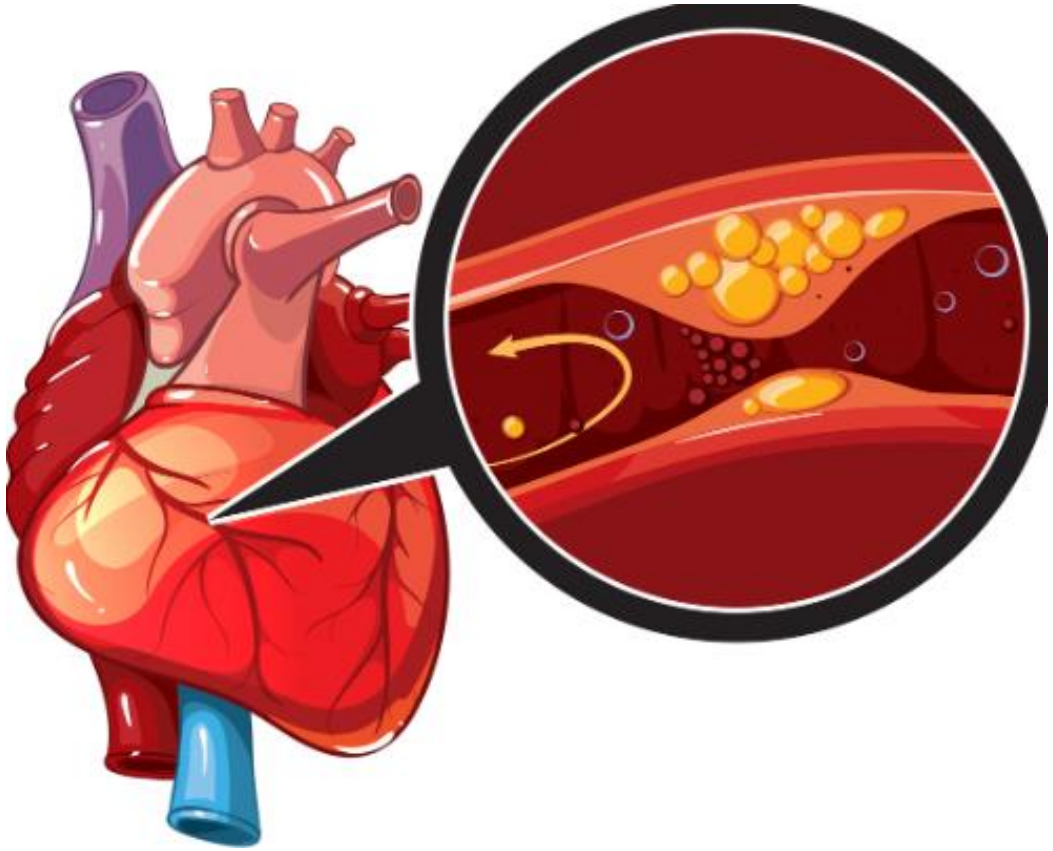


Common Heart diseases.

Coronary heart disease (Heart Attack)

This is a condition resulting from Blockage or Narrowing of the Coronary arteries that supply the Heart muscle with blood.

The result is that the heart muscle does not get enough oxygen or glucose, therefore it stops functioning properly causing a heart attack.



Causes

- ✓ Buildup of fatty deposits (Plaque) on the inner walls of the coronary artery which narrows its lumen restricting blood flow to the heart muscle
- ✓ Formation of a Blood Clot in the coronary artery, which prevents blood supply reaching the heat muscle leading to a heart attack.
- ✓ Smoking. promotes formation of clots and buildup of plaque in the arteries, narrowing their lumen hence restricting blood flow to vital organs like the heart.

- ✓ Diabetes mellitus. High blood sugar levels in blood can damage blood vessels that supply the heart hence preventing oxygen and glucose reaching the heart muscle. It also promotes build up of plaque in the coronary artery that supply oxygen and nutrition to the heart muscle.
- ✓ High blood pressure. Damages the walls of arteries causing them to narrow but also promotes buildup of plaque and this can block blood flow to the heart.
- ✓ Diets rich in saturated fat increase levels of Cholesterol in the bloodstream and this can lead to buildup of plaque in arteries such as the coronary arteries narrowing their lumen.
- ✓ Lack of physical exercise promotes buildup of plaque in the arteries

Ways of prevention

- ✓ Quit smoking or going to rehab centers for counselling and guidance
- ✓ Having regular exercise. Widens blood vessels improving blood flow to vital organs like the heart, lowers blood pressure and cholesterol levels but also improves ability of heart muscle to extract oxygen from blood
- ✓ Reduce intake of sugars or saturated fat. This reduces risk of obesity and type II diabetes.

High blood pressure (hypertension)

Is a condition in which the force of blood against the artery walls is too high.

It results from narrowing of the lumen of arteries due to buildup of fatty material (plaque) on their inner walls.

Causes of hypertension

- ✓ Diet rich in saturated fat increase levels of cholesterol in the bloodstream, this can lead to buildup of plaque in arteries such as the coronary arteries narrowing their lumen.
- ✓ Too much salt consumption. Increases levels of sodium in blood causing the body to retain fluid but also promotes formation of plaque.
- ✓ Lack of exercise
- ✓ Being overweight/obese
- ✓ Tobacco smoking
- ✓ High consumption of alcohol. Alcohol causes muscles in blood vessels to tighten hence narrowing their lumen.
- ✓ Stress causes release of hormones such as adrenaline and cortisol which constrict blood vessels thus raising blood pressure.

Ways of preventing hypertension

- ✓ Regular exercise
- ✓ Regulating intake of salt, fats and alcohol

Stroke

A damage to the brain resulting from interruption of its blood supply.

Symptoms include;

Trouble walking, Speaking and understanding as well as Paralysis of the face, arm or leg usually on one side of the body.

Causes of stroke

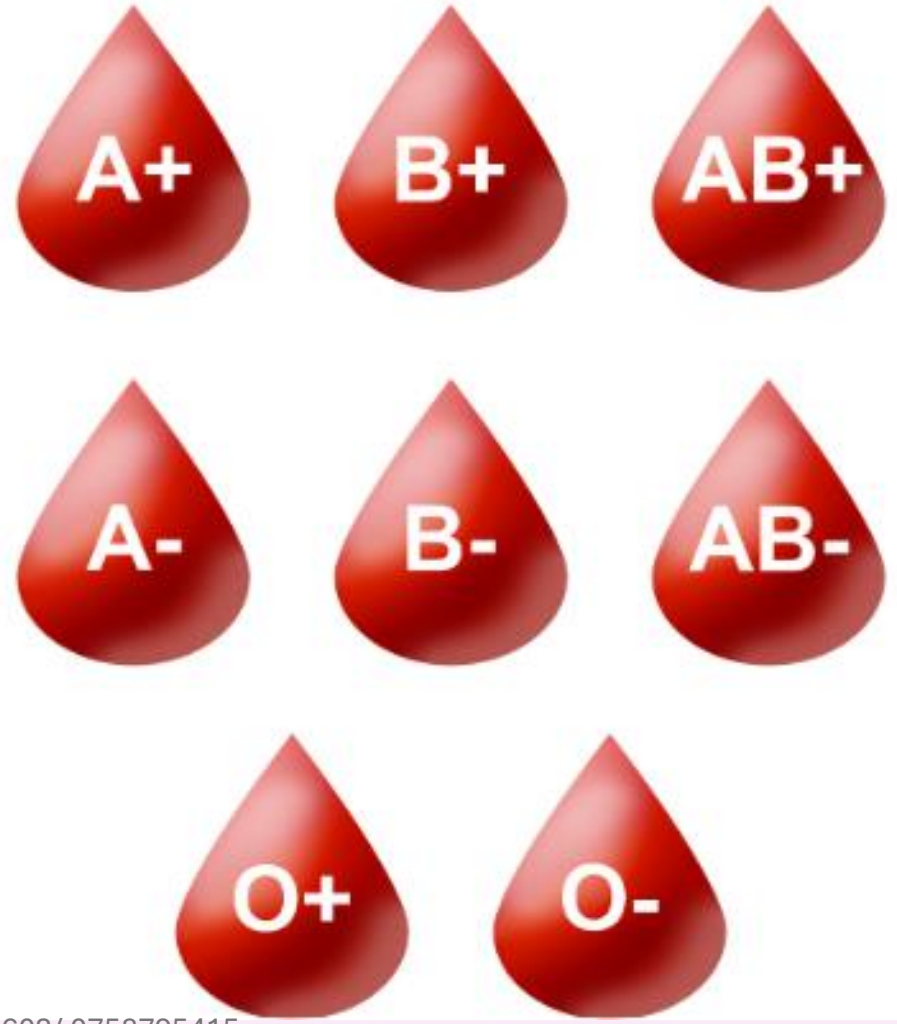
- ✓ Blood clot in the carotid arteries suppling brain with blood. This blocks supply of oxygen and nutrients to some cells of the brain,
- ✓ Buildup of plaque in the carotid arteries
- ✓ Head injuries that may rapture some of the arteries in the brain.

Ways of prevention

- ✓ Avoid smoking cigarettes and drinking too much alcohol.
- ✓ Having regular exercise.
- ✓ Eating a health balanced diet rich in vegetables, whole grains, health fat and protein while limiting consumption of processed sugars, and food high in saturated fat.

Blood groups

In man, there are four blood groups; blood group **A**, blood group **B**, blood group **AB** and blood group **O**



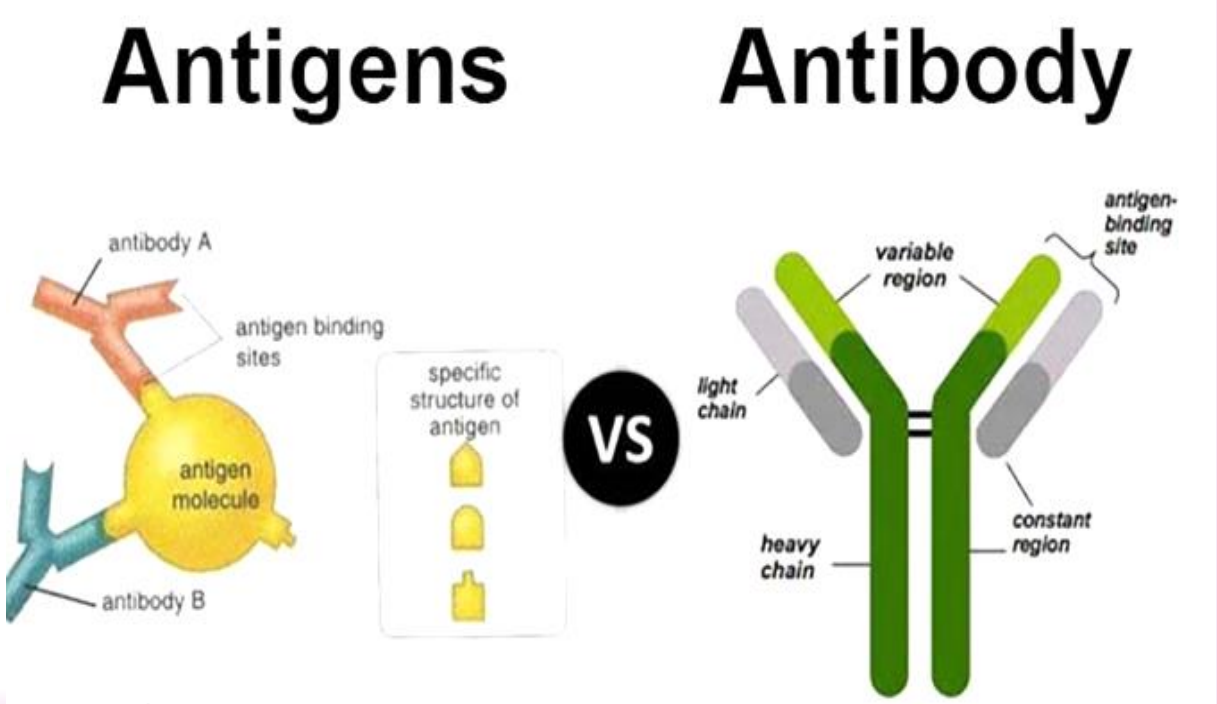
Determination of blood groups

The blood group of an individual is determined by the type of antigen found on the membrane of one's red blood cells.

An antigen is molecule which can cause production of antibodies.

Antigens can be foreign to the body (non-self) such as pathogens or can be part of the body (self-antigens) such as those that determine one's blood group.

Note: The body can only produce antibodies in response to antigens that are foreign/non-self.



Two types of antigens determine the blood group of individuals .i.e. **Antigen A** and **Antigen B**

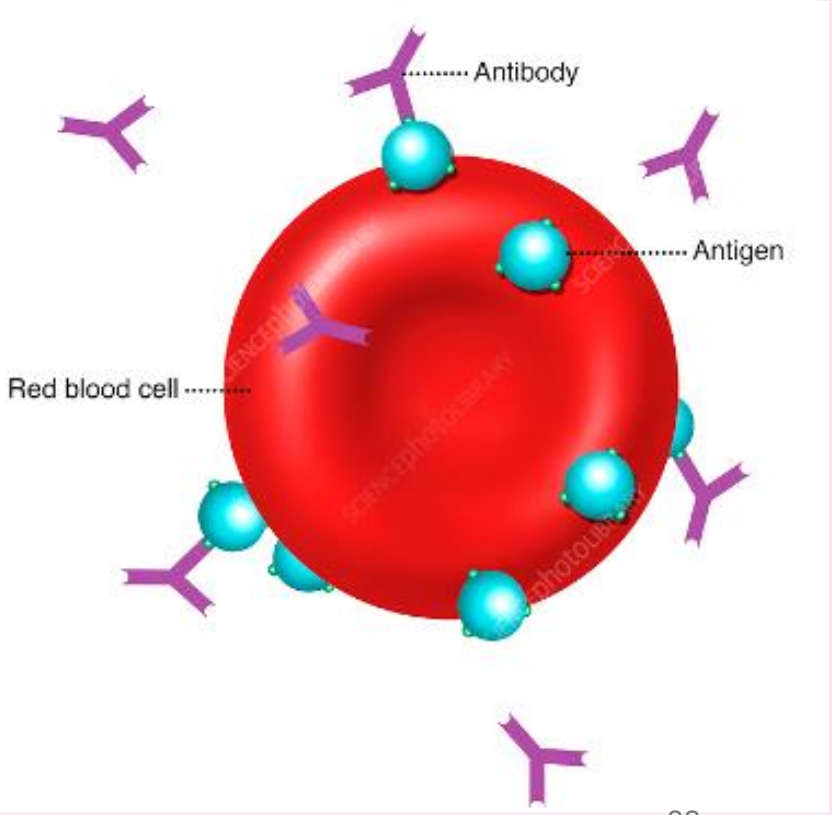
for example;

An individual with **antigen A** on their red blood cells is of blood group **A.**

An individual with **antigen B** on their red blood cells is of blood group **B.**

An individual with both **antigens A and B** on their red blood cells is of group **AB.**

An individual with **no antigens** on their red blood cells is of blood group **O.**



Each blood group type produces particular antibodies in plasma which work against particular foreign antigens when introduced in the body for example;

i. A person of **blood group A** produces **Antibody b**. This antibody specifically responds to **antigen B** which is the foreign antigen to their body

ii. A person of **blood group B** produces **Antibody a.** This antibody specifically responds to **antigen A** which is the foreign antigen to their body

iii. A person of **blood group AB** produces **No antibodies.** This is because both antigen A and antigen B are part of their body.

iv. A person of **blood group O** produces both **Antibody a and Antibody b.** These respectively respond to antigen A and antigen B that are foreign to their body.

NB: antigens are assigned capital letters whereas antibodies are assigned small letters.

Table showing the blood groups, the antigens they carry and the antibodies they produce

Blood group	Antigen present	Antibody produced
A		
B		
AB		
O		

Blood Transfusion

This is the transfer of blood from a healthy adult to a patient with a compatible blood group by trained medical personnel.

During transfusion, the person who gives out blood to a patient is called the **Donor** and the one receiving is known as the **Recipient**.

Examples of recipients include;

Individuals that have lost a lot of blood during Injury, Accidents, Surgery, Birth, Disease and those having Bleeding disorders such as Haemophilia

Precautions taken during the transfusion

Before the transfusion, doctors would carry out tests to make sure that;

i. Blood of the donor is free from infections to prevent infecting the patients.

ii. The blood of the donor and that of the recipient are compatible. This means that “the recipient’s blood should not contain antibodies that attack antigens in the donor’s blood”.

NB:

If the blood of the donor and the recipient are **Not Compatible**, the antibodies in the recipient's blood attack antigens in the blood of the donor **Clumping** them together.

This reaction is known as **Agglutination** and results into formation of **Blood clots** in blood vessels that interrupt blood supply to vital organs resulting into **Death** due to **Multi-organ failure**

Table showing compatibility of blood groups during transfusion

Donor	Recipient			
	A	B	AB	O
A				
B				
AB				
O				

Key:

✓ - Compatible X – Incompatible

Individuals of Blood group AB can receive blood from all blood groups because their plasma contains **No antibodies**. They are therefore known as **Universal Recipients.**

Individuals of **Blood group O** can donate blood to all other blood groups because their blood has **No antigens A and B**. They are therefore known as **Universal donors**

Benefits of a blood transfusion

- ✓ Replaces blood lost during hemorrhages (loss of blood within or from the body). This stabilizes blood pressure
- ✓ Provides platelets to prevent post-operative bleeding by promoting clotting.
- ✓ Provides more red blood cells to increase the oxygen carrying capacity of patients as those of sickle cell anaemia
- ✓ Plasma provides clotting factors that increase the rate of blood clotting among hemophiliacs.
- ✓ Plasma contains antibodies that give immunity to certain infections.

Risks involved in Blood transfusion

- ✓ Accidental administration of incompatible ABO blood which causes agglutination in the patient
- ✓ Transfusion of infectious diseases such as AIDS, syphilis, malaria.
- ✓ Allergic reactions due to presence of allergens in the donor's blood.

Rhesus factor

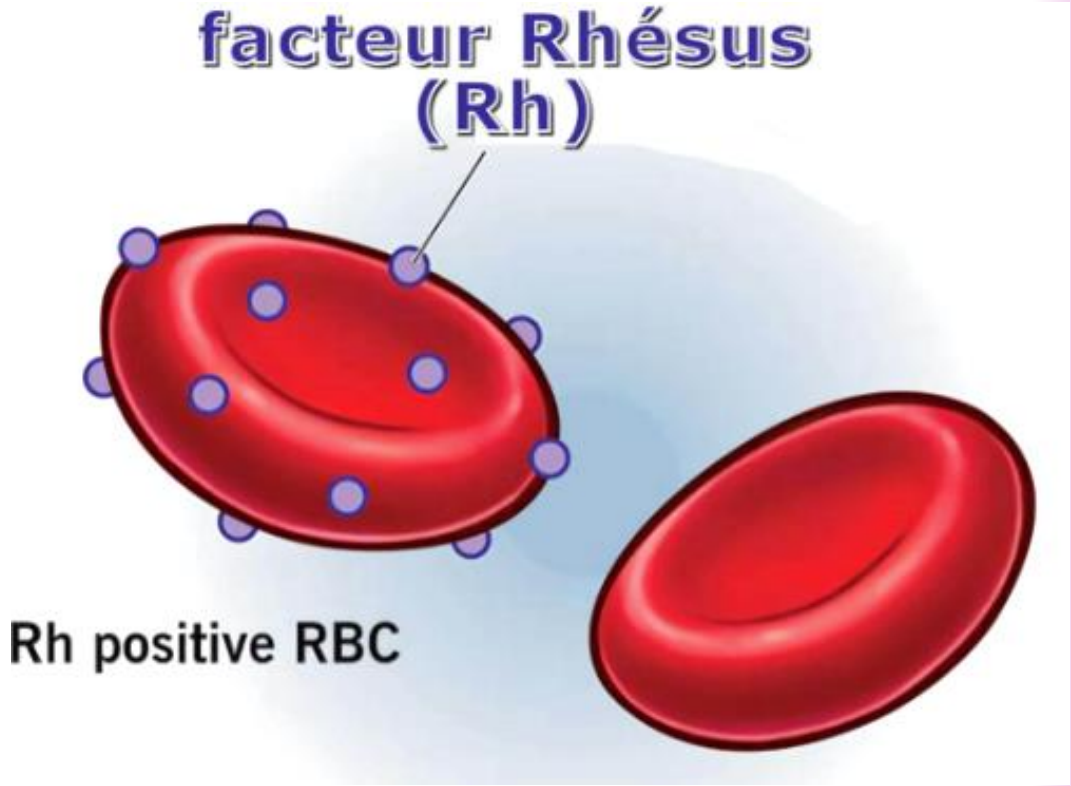
The Rhesus factor is a Protein/Antigen found on the cell membrane of Red Blood Cells.

It is also known as **Antigen D.**

About 85% of the population possess the rhesus antigen (antigen D) on their red blood cells.

These are said to be **Rhesus Positive**

However very few individuals do not have the rhesus antigen and these are said to be **Rhesus Negative**.



Immunity

This is the ability of an organisms to resist and fight infection

Types of immunity

There are two basic types of immunity

Natural immunity.

Is the type of immunity which is either Inherited or Acquired during the lifetime of an individual

For example;

When the body makes antibodies against a pathogen after recovery from an infection, or when antibodies are passed from mother to child across the **Placenta** and during **Breasting**.

Artificial immunity.

Is the immunity acquired as a result of deliberate exposure of the body of an individual to **antibodies or antigens in non-natural situations**

For example;

during Vaccination/**Immunization**.

NB: Both natural and artificial immunity can be actively or passively acquired

Assignment

Research and summarize about;
natural passive and natural active immunity, artificial passive and artificial active immunity

Role of blood in defense against disease

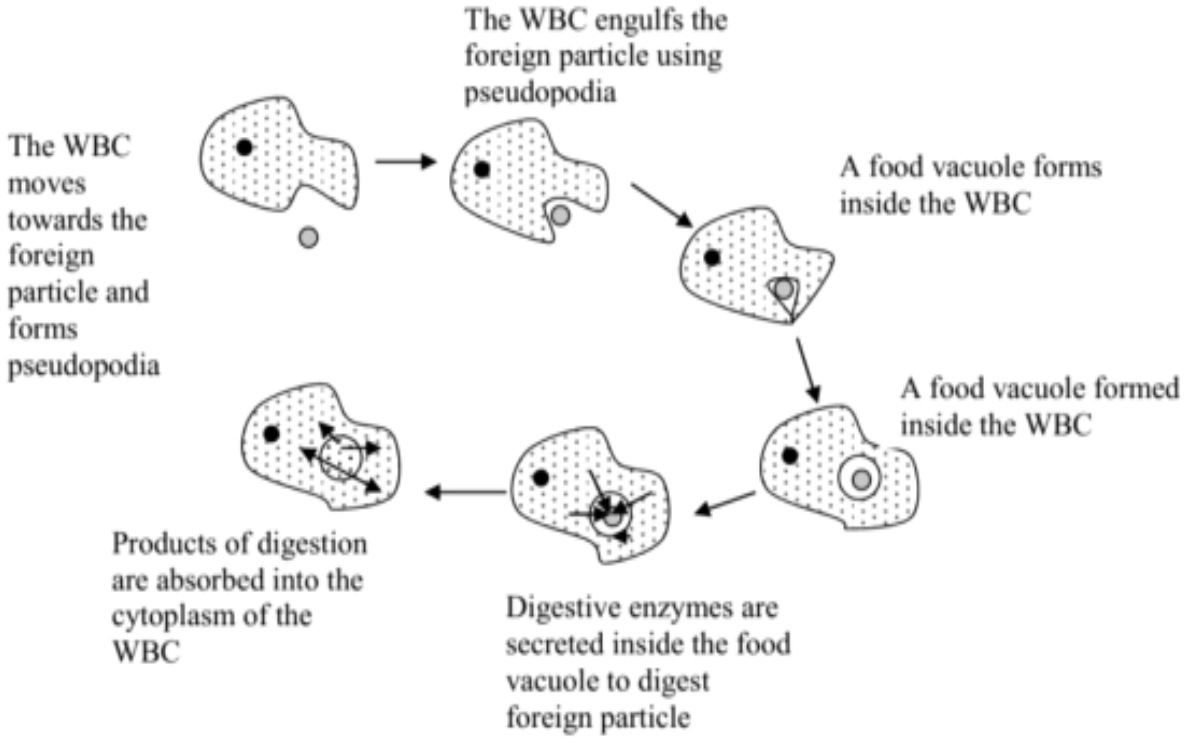
Components of blood defend the body against infection in three ways;

Clotting of blood by platelets and fibrinogen. The clot formed acts as a physical barrier preventing entry of pathogens into the body at the site of injury.

White blood cells known as phagocytes engulf pathogens then release enzymes that digest the pathogens which enter the blood stream and body tissues.

This process is known as **Phagocytosis**.

Illustration of Phagocytosis



White blood cells also release antibodies in the bloodstream in response to presence of foreign antigens such as pathogens.

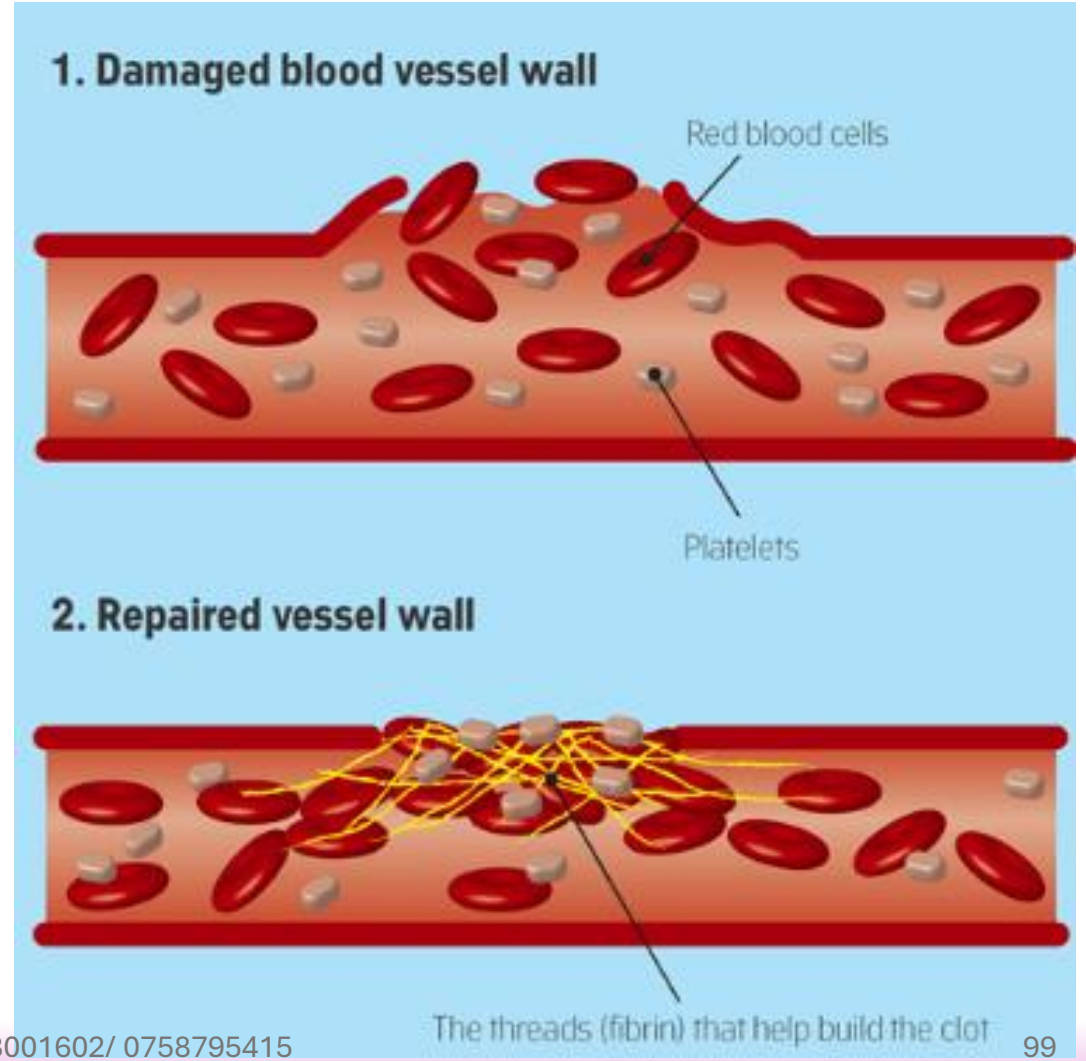
These antibodies destroy the invading pathogen before it causes any infection to the body.

This is known as an ***Immune response to disease.***

Blood clotting (coagulation)

Is the process by which blood stops oozing out of a cut or wound by formation of a clot.

Clotting of blood occurs when a blood vessel is injured or raptures either externally or internally to quickly stop loss of blood.



Process of blood clotting/coagulation

Blood clotting is a complex process that involves substances known as Clotting factors.

- ✓ When a blood vessel is injured/cut/raptures, the damaged cells and raptured platelets release **Thromboplastin** which stimulates the conversion of the Inactive plasma protein, **Prothrombin** to an Active enzyme, **Thrombin**.
- ✓ In presence of Calcium ions and Vitamin K, **Thrombin** catalyzes the conversion of a soluble plasma protein, **Fibrinogen** to its insoluble form, **Fibrin**.
- ✓ The **Fibrin** forms a mesh-work of threads across the wound/damaged part, in which red blood cells become trapped. These dry to form a **Clot**.

Importance of blood clotting

- ✓ Prevents excessive loss of blood from the body.
- ✓ Blood clot forms a physical barrier that prevents entry of pathogens into the body.
- ✓ It is a step towards the healing of cuts and wounds.

Consequences of excessive bleeding

- ✓ Reduces blood volume which then reduces blood pressure hence slowing down flow of blood to vital body organs like the brain. This can lead to unconsciousness and eventually death
- ✓ Reduces number of red blood cells which lowers the ability of blood to carry oxygen (Anaemia).

Effects of infections on the body's immunity

Some pathogens such as the HIV attack and destroy white blood cells.

This weakens the body's immune/defense system making other Secondary infections known as Opportunistic infections such as **Tuberculosis** to easily attack the body and the individual develops AIDs

NB: The immune system can also be weakened by Smoking, taking Alcohol and Poor Nutrition.

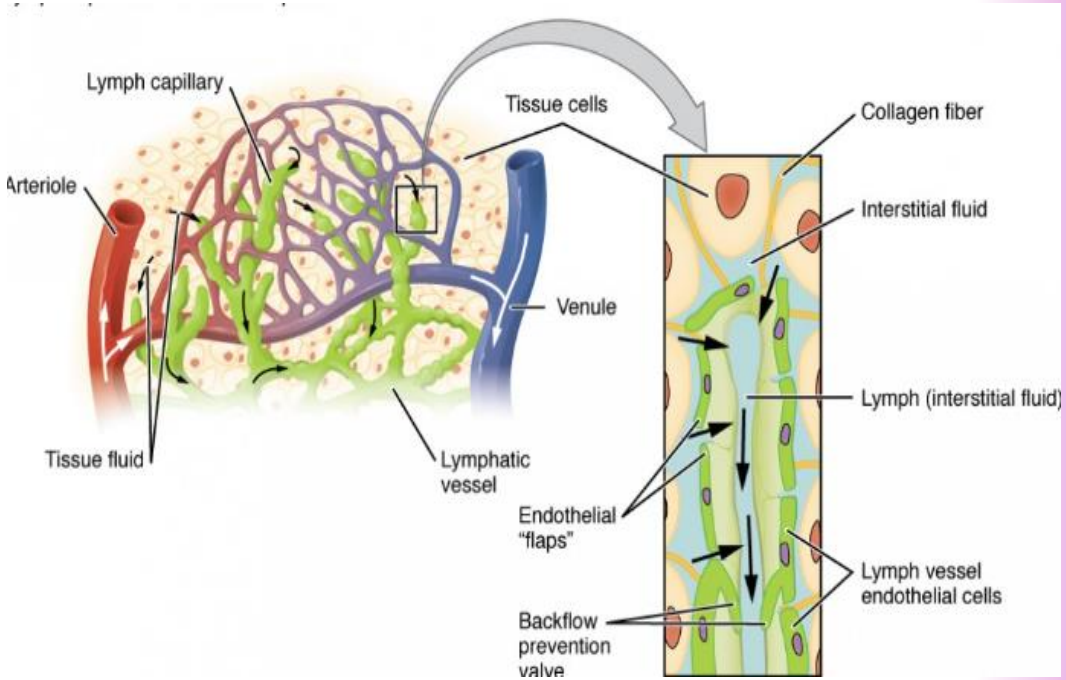
Capillary exchange, formation of tissue fluid and lymph

High pressure of blood flowing through arteries, arterioles and the capillary bed forces Small molecules such as ***glucose, amino acids, vitamins and the fluid part of blood*** to leave the capillaries and enter the spaces between the cells.

Large molecules such as ***plasma proteins and blood cells*** do not filter out and are left behind in blood.

This process is known as Ultrafiltration.

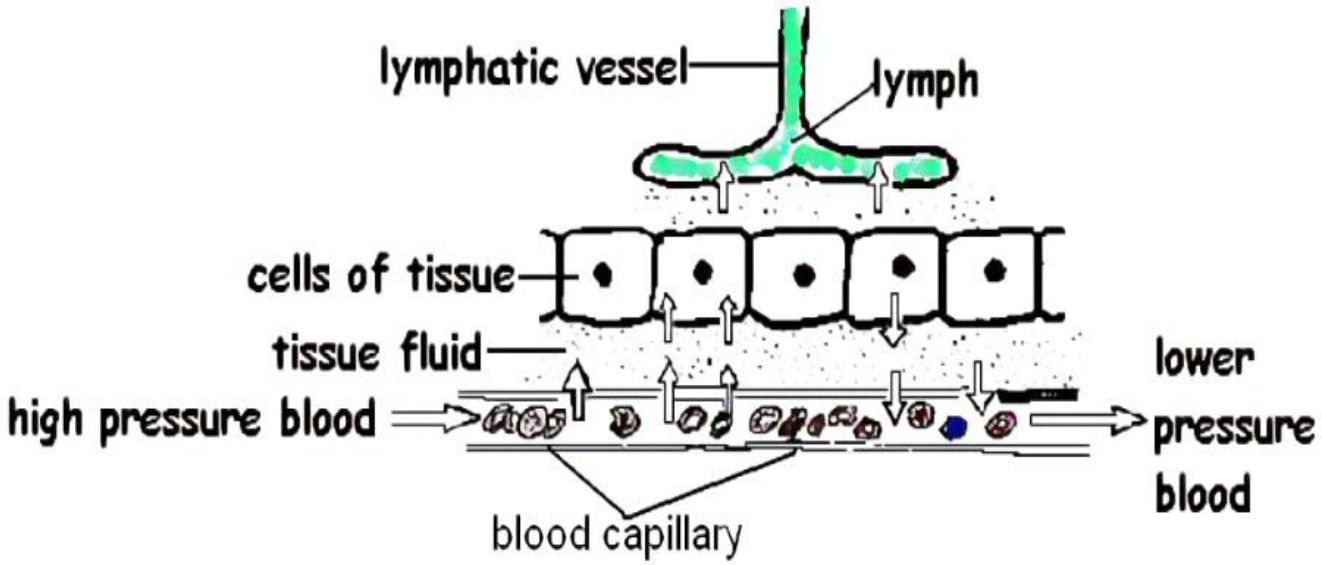
Once the fluid is in the intercellular spaces, it is called **Tissue fluid**



Tissue fluid circulates among the cells. The body cells obtain their requirements such as *Glucose, Amino acids, Oxygen* etc. from the tissue fluid and add excretory materials such as Carbon dioxide into the fluid.

Some of the tissue fluid returns to the blood capillaries at the venule/venous end while excess tissue fluid enters into a system of narrow vessels called vessels lymph where it forms **Lymph**.

Illustration



Flow of lymph around the body

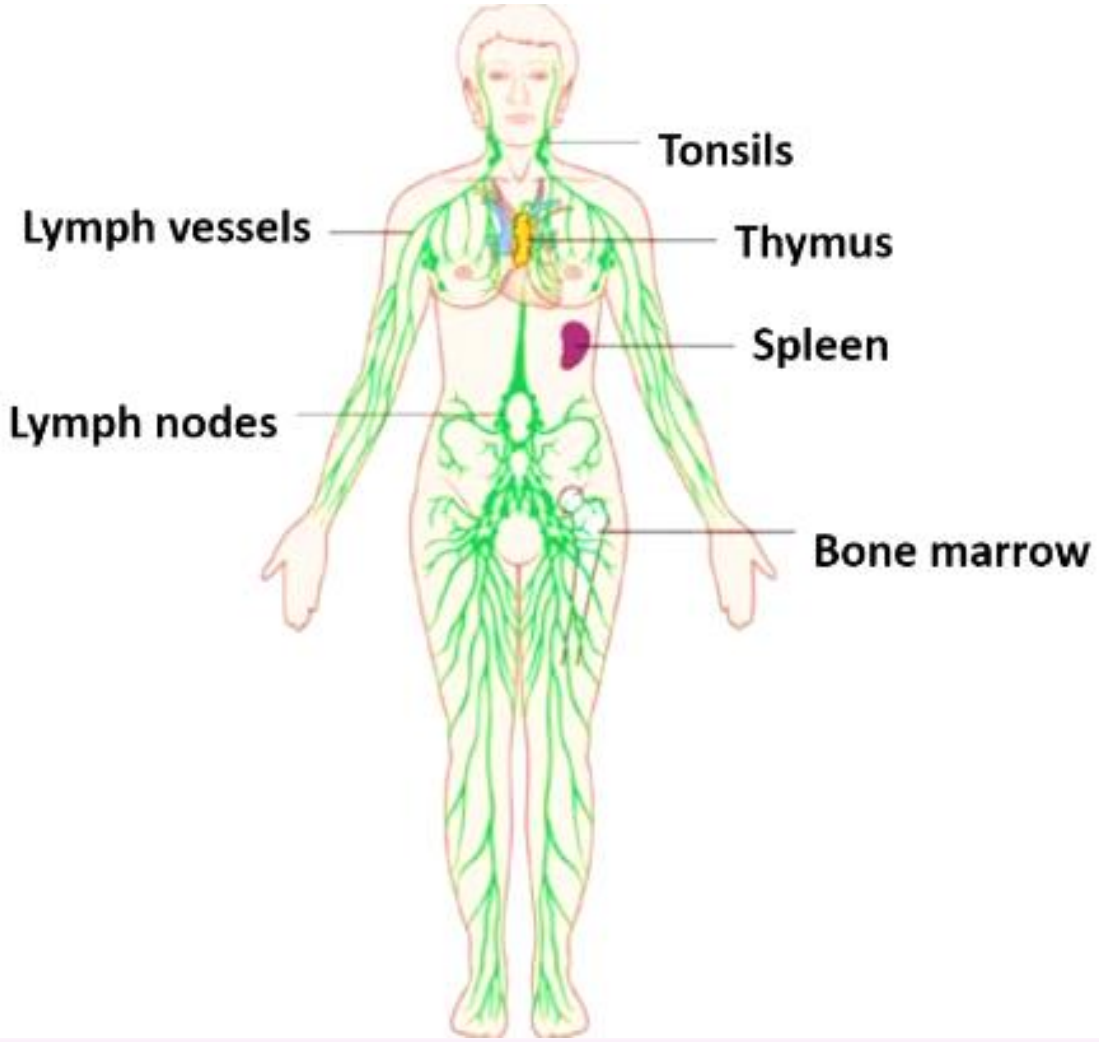
- ✓ Lymph is transported through lymph vessels.
- ✓ Movement of lymph through the lymph vessels is due to the **contractions** of the **skeletal muscles** surrounding the lymph vessels. As they contract and relax, they squeeze the lymph vessels to generate the force/pressure by which lymph moves.
- ✓ Lymph vessels also have **valves** to ensure that lymph flows in one direction
- ✓ Before reaching the blood, lymph passes through the **Lymph nodes** where **pathogens like Bacteria are removed**.
- ✓ The lymph then joins blood circulation via the **Thoracic ducts**, which join the vena cava returning the blood to the heart

The lymphatic system

This system forms the second type of circulation.

It transports materials using a fluid called Lymph which is transported within the lymph vessels.

The lymph vessels are connected to organs such as the **Thymus gland**, **Spleen**, **Bone marrow** and the **Lymph nodes**. These form the lymphatic system.



Roles played by the lymphatic system in maintaining a healthy body

- ✓ Drains lymph (excess tissue fluid) from the tissues back into the blood stream. This prevents conditions like **Oedema** (*Fluid retention*)
- ✓ Lymph nodes contain white blood cells called **Lymphocytes** that filter and destroy bacteria in the lymph.
- ✓ The lymphatic system also consists of the bone marrow and the thymus gland that are responsible for the production and maturation of Lymphocytes concerned with production of **Antibodies** which fight infections in the body

Infections that affect the lymphatic system

Elephantiasis

This is the enlargement/swelling of regions of the body whose lymph vessels have been infested with ***Filarial worms, Wuchereria bancrofti***

These worms are spread by the **Culex mosquito.**

Signs include;

Swollen Legs, Arms, Breasts, Scrotum.

The condition can be Treated using anti parasitic drugs like albendazole, Massage to stimulate lymph flow and reduce swelling

Tonsillitis

This is inflammation of the tonsils due to infection by either Bacteria (mostly streptococcus) or Viruses.

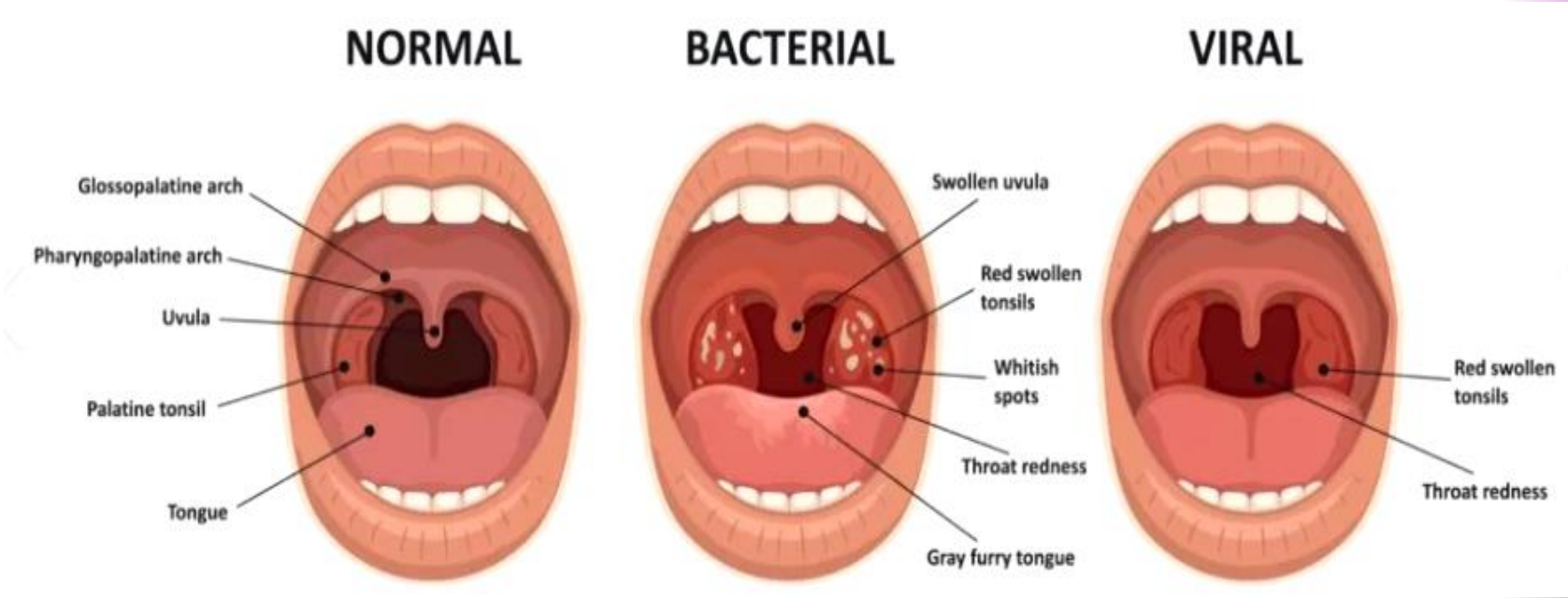
Signs include;

Swollen tonsils,

sore throat,

difficulty swallowing,

bad breath



Treatment involves use of antibiotics, pain relievers like ibuprofen to reduce pain and fever, surgery if chronic.

END

BIOLOGY IS LIFE

SLIDES PREPARED

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