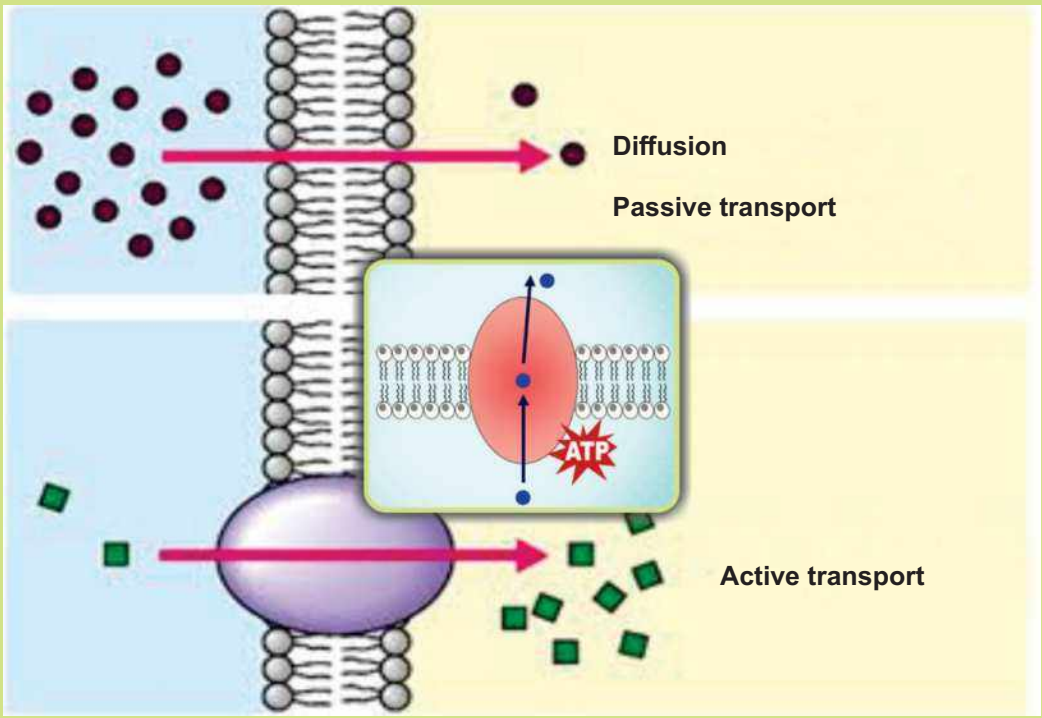
TRANSPORT

Chapter 9

Major Concept

In this Unit you will learn:

- Introduction
- Transport in Plants
  - Water and ion uptake (Structure and function of root hairs)
- Transpiration
  - Introduction and Significance
  - Factors affecting the rate of transpiration
- Transportation of Food and Water
  - Pathway of water and food in stem
  - Structure and function of Xylem and Phloem
- Transport in Animals
- Transport in Man
  - Blood
  - Components of Blood and their Functions
  - Disorders of Blood (Leukemia and Thalassemia)
  - Blood Groups and Blood Transfusion
- Human heart
  - Blood Vessels



Every organism requires number of substances for their survival and maintenance of healthy life. These substances or their raw materials are taken by organism from environment or may be from internal sources. If the distance between source and required organ is small enough, organism does not require any transport system but if the distance is too long then the organism require to develop a system called **transport system**. The transport system requires atleast two component.

(i) Transport of raw material from environment to organ where they required for metabolism.

(ii) Transport of metabolites from cell to organs where they require.

Plants are autotrophs which synthesize organic biomolecules from inorganic molecules. These inorganic molecules are transported from environment into plants, converted into biomolecules. These biomolecules are also transported within the plant where they required.

Animals are heterotrophs which get organic molecules as food, digest them into digestive tract, diffuse into blood and transport to organs where required.

9.1 TRANSPORT IN PLANTS

Root as important organ for water and Mineral transport:

Water and mineral salts enter the plant through root, so it is necessary to understand the external and internal structure of root. Externally, root has a root tip which is the growing part of root covered by root cap. The remaining part of root is highly branched and each branch is heavily covered by root hairs. Each root hair is a fine tubular outgrowth of an epidermal cell. It grows between soil particles which remains in close contact with the soil solution surrounding them.

Internally, we can study the root by taking transverse section (T.S.) of root. The T.S. of root shows that root is mainly consist of:

- **Epidermis** (Epiblema) the outer layer of cells, some of these cells have root hair.
- The **Cortex** part of root between epidermis and endodermis, consist of number of cellular layers.

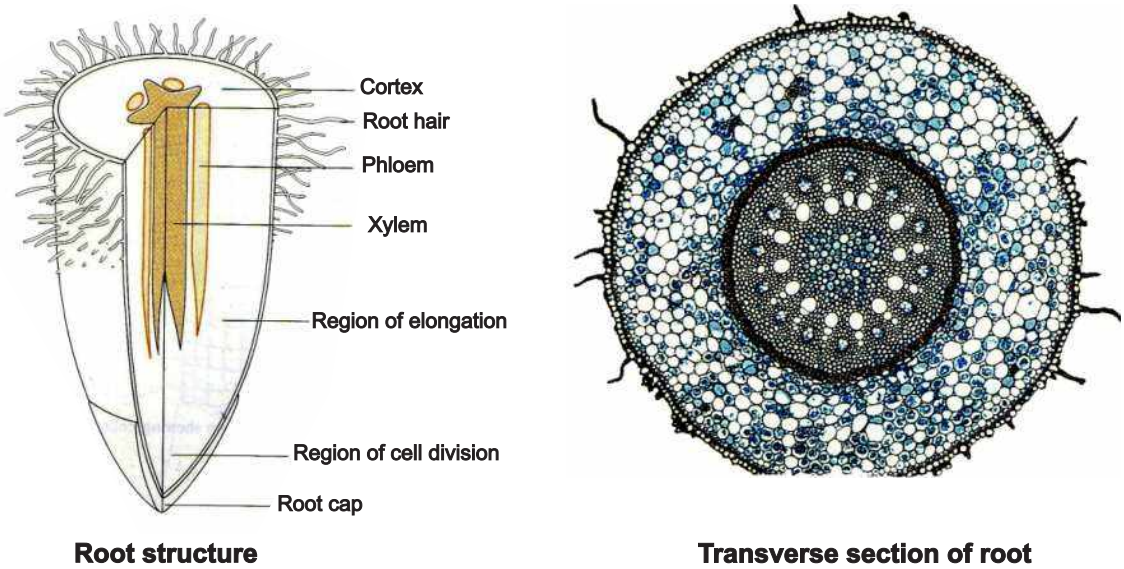


Fig: 9.1 Root structure with transverse section of root

9.1.1 Water and ions uptake:

The root absorb water and minerals from soil through root hairs. There are two processes of transport:

(a) **Passive transport:** The uptake of water and mineral by osmosis and diffusion without using energy of ATP. It is due to concentration gradient i.e. always takes place from high to low quantity of substances.

(b) **Active transport:** Movement of substances from low quantity to high quantity i.e. against the gradient and it requires energy of ATP. This movement is called active transport.

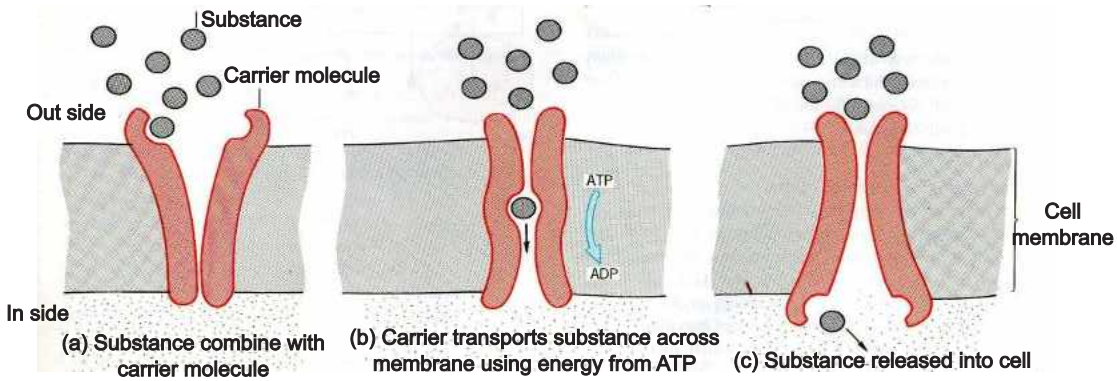


Fig: 9.2 Active transport

1. Uptake of Water From Soil:

The root hair is long, thin and tubular structure. It increases the surface area which increases the rate of absorption of water and minerals. The cell membrane prevents the cell sap (a mixture of sugar, salts and amino acids in solution form) from leaking out. The cell sap has low tendency of water loss i.e water potential, than the solution of soil which result in water movement from soil to root hair. This process of water movement from a solution of high water potential to a solution of low water potential is called **Osmosis**. As a result of osmosis of water, the root hair become turgid and their cell-sap become dilute than that of adjacent cells so the water moves from root hair to their neighbour cells. In this way, water may pass from cell to cell and finally forced into xylem and ascend up to the aerial part of plant. This upward movement of water with mineral is called ascent of sap, other factor and forces are also involved in ascent of sap.

For absorption of water by root, it is necessary that the solute quantity in soil solution should be low and solute quantity in sap should be comparatively high, otherwise the direction of water movement will be reversed and plant may die due to dehydration.

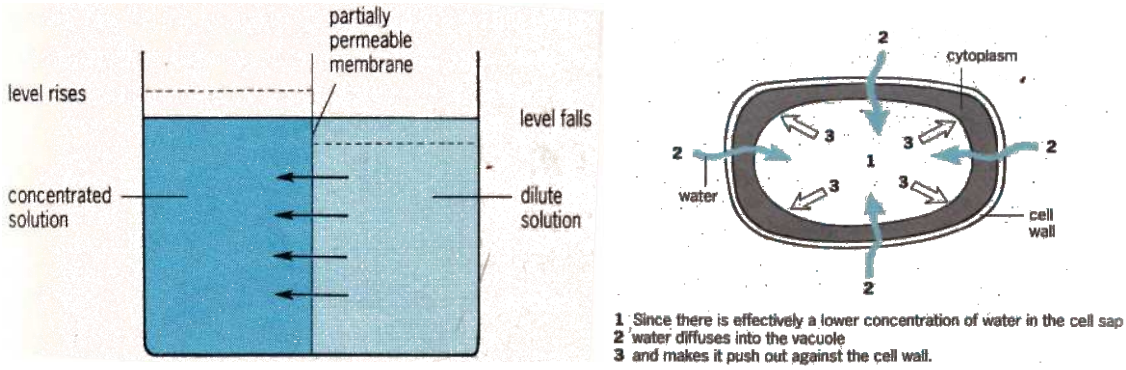


Fig: 9.3 Diagram showing process of Osmosis and Diffusion

2. Mineral transport:

Plant also require minerals i.e nitrates, sulphates, phosphates etc. These minerals are also taken up by root hair in two ways:

(a) By diffusion, when the concentration of certain ions in soil is higher than that in root hair cells i.e passive transport.

(b) By active transport, plant requires some substance even they found in soil in low quantity. The roots have to absorb these ions against a concentration gradient by using energy of ATP, which is active transport.

9.2 TRANSPIRATION

Plants absorb water continuously from soil. Some of its quantity utilized in photosynthesis and other metabolic functions while the rest is retained in cell to maintain turgidity of cell. Some water is removed in the form of vapours. This loss of internal water of plant in the form of vapours from aerial part of plant is called **transpiration**. Transpiration mainly takes place through special pores guarded by specialized guard cells called **stomata** (sing: stoma).

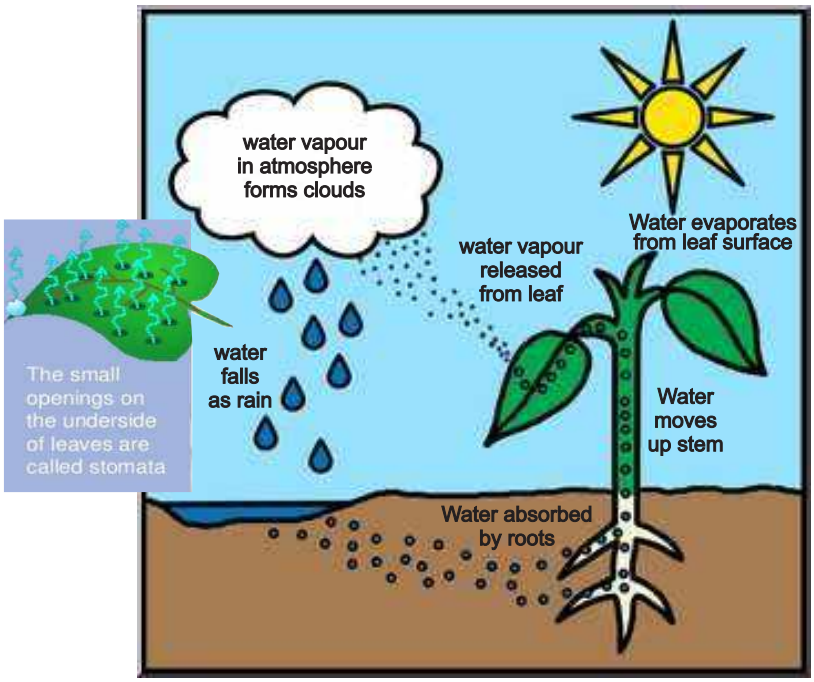


Fig: 9.4 Transpiration – showing loss of water vapours from stomata

Evidences of transpiration:

- Take a potted plant and wrap a polythelene bag around pot not around the plant to make sure that water is not coming from soil of pot and surface of pot.

- Place the pot on the glass plate and cover it with dry bell jar.
- Take another jar without plant for control setup.
- Put these two jars side by side in an area where light fall on it for two hours.

Observation:

You will observe water droplets at the bell jar which has plant while other jar remains dry.

9.2.1 Relation of transpiration with leaf surface:

Plants have three types of leaves on the basis of stomatal distribution.

(i) Leaves that have stomata at lower epidermis called **bifacial leaves** e.g leaves of mango plant.

(ii) Leaves that have stomata at both surfaces (upper and lower epidermis) called **monofacial leaves** e.g leaves of maze plant.

(iii) Leaves that have stomata at upper epidermis only e.g leaves of water lily.

Activity: To find that transpiration mainly take place through stomata perform simple experiment.

Requirement:

Few leaves, petroleum jelly or wax, scale etc.

Procedure:

- Take three leaves of pepal or mango tree where stomata are mainly present at lower surface of leaves.
- The leaves should be of equal size.
- Treat leaves as follows:
  Leaf 1- cover the upper epidermis surface with petroleum jelly or any wax.
  Leaf 2- cover lower surface with same.
  Leaf 3- cover both surfaces with same.
- Weigh each leaf before and after covering.
- Hang these leaves near window in sunlight.
- After few hours note the conditions and weigh again.
- Leaf which loss more weight transpire effeciently.
- It will be observed that the leaf 1 transpire more effeciently because it has stomata at lower epidermis.

The experiment shows that most of the water vapour is lost from the surface where stomata are present.

Surface area of leaf is also an important factor for the rate of transpiration, because the larger size leaves have high number of stomata which increases the rate of transpiration. The desert plants require to save their water so they have smaller size leaves or their leaves become spines to reduce number of stomata as well as rate of transpiration.

9.2.2 Stomata and its opening/closing mechanism:

Stomata are the pores usually found in the leaf epidermis surrounded by two kidney shaped guard cells, these cells contain chloroplast while other epidermal cells do not. The guard cells control the opening and closing of stomata. The inner wall of guard cells is thick and inelastic whereas the outer wall is thin, elastic and permeable. The changes in the turgidity of guard cells controls the opening and closing of stomata. Stomata open when the guard cell become turgid and close when the guard cells become flacid. The turgidity of guard cell is regulated by concentration of solutes present in it which mainly depends upon the rate of photosynthesis. Opening and closing of stomata is one of the important factor to control rate of transpiration. The stomata remain open during the sunny day, as a result rate of transpiration increases. But at night they are closed, hence transpiration also stops.

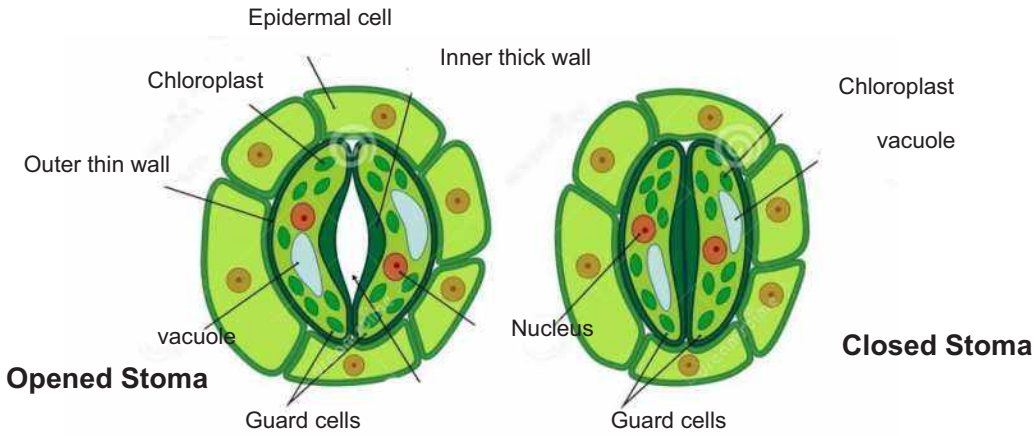


Fig: 9.5 Diagram showing opening and closing of stoma

9.2.3 Significance of transpiration:

Transpiration maintains low concentration of water and high concentration of solutes in cell i.e. high solute potential. The high solute potential of leaf cells attract more water and draw more water from xylem. This continuous withdrawl of water from xylem develops deficit of water in xylem which develops a pull or tension called transpiration pull. As a result of this transpiration pull and water attraction for other water molecule i.e cohesion of water, water is pulled upward in the xylem vessels through a continuous column called transpiration stream, which helps in ascent of sap.

- By active transpiration, transpiration pull is created which helps in the ascent of sap.
- Transpiration also increases the rate of absorption because the loss at one end increases demand on other end.
- Transpiration gets rid of the excess amount of water from plant.
- Transpiration helps in mantaining the temperature of plant for its metabolism and survival because evaporation causes cooling.
- Opening and closing of stomata is also regulated by transpiration, which indirectly influences upon the rate of photosynthesis and respiration.

Every year number of plants die in hot summer day due to excessive loss of water from aerial parts which results in wilting and dehydration and ultimately may lead to death of plant in extreme conditions.

Transpiration is considered as necessary element for plant due to its advantages which are discussed above but on the other hand, it is also considered as an evil for plant because million of plants die every year due to excessive transpiration.

9.2.4 Factors affecting the rate of transpiration:

The rate of transpiration is also affected by some of the following environmental factors.

(i) **Temperature:** Rate of evaporation of water from cell surface increases with increase in temperature.

(ii) **Humidity:** Transpiration takes place only when concentration of the vapours must be low outside than inside, so dry atmosphere is also the condition for transpiration.

The rate of transpiration decrease with the increase in water vapours in atmosphere i.e. humidity.

(iii) **Wind:** The increase in wind velocity increases the rate of transpiration. The wind decreases the water vapours around plant and make the atmosphere dry.

(iv) **Atmospheric Pressure:** Low atmospheric pressure increases the rate of transpiration through reduction in the density of air.

9.3 TRANSPORT OF WATER AND FOOD IN STEM

Flowering plants have a system of vessels for transport of water, minerals and food. These vessels are called transport or vascular tissues. There are two types of transport tissues in plants.

Xylem (Wood):

In flowering plants xylem is made up of four type of tissues but the main tissues are the xylem vessels. A xylem vessel is a long, hollow, tubular structure from root to leaf. It is made up of many dead cells arranged vertically. The walls of these vessels become strong by the deposition of chemical substance called lignin.

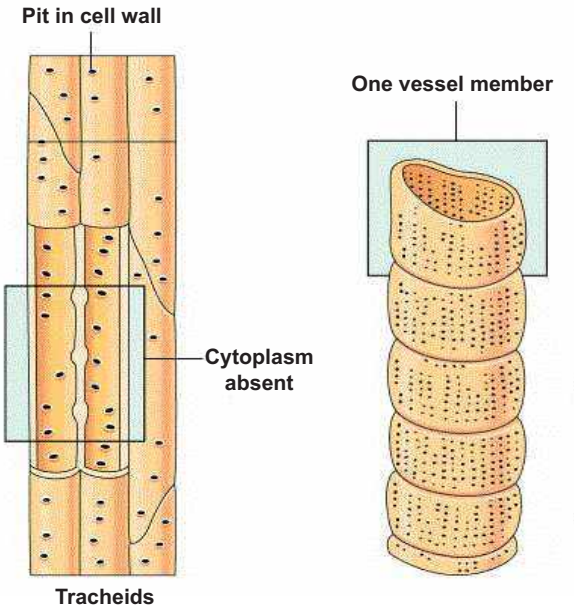


Fig: 9.6 Xylem conducts water and dissolved minerals

9.3.1 Water and mineral transportation:

Dead cells of xylem vessels arranged vertically have empty space inside called lumen, without protoplasm and end walls. This tube reduces the resistance of water flowing through the xylem. It gives faster passage to sap, as a result transpiration pull is created in leaf. The thick, rigid and lignified walls of vessels also provides mechanical support which strengthen the wall.

Phloem (Bast):

Like xylem, phloem is also made up of four type of tissues but mainly consist of sieve tubes and companion cells. Phloem conducts manufactured food (sucrose) from part of plant where it is synthesized in high quantity to other parts of plant where it is required.

The sieve tubes or sieve tube elements of phloem is made up of columns of elongated and thin walled living cells. The transverse walls separating the cells have lots of minute pores. The cross walls look like a sieve and therefore called **sieve plates.**

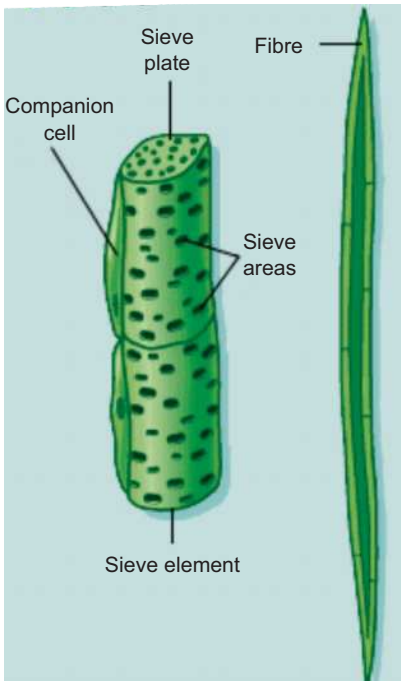


Fig: 9.7 (a) Phloem and its component

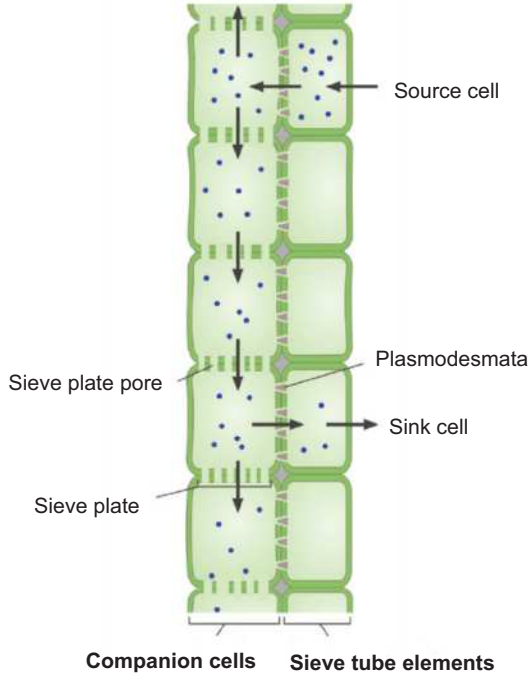


Fig: 9.7 (b) Phloem "conduct of food"

A mature sieve tube cell has only a thin layer of cytoplasm inside the cell. This cytoplasm is connected to cells above and below through sieve plates. Each sieve tube cell has lost its central vacuole, nucleus and most organelles. Each sieve tube cell has a companion cell beside it, which carries out the metabolic processes need to keep the sieve tube cells alive. Each companion cell is a narrow, thin walled cell with many mitochondria, cytoplasm and a nucleus. Companion cells provide nutrients and help the sieve tube cells to transport manufactured food.

Conduction of food by phloem:

In contrast to sieve tube cell, the companion cells have many mitochondria to provide energy needed for the companion cells to load sugar from mesophyll cell to sieve tube cells by active transport. The perforations of sieve plates allow rapid flow of manufactured food substance through the sieve tube.

9.3.2 Transport of organic materials (food) in plants:

In higher plant, only the green parts specially leaves can manufacture food and it must be supplied to other non green parts like root, stem and flower for consumption and storage.

The movement of organic materials (food) take place through phloem. Along with food, phloem also conducts other substances such as vitamins, hormones etc. The movement of prepared food from leaves to different parts of plant through phloem elements (sieve-tubes) is called translocation.

It is an established fact that translocation of solutes take place through phloem but it is still debatable that how it occurs. Several hypothesis and theories have been proposed to explain the mechanism of translocation. Among them bulk-flow or Munch hypothesis is the most convincing.

According to this hypothesis, solutes are translocated through the sieve tubes which flow in bulk from the supply end i.e source (leaves) to the consumption end i.e sink (root) under a turgor pressure gradient.

As a result of photosynthesis, the supply ends (leaves) have a large amount of organic solutes, which causes tremendous increase in suction

pressure of leaf cells (Mesophyll cells) and they draw water from the xylem of the leaf. As a consequence their turgor pressure is increased. The turgor pressure in the cells of stem and root is comparatively low and hence, the soluble organic solutes begin to flow in mass from mesophyll through sieve-tubes down to the cells of stem and root under the gradient of turgor pressure. These solutes are either consumed or stored in insoluble form. The excess water is released back into the xylem vessels.

9.4 TRANSPORT IN ANIMALS

cytoplasm of unicellular animals remains very much close to plasma membrane which remains in contact with environment. In these animals oxygen can diffuse through the body surface and reach easily to energy producing organelles. Similarly, the waste products can rapidly move from the body by simple diffusion.

On the other hand, in multi-cellular organisms like mammals including man, many cells are situated away from environment. Only simple diffusion is not enough to supply O_2 (oxygen) to these cells and to get rid of wastes from there. It needs proper transport system to carry substances from one part of the body to another. The system involved in the transport of various substances within the body of an animal is called Circulatory System. The circulatory system transports gases like O_2, CO_2 etc, nutrients, wastes, hormones and defense proteins.

There are two types of Blood Circulatory Systems found in animals

(i) Open circulatory system

(ii) Closed circulatory system

(i) Open circulatory system:

In this type of Circulatory System blood flows through the spaces among tissue so it directly comes in contact with tissues. It remains filled in the open tissue spaces called Sinuses.

After exchange of materials with tissues, blood enters the pumping organs or heart which pumps it into blood vessels.

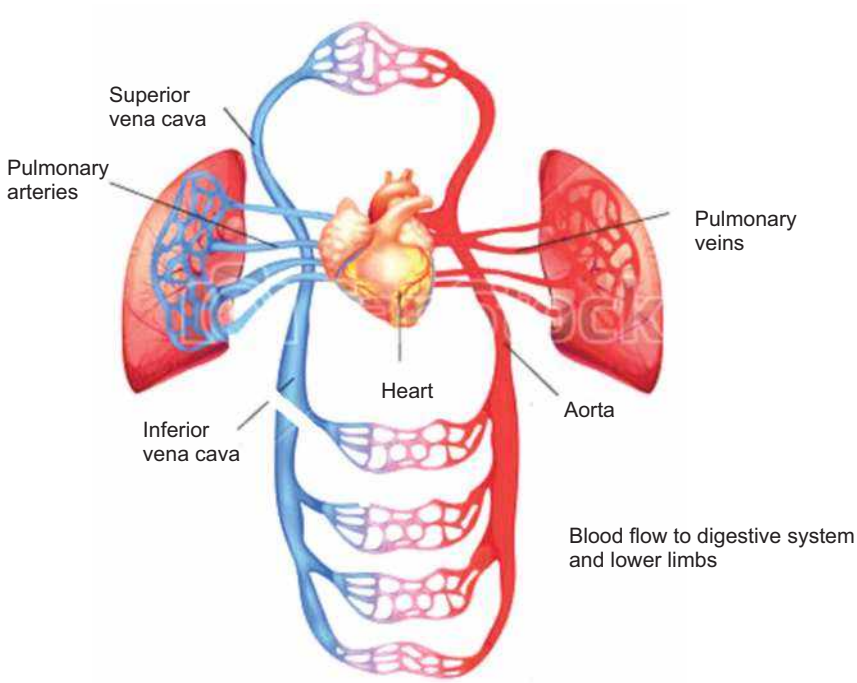


Fig: 9.8 Blood flow to head and arms

These vessels again drain out blood into sinuses so it remains in Circulation. This type of circulatory system found in arthropods and molluscs.

(ii) Closed circulatory system:

This type of system allows blood to flow inside the closed tubular blood vessels and never comes out in direct contact with tissues.

9.5 TRANSPORT IN MAN

In man, closed type of circulatory system is found, which consists of following components.

(i) Blood: A fluid with cells and other dissolved substances.

(ii) Heart: A pumping, pulsatile organ.

(iii) Blood vessels: Tubes i.e. Arteries, veins and capillaries.

This is much more efficient and rapid system of transport.

9.5.1 Blood:

Blood is a special type of tissue, found in the form of fluid which circulates in the body. It transports substances in the body of an organism. It consists of two parts:

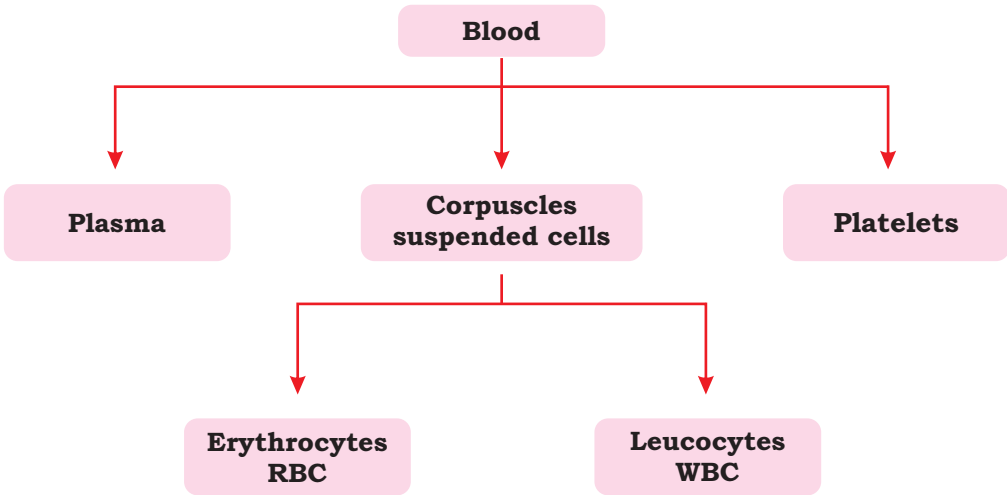
(i) Plasma (ii) Corpuscles

(i) Plasma:

Plasma is the fluid part of blood and constitutes about 55% by volume of whole blood. It is pale yellowish liquid. About 90% of plasma is water in which complex mixture of various substances are dissolved. There are dissolved mineral salts like bicarbonates, sulphates, chlorides and phosphates of sodium (Na) and potassium (K). All these are found in the form of ions. Salts of calcium are also present in blood for clotting of blood.

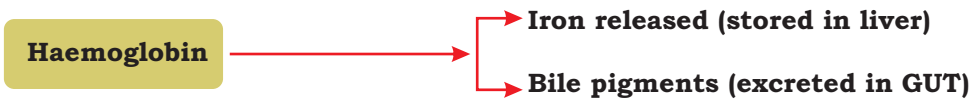
Soluble proteins are also present in plasma i.e. Serum albumin, Serum globulin, fibrinogen and prothrombin. The last two play important part in clotting of blood. Antibodies are also present in plasma, which are involved in fighting diseases.

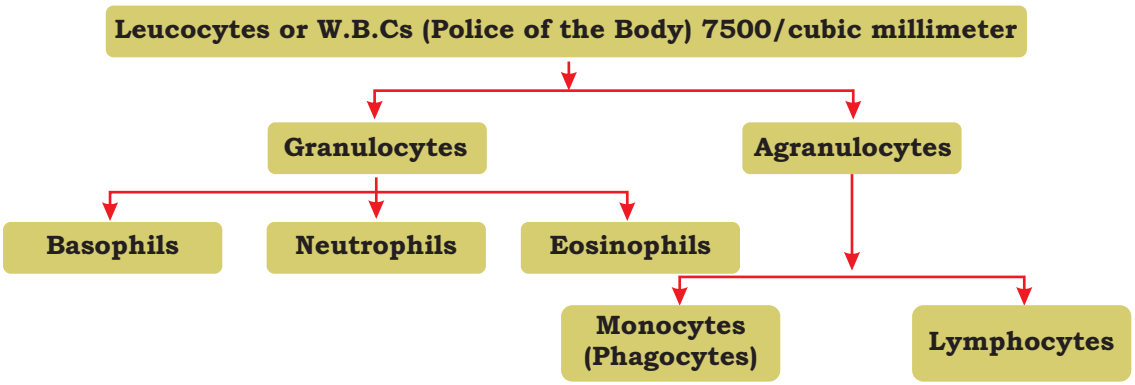
Plasma contains digested food substances such as glucose, amino acids, fatty acids and vitamins. It also contains excretory products such as Urea, Uric acid and creatinine. Carbondioxide (CO_2) is also present as bicarbonate ions. It also contains hormones.



Erythrocytes (R.B.Cs)	
SHAPE	Bi-concave; Circular like disc
SIZE	0.007-0.008 mm in diameter
COMPOSITION	Non-nucleated, contain red pigment haemoglobin protein containing iron.
QUANTITY	5,000,000/cubic millimeter
PLACE OF PRODUCTION	Bone marrow
LIFE	120 days on Average
PLACE OF DESTRUCTION	Spleen and liver
FUNCTION	Transports O_2 from lungs to body cell Transports CO_2 from body cell to lungs

Break down of Haemoglobin





Leucocytes or WBCs are colourless, irregular in shape, nucleated and lager sized cell than R.B.Cs. They protect the body by killing germs that enter the body. There are several types of White blood cells which perform different functions.

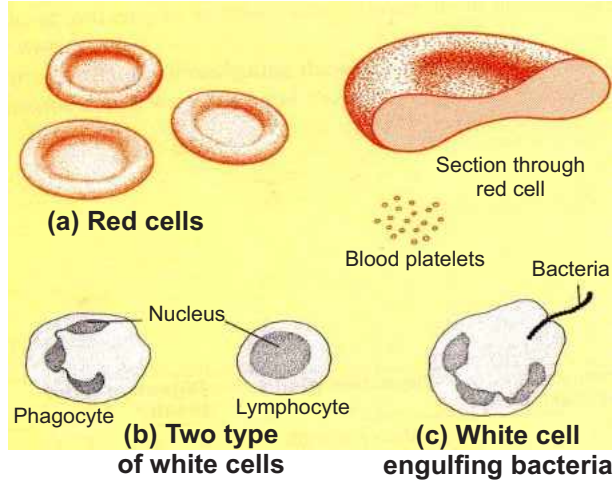


Fig: 9.9 Blood cells

Types of WBCs	Description	Average number	Function
(A) Granulocytes			
Neutrophils	About twice the size of RBCs, nucleus 2 to 5 lobed	62% of W.B.Cs	Destroys small particles by Phagocytosis
Eosinophils	Nucleus bilobed	2% of W.B.Cs	Inactivates inflammation producing substances, attack parasite
Basophils	Nucleus bilobed	Less than 1% of W.B.Cs	Release heparin to prevent blood clots and histamine which causes inflammation
(B) Agranulocytes			
Monocytes	3 to 4 times larger than RBCs, nuclear shape from round to lobed	3% of W.B.Cs	Macrophages, destroys large particles by phagocytosis
Lymphocytes	Slightly larger than RBCs, nucleus nearly occupies cell	32% of W.B.Cs	Immune response by producing antibodies

(ii) Platelets:

Platelets are the fragments of cells which are formed from large precursor cells in the bone marrow. On injury, exposure to the air stimulate the platelets at cut end to produce an enzyme in blood. This enzyme causes the soluble plasma protein fibrinogen to form insoluble fiber of another protein fibrin which forms a network of fibers around wound. It protects blood to flow, that is called clot, which prevents bleeding and stops the entry of pathogen.

Blood disorders:

(a) Leukemia:

It is a type of cancer that affects the blood, bone marrow and lymphatic system. In this type of blood cancer, number of W.B.Cs increases and R.B.Cs decreases.

Symptoms:

- Fever or chill
- Frequent or severe infections
- Swollen lymph node
- Easy bleeding or bruising
- Ting red spots on skin
- Bone pain or tenderness
- Persistent fatigue, weakness
- Loss of weight without try
- Enlarge liver or spleen
- Recurrent nose bleeding
- Sweating at night

Causes:

Leukemia is thought to occur when some blood cells acquire mutations in their DNA. Some abnormalities cause the cell to grow and divide more rapidly and continue living when normal cells would die. With passage of time, these abnormal cells in the bone marrow, leading to fewer healthy white blood cells, red blood cells and platelets.

- Genetic disorder
- Exposure to certain chemicals
- Smoking
- Family history

(b) Thalassemia:

It is the name of a group of inherited conditions that affect the blood haemoglobin. Persons having thalassemia do not produce or produce little amount of haemoglobin, which is used by red blood cells to carry oxygen around the body. Person having problems of thalassemia having following symptoms.

Symptoms:

- A pale and restless appearance
- Slowed growth and delayed puberty
- An enlarged spleen, liver or heart
- Poor appetite
- Dark urine
- Jaundice

Thalassemia major:

It occurs when a child inherits two mutated genes, one from each parent. Children born with this disorder usually develop the symptoms of severe anemia within the first year of life. They lack the ability to produce normal, haemoglobin and feel chronic fatigue.

Thalassemia minor have occurred when a child inherit it from one of the parent. Persons have mild anemia and slight lowering of haemoglobin level in the blood. It resembles with mild iron deficiency anemia. People with this disorder do not have any symptoms.

9.5.2 Heart:

Heart is the major organ of Circulatory system. It is a muscular pump which keeps the blood circulating through out the body. It is located in the thorax slightly at the left side. It is enclosed in a fibrous bag like protective cover called Pericardium. It is conical in shape externally. The space between pericardium and heart is pericardial cavity which is filled with a fluid called pericardial fluid. This fluid reduces friction and Pericardium protects the heart, prevent it from over extension.

Internally, it consists of four chambers, the upper two are thin walled called atria (sing: artrium) the lower two are thick walled called ventricles. Atria are completely separated from each other by a septum called inter-atrial septum. Similarly, the two ventricles are also separated from each other by a muscular partition called inter-ventricle septum. Each atrium is connected with its ventricle by an auriculo-ventricular aperture. The

right atrium and right ventricle are connected by Tricuspid Valve. Similarly, left atrium and left ventricle are connected by bicuspid valve. These valves prevent the backward flow of blood from the ventricles to the atria. Two main blood vessels are arising from ventricles to carry blood from heart to all parts of the body.

The blood from the right ventricle is pumped through pulmonary arch to the lungs for oxygenation while the blood from the left ventricle is pumped through a systemic aorta to all the parts of the body. The pulmonary arch and systemic aorta, both are guarded by semi-lunar valves to prevent backward flow of blood.

There is a difference in thickness of muscle wall of the left ventricle as compared to right ventricle.

The left ventricle is much thicker and narrow in space. This is related to their functions. The right ventricle only pumps blood to the lungs while the left ventricle pumps blood to all other parts of the body. The resistance to blood flow through the body capillary networks is for higher than that through the lung capillaries so, a high pressure is developed in the systemic circulation, it requires a thicker muscle wall and narrow space.

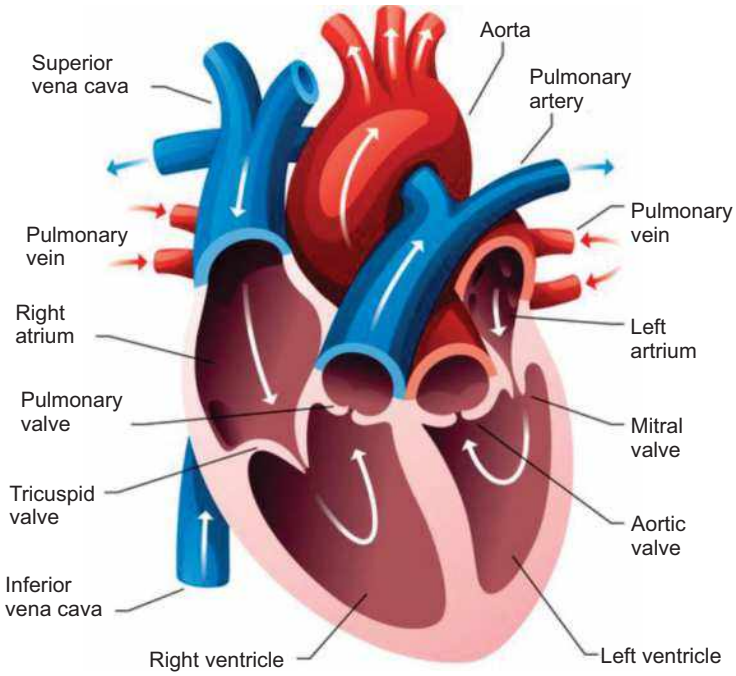


Fig 9.10: of Heart (internal and external L.S. of heart).

The function of atria is to stretch to receive blood as it returns to the heart and then contract with enough force to push the blood through the atrioventricular valves into the ventricles. This requires a lower pressure than that developed in the ventricles, so the walls of the atria are much thinner and more elastic than those of the ventricles.

The circulation of blood in our body is called double circuit system because it circulates blood in two separate circuits and enter twice in heart during complete circulation. These two circuits are:

1. **Pulmonary Circuit;** from heart to lungs and back from lungs to heart.
2. **Systemic Circuit;** from heart to different organs and from organs back to heart.

1. Pulmonary circuit:

It transports blood from right ventricle to lungs through pulmonary arteries and flow back to heart in left atrium through pulmonary veins.

The deoxygenated blood from all over the body except lungs received in right atrium and then collected into right ventricle, upon contraction of ventricle this deoxygenated blood enters into pulmonary arch which supply this blood to the lungs, where blood gives up its CO_2 and receives O_2 from air at capillary level. The deoxygenated blood now becomes oxygenated which flow back to the left atrium through pulmonary veins. This oxygenated blood now circulates through the body by Systemic Circulation.

2. Systemic circuit:

Circulation of oxygenated blood from left ventricle through systemic aorta to all organs of body and back to heart by superior and inferior vena cava as deoxygenated blood is called systemic circulation or circuit. Upon contraction the left ventricle forces oxygenated blood into systemic aorta, the largest artery of our body. Initially, the aorta gives off three branches which supply blood to head, arms and shoulders. This aorta then descends down and gives off many branches which supply blood to their respective organs e.g. a branch which supplies blood to liver called Hepatic artery, another branch called renal artery supplies blood to the kidney and coronary artery to heart etc.

Heart beat:

The pumping of blood by the rhythmic pulsation of heart throughout the body is called heartbeat. It is a two phase pumping action of blood that takes less than a second. When blood is collected in the left and right atria, the heart receives an electrical signal that causes the atria to contract. This contraction pushes blood into the right and left ventricles through tricuspid and bicuspid valves respectively.

The second phase of pumping blood begins when the ventricles are full of blood. The electrical signals travel along a pathway of cells to the ventricles, this causes ventricles to contract. The relaxation of heart muscle and allowing the chambers to fill with blood, this phase of heartbeat is called **diastole**. The contraction of heart muscle and pumping the blood from the chambers into the arteries named as **systole**.

Heart rate:

The number of heartbeats in a minute i.e. the heart rate can be measured by the beating of heart. On average, a healthy heart beats 72 times in a minute. The normal range of heart rate is 60 – 100 beats in a minute. It is necessary to keep the heart rate within the normal range. The slow or fast heart rate may cause severe heart diseases. The heart rate may vary from person to person. The decreasing heart rate is a result of slow heartbeat, which leads to a condition called bradycardia. In this condition, the heart rate is too slow (or below 60 beats per minute) due to very slow heartbeat. This slow heart rate reduces amount of blood and oxygen to vital organs of body, and causes shortness of breath, dropping of blood pressure, extreme fatigue etc.

On the other hand, when a heart beats very fast (more than 100 beats per minute), this condition is called tachycardia. Due to this rapid heart rate, the function of heart becomes very hard. It means that the heart does not have enough time to fill with blood and enough blood is pumped forward. The tachycardia is caused by the fever, dehydration, excessive caffeine or a reaction to medication. Chest pain, dizziness and fainting are the symptoms of tachycardia.

Causes of tachycardia can be:

- Sudden cardiac arrest
- Weaken heart muscle
- Heart failure
- Lung diseases

Pulse rate:

Contrary to the heart rate, the pulse rate is exactly equal to the heartbeat. If the heartbeat is faster so as the pulse rate and if the heartbeat is slower, the pulse rate will be slower too. Taking a pulse is therefore a direct measure of heart rate.

9.5.3 Blood vessels:

The way large buildings have the corridors, similarly blood vessels run through all of the tissues of body, while some blood vessels are as wide as your thumb, most of them are much finer than a human hair. There are three types of blood vessels, which are;

(i) Arteries, (ii) Veins and (iii) Capillaries.

(i) Arteries:

Blood vessels carry oxygenated blood (except pulmonary artery) away from the heart. Right ventricle of heart pumps blood into the pulmonary artery that goes to the lungs. Left ventricle of heart pumps blood into the aorta (largest artery in body). Every organ receives blood from arteries that branch off the aorta. The first branch called the coronary artery, carry blood to the walls of heart itself. Other branches carry blood to the brain, intestine and other organs.

Arteries wall consist of three layers, the inner most layer, which is made up of epithelial tissues. The middle layer consists mostly of smooth muscle and elastic fibers. The outer wall is made up of flexible connective tissue. Because of layered structure arteries have both strength and flexibility.

(ii) Veins:

Blood vessels carry deoxygenated blood (except pulmonary vein) from body towards the heart. The walls of veins, like those of arteries have three layers, with muscle in the middle layer. However, the walls of vein are generally thinner than those of arteries. They have large lumen.

Blood pressure in the veins is much lower than the blood pressure in the arteries. Semilunar valves in the veins prevent backflow of blood. Flow of blood along the veins is assisted by the action of skeletal muscles on the veins.

(iii) Capillaries:

Microscopic blood vessels are found in the cells of tissues. They have walls made up of single layer of flattened cells called endothelium. Capillary walls are partially permeable that enable substances diffuse readily through it. They are originated from arterioles and branches repeatedly to provide large surface area for the exchange of substances between the blood and the tissue cells.

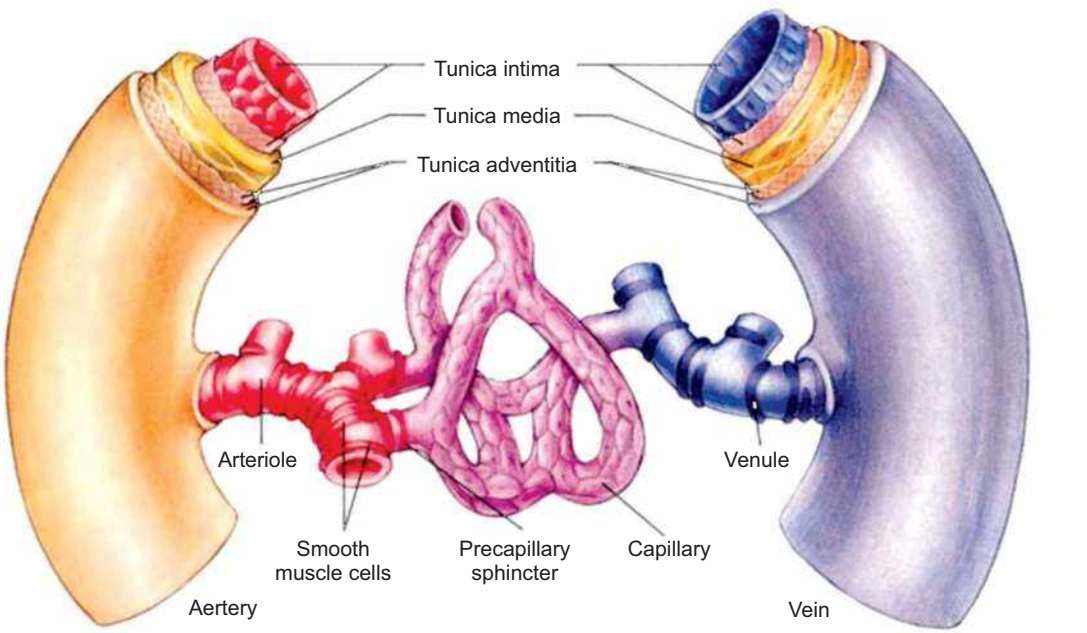


Fig 9.11 Network of blood vessels

Main arteries of the body:

The pulmonary artery which originates from the right ventricle carries deoxygenated blood towards the lungs and aorta which originates from the left ventricle carries oxygenated blood towards the body. Aorta terminates into arteries of the head, neck and arms. Aortic arch curls backward to the left side of the heart and continues downwards as the dorsal aorta, which distributes blood to regions of the body below the heart.

For example, it supplies blood (oxygenated) through hepatic artery to the liver, renal artery to kidney and femoral artery to lower limb.

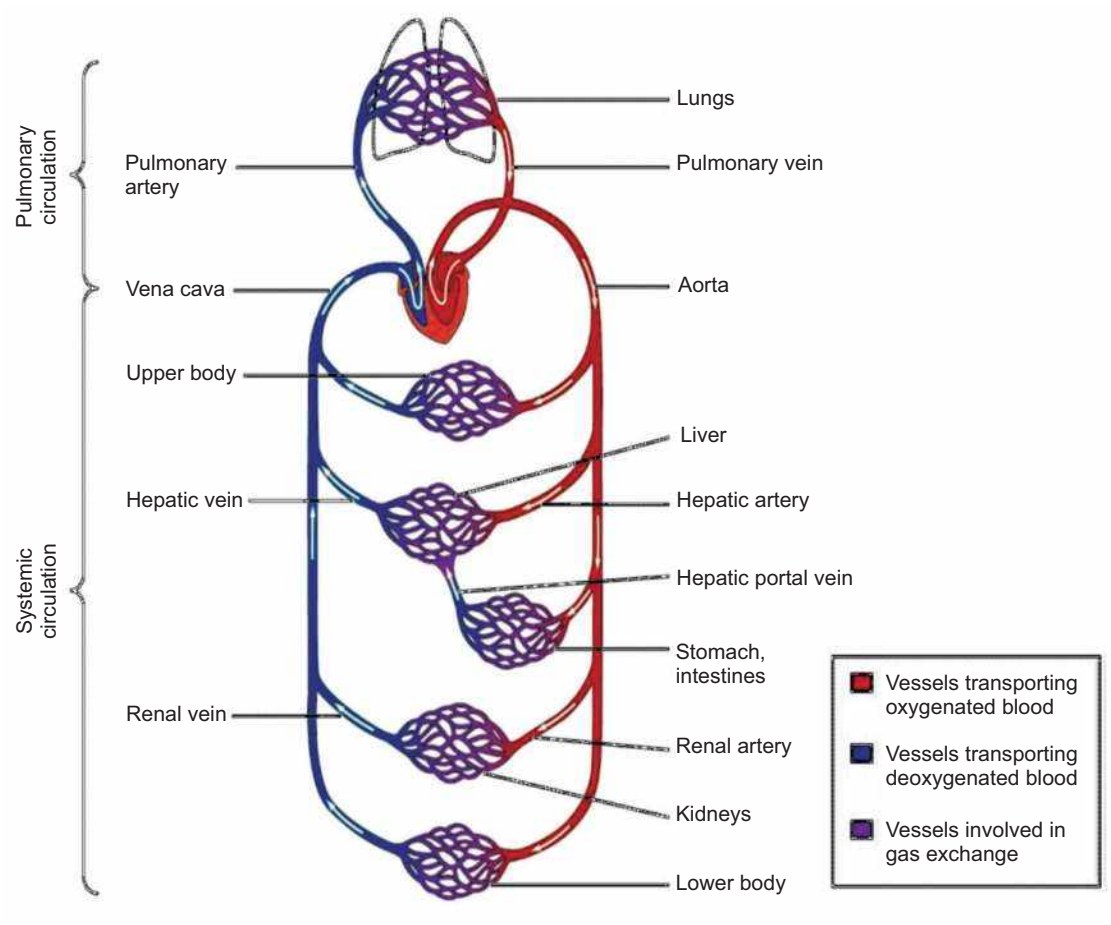


Fig 9.12 Diagram of human circulation

Main veins of the body:

Blood returned to the heart by the main veins as follows:

Pulmonary veins bring oxygenated blood from the lungs to the left atrium of the heart. Inferior vena cava runs upwards parallel to the dorsal aorta and brings deoxygenated blood from the lower body. Among these are renal vein bringing blood from kidneys, hepatic vein bringing blood from the liver and femoral veins bring blood from lower limb to the right atrium. Superior vena cava brings deoxygenated blood from the head, neck and arms to right atrium.

Ibn-al-nafees was the first Arab Physician to explain pulmonary circulation. He believed that all the blood that reached the left ventricle passed through the lungs.

William Harvey was an English Physician to explain systemic circulation in detail. He believed that blood being pumped to the brain and body by the heart.

9.5.4 Cardiovascular disorders (CVD):

Cardiovascular disorders related to cardiovascular system i.e. heart and blood vessels.

In recent days CVD becomes leading cause of death around the world so it is essential to understand them.

Atherosclerosis (ATH): Most common among cardiovascular disease is atherosclerosis (ATH). ATH is a disorder in which bad fats (i.e. low density lipoprotein or LDL and cholesterol) get deposited in blood vessels internal layer.

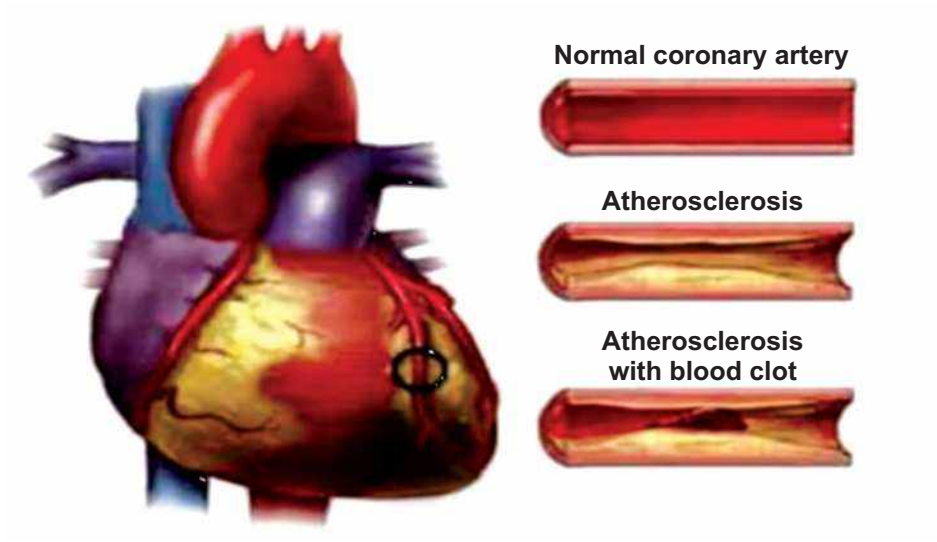


Fig 9.13 Cardiovascular disorders

Accumulation of fats leads to gradual narrowing of lumen of blood vessel. Narrow lumen leads to gradual compromise of blood supply to target organs, and leads to myocardial infarction and stroke.

Arteriosclerosis: It is a process in which arteries loss their elasticity due to some pathological process (e.g. ATH) or simply by aging. Loss of elasticity leads to high blood pressure which may eventually be able to lead to vascular hemorrhage.

Causes of myocardial infarction:

Causes of myocardial infarction can be divided in to non-modifiable factors (which we cannot change) and modifiable factors (which we can change).

Non-modifiable factors	Modifiable factors
Sex (More in males)	Stationary life (no exercise)
Age (More in old age)	Smoking
Race (More in blacks)	Stress
Family history	Heavy alcohol consumption
	High fat diet

Vascular surgery:

Vascular surgery is a prominent field of surgery in which vessels i.e. arteries, veins and lymphatic vessels are managed by vascular surgeons. Field gained very prominence when surgery involves bypass surgeries of heart, angioplasty, and fistula formation in cases of renal failure.

Leading causes of death in Pakistan:

In 2018 cardiovascular disorders (ischemic heart diseases) and stroke (paralysis which is due to damage of brain tissue) becomes major cause of deaths in the world. Stationary life style, poor socioeconomic status, unavailability of state of the art facilities of health, unavailability of doctors in rural areas, lack of health and dietary awareness, etc. all contributed to increase incidence of cardiovascular disorders in our country.

Summary

- Substances required to transfer from one place to another place in an organism requires a system called transport system.
- Autotrophs like plant requires inorganic molecules to synthesize organic molecules. The inorganic molecules transported from environment into them.
- T.S of root shows the internal organization of tissues from epidermis-cortex-endodermis.
- Root absorb H_2O and minerals by two processes:

  (i) Passive transport (ii) Active transport
- The upward movement of H_2O and mineral is called ascent of sap.
- It is the solute in soil should be low for root absorption.
- Loss of internal water of plant in the form of vapours from aerial part of plant called transpiration.
- Surface area of leaf is important for rate of transpiration due to presence of stomata.
- Stomata are the pores surrounded by two ground cells.
- Temperature, humidity, wind, atmospheric pressure are the factors responsible for the rate of transpiration.
- Flowering plant has system of vessels for the transport of water minerals and synthesized food i.e xylem and phloem.
- Xylem made up of four types of cells in flowering plants conducts H_2O and mineral.
- Phloem (Bast) is also made up of four different types of cells conduct synthesized food.
- Unicellular organisms do not require transport system because they remain in contact with environment.
- Multicellular large animals require transport system in the form of circulatory system. Theses are two types; (i) Open circulatory system and (ii) Close circulatory system.

- System where blood flows through spaces among tissues and remain in contact with tissues called open circulatory system.
- System where blood flows in vessels and never come in contact with tissues called close circulatory system.
- Blood is fluid tissue that circulates in body to transport substances.
- Blood has two main parts; (a) Plasma and (b) Corpuscles.
- Corpuscles are R.B.Cs. and W.B.Cs. where as fragments of cells called platelates.
- Leukemia, thalassemia are the blood disorders.
- Heart is major circulatory and muscular pump. In human it consists of four chambers.
- The circulation of blood in the body of man called circuit. There are two circuits in man.
  (i) Pulmonary circuit; Heart to lungs and lungs to heart.
  (ii) Systemic circuit; Heart to all body organs and all body organs to heart.
- Pumping of blood by rhythmic pulsation of heart through out the body is called heart beat.
- Phase of heart beat where cardic muscle contract called systolic and where it release diastole.
- Arteries, veins and capillaries are blood vessels required for transport of blood.
- Atherosclerosis, myocardial infection are the vascular disorder.

Review Questions

1. Encircle the correct answer:

(i) The movement of organic materials (food) take place through

(a) Xylem (b) Vessels

(c) Tracheid (d) Phloem

(ii) What regulates the flow of water through the xylem?

(a) Passive transport by the endodermis

(b) The number of companion cells in the phloem

(c) The evaporation of water from the leaves

(d) Active transport by sieve-tube membrane

(iii) Phloem transport of sucrose can be described as going from "source to sink" which of the following would not normally function as a sink?

(a) Mature leaf (b) Storage organ

(c) Growing root (d) Both 'b' and 'c'

(iv) Human plasma proteins include which of the following?

(I) Fibrinogen (II) Haemoglobin (III) Albumin

(a) I only (b) II only (c) I and II (d) I and III

(v) Which of these are involved in the clotting of blood?

(a) Platelets (b) Haemoglobin

(c) Albumin (d) Globulin

(vi) In human heart blood returning from lungs first drains into the

(a) Left atrium (b) Left ventricle

(c) Right atrium (d) Right ventricle

(vii) Root hairs are most important to a plant because they

(a) Store starch (b) Contain xylem tissues

(c) Provide a habitat for nitrogen fixing bacteria

(d) Increase the surface area for absorption.

(viii) A type of circulatory system blood flow through the spaces among tissues called.

(I) Open type circulatory system

(II) Close type circulatory system

(III) Pulmonary circulatory system

(a) I only (b) II only

(c) I and II (d) II and III

(ix) Part of root between epidermis and endodermis called

(a) Xylem (b) Root hair

(c) Phloem (d) Cortex

(x) Movement of water molecules from the area of higher water potential to the area of lower water potential called

(a) Diffusion (b) Osmosis

(c) Active transport (d) Water potential

2. Fill in the blanks:

(i) Loss of internal water of plant in the form of vapours from aerial parts of plants is called_____.

(ii) In flowering plants xylem is made up of _____ types of tissues.

(iii) Root hair is long, thin and tubular structure, it increases surface area which increases the _____.

(iv) Opening and closing of stomata is also regulated by_____.

(v) A type of cancer that affects the blood, bone marrow and lymphatic system called_____.

(vi) Pumping of blood by the rhythmic pulsation of heart throughout the body is called_____.

(vii) Relaxation of heart muscles and allowing the chambers to fill with blood called_____.

(viii) Dead cells of xylem vessels arranged vertically have empty space inside called_____.

(ix) Colourless, irregular in shape, nucleated and larger sized cell than R.B.Cs called_____.

(x) Inherited condition that affects the blood haeomoglobin called_____.

3. Define the following terms

(i)	Blood	(ii)	Water potential	(iii)	Diffusion
(iv)	Stomata	(v)	Bifacial leaves	(vi)	Humidity
(vii)	Sieve plates	(viii)	Sink	(ix)	Granulocytes
(x)	Heart beat				

4. Distinguish between the following in tabulated form

(i) Pulmonary circuit and systematic circuit

(ii) Open type circulatory system and close type circulatory system

(iii) Xylem and Phloem (iv) Arteries and Veins

(v) W.B.Cs and R.B.Cs

5. Write short answers of following questions

(i) Why capillaries are made up of single layer of endothelium?

(ii) Why transpiration is necessary for plants?

(iii) How water flow through xylem?

(iv) Why veins contain semilunar valves in it?

(v) Why atherosclerosis cause myocardial infraction and stroke?

6. Write detailed answers of the following questions

(i) Describe structure of human heart with suitable diagram.

(ii) What is blood? Explain composition of blood and function of corpuscles.

(iii) What is transpiration? Explain mechanism of transpiration and factors affecting transpiration.