TRANSPORTATION

The process by which the substance synthesized or absorbed in one part of the body is transported to other parts of the body is called transportation.

(A) Transportation in plants

There are two main kinds of transportation in plants-

(1) Transportation of water and minerals

(2) Transportation of food and other substances.

The processes adopted for interchanging material between the cell and its environment ; and between the cells themselves are -

(i) Diffusion

(ii) Osmosis and

(iii) Active Transport

(i) Diffusion - e.g. gaseous exchange in leaves . It is the movement of gases or dissolved substances in solution from higher concentration region to their lower concentration region. The thin, freely permeable cell walls of the root hair permits free movement of minerals in and out of the cell through diffusion.

(ii)Osmosis - e.g. water drawn from the epidermal cells into the guard cell. It is the movement of solvent molecules across ***a semi permeable membrane*** from a higher concentration solution to a lower concentration solution or pure solvent. The semi permeable cell membrane allows water entry and restricts salts entry through osmosis. The water concentration in the cell sap of the root hair is lower than its surrounding soil. This also helps in absorption of water by osmosis.

(iii)Active transport - e.g. absorption of the ions or radicals of nitrates, potassium, sodium, calcium etc. with water from the soil into the cells and from one cell to another. This process requires energy which is obtained from the cell in the form of ATP. It ***happens forcibly*** from their lower concentration region to their higher concentration region.

The water and minerals is absorbed by the roots and the organic food is synthesized in green leaves.They are transported through two special conducting tissues, ***Xylem*** (carries water and minerals) and ***phloem*** (carries food) to all the parts of the plants.

(1) Transportation of water and minerals

It involves following interconnected processes-

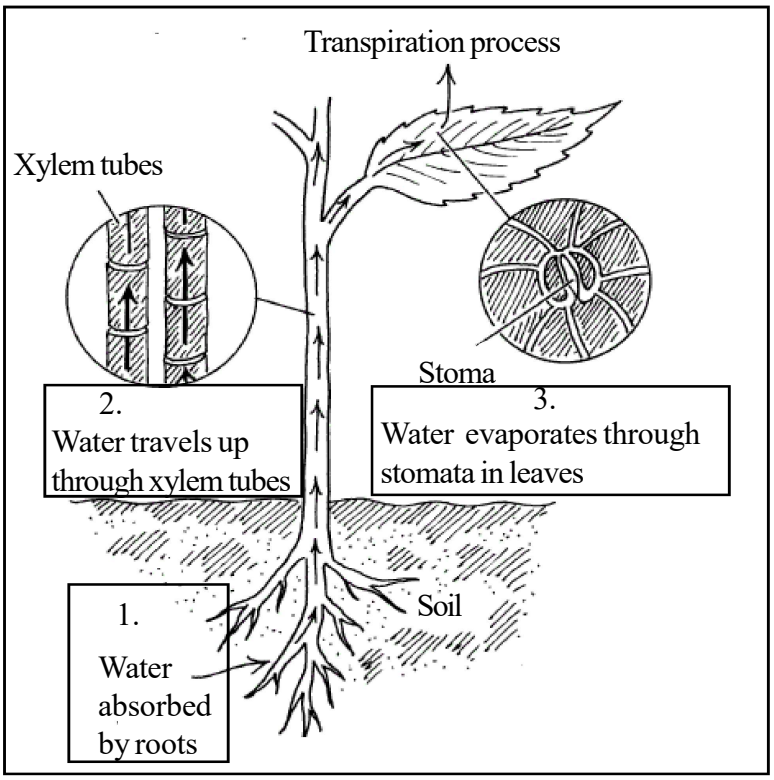
(a) Absorption of water and minerals - Roots absorb water and minerals through diffusion, osmosis and active transport. Cells in contact with the soil actively take up ions which creates concentration difference (higher concentration in root cells and lower concentration in soil) of these ions between the root cells and the soil. Water moves into the root cell (lower concentration of water) from the soil (higher concentration of water) to nullify this concentration difference.

(b) Ascent of sap or Upward movement of water and minerals – Tracheids and vessels of xylem which are tubular structures, help in upward transportation of water and minerals by forming a continuous channel to all parts of the plants. ***The upward movement of water and minerals from the root to the leaves through the xylem is called ascent of sap***. Ascent of sap involves -

(i) Root Pressure - The cells at the surface exert pressure,called root pressure on neighbouring cells. Through this process , the water absorbed by the root hairs gradually passes from cell to cell accumulates

in the tissue of cortex and then migrate from cortex to xylem vessels and tracheids. It creates a column of water that is steadily pushed upwards.

(ii) Transpiration pull - The root pressure is enough to move water in small herbs but not in tall trees. Transpiration pull explains the upward movement of water in tall trees. ***Transpiration is the process by which water in the form of water vapour is lost from the aerial parts such as stomata of the leaves of the plant.*** The loss of water is replenished by movement of fresh supply of water to the leaf. This forms a suction that pulls the water column (sap) from the xylem cells (from roots to leaves) upward, and help in absorbing more water.



Transpiration not only helps in absorption and movement of water and minerals but also in temperature regulation. The effect of transpiration pull in transport of water is important during the day when the stomata are open while the effect of root pressure is major driving force at night.

(2) Transportation of food and other substances

Food (glucose) prepared by the leaves is transported in solution form by the phloem to storage organs and to parts where they are utilized. This process is called as ***translocation.***

- Translocation takes place through the sieve tube of phloem in any direction i.e. upward as well as downward direction according to the plant needs. E.g. the upward movement of food takes place from the leaves to developing buds, flowers, fruits etc., during the germination of seeds.
- Translocation needs energy which is obtained from ATP.
- When material like sucrose is transferred into phloem tissue using ATP, the concentration of water molecules decreases in that area. This results in the movement of water into the cells due to osmosis. The increased contents within the cells exert a high amount of pressure on their wall. This pressure moves the food materials to the adjacent cells with low pressure . This allows the phloem to move material according to the plants's need. E.g. in the flowering season, sugar stored in the roots or stem is translocated to the buds for growing them into flowers.

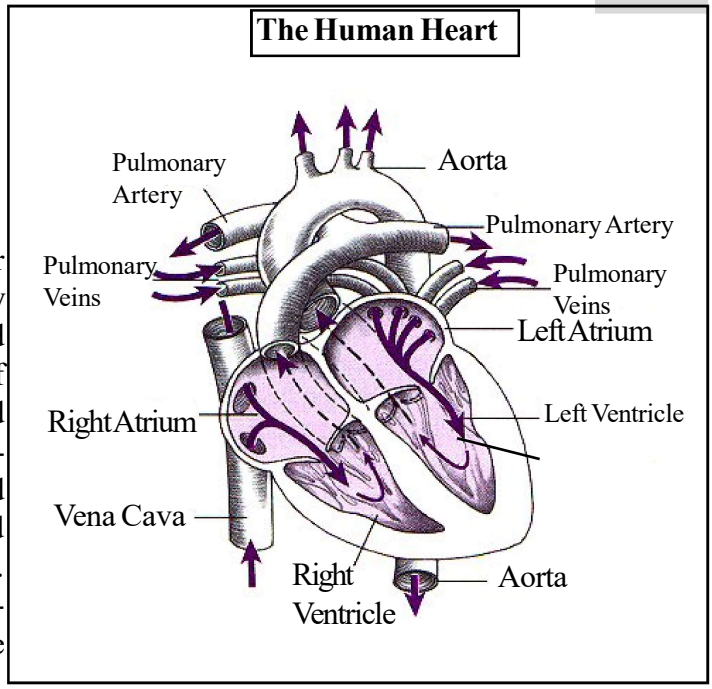
♦ Xylem consists of four types of cells - tracheids, vessels, xylem parenchyma and xylem fibres.

(B) <u>Transportation in Human Beings</u>

The process of transportation of oxygen, food, waste materials and other substances in animals is known as ***circulation*** and the system that help in circulation is called ***circulatory system.***

Parts of the Circulatory system

1. Heart - the involuntary pump
2. Blood vessels - arteries, capillaries, veins
3. Blood - plasma, RBC, WBC, platelets



1. Heart

It is a small (as big as our fist), muscular organ located between the lungs and is slightly tilted to left. Heart transports both oxygen and carbon dioxide through blood. The left half carries oxygenated (oxygen - rich) blood and right half carries deoxygenated (carbon dioxide - rich) blood. Each half is further divided into two chambers. The upper one is called atrium and the lower one is called ventricle. Thus, internally heart is divided into four chambers - right atrium, left atrium, right ventricle and left ventricle.

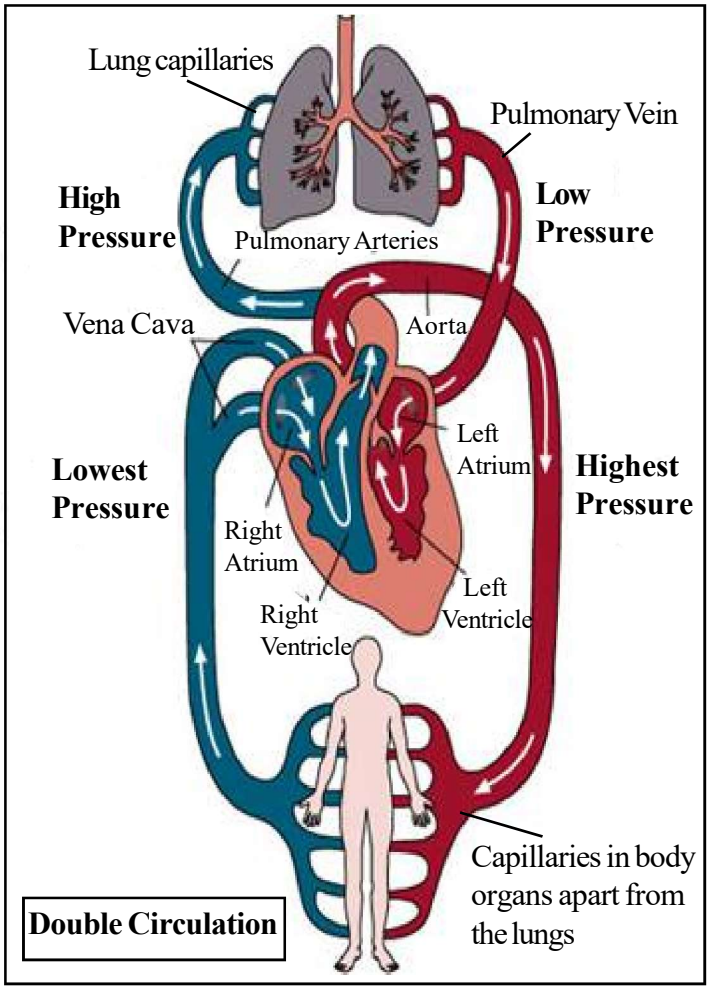
Circulation of Blood -

(a) Right atrium - When the muscles of the right atrium relaxes, it receives deoxygenated blood from the body by a large vein called ***vena cava***. It then contracts and sends blood to the corresponding lower chamber, the right ventricle.

(b) Right ventricle - It expands and receives blood. Further, it contracts and pump the deoxygenated blood to the lungs for oxygenation through the ***pulmonary artery***.

(c) Left atrium - The oxygen rich blood from the lungs comes to the left atrium through the four ***pulmonary veins***. When it contracts, the blood transfers to the corresponding lower chamber i.e. left ventricle.

(d) Left ventricle - It pumps the oxygenated blood to the different parts of the body through the ***aorta*** (the largest artery).



Ventricles have thicker muscular walls than atria (plural; singular - atrium) as they have to pump blood into various organs.

There are valves (muscular flaps) present between the atria and ventricles in the heart. These valves allow the blood to flow in only one direction and prevent back flow of the blood. This means, the valves permit the flow of blood from atrium to ventricle and not in the reverse order.

Double Circulation -

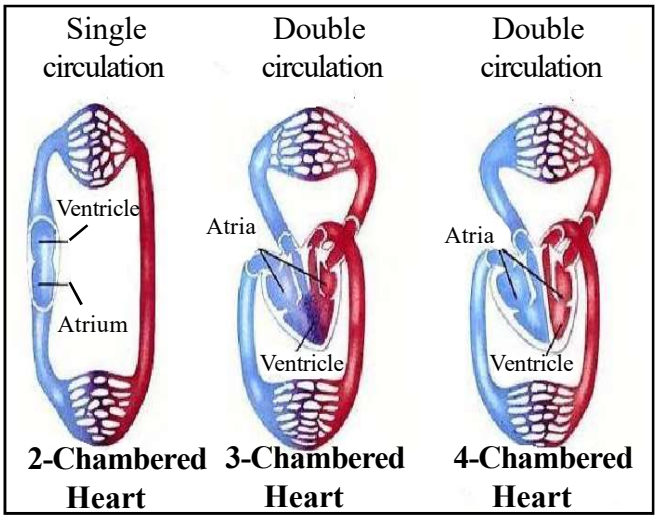
Blood passes twice through the heart during each cycle.

(1) First time in the form of deoxygenated blood in the right part of the heart.
(2) Second time in the form of oxygenated blood in the left part of the heart.
This is known as double circulation.

♦ 4- Chambered heart - Present in birds and mammals. They need high energy to maintain their body temperature.

♦ 3- Chambered heart - Present in amphibians and many reptiles. They are cold blooded animal i.e. body temperature varies according to environmental temperature. They can tolerate some mixing of the oxygenated and deoxygenated blood.

♦ 2- Chambered heart - Present in fish. The blood goes into the gills for oxygenation and pumps directly to the rest of the body. Thus, blood goes only once through the heart during one cycle.



♦ The other vertebrates except fish, blood goes twice through the heart during one cycle. It is known as double circulation.

2. Blood Vessels -

The three main types of blood vessels are -

(i) Arteries - These ***carry blood (oxygenated) away from the heart*** to various parts of the body. Arteries are thick walled, elastic and deep seated as they emerge blood from the heart under high pressure.

(ii) Capillaries - Before entering an organ or tissue, the arteries divide into very fine, thin walled (one cell thick) branches known as capillaries. Exchange of gases and nutrients between the cells of the organs and the blood take place through the walls of the capillaries. The capillaries then join together to form veins that take the blood away from the organ to the heart.

(iii) Veins - These ***carry blood (deoxygenated) from the various organs to the heart***. Veins are inelastic, superficial and not exactly thick walled as the blood is not under pressure.

	Artery	Vein
1.	carries blood away from the heart.	• carries blood from the various organs to the heart.
2.	carries oxygenated blood.	• carries deoxygenated blood.
3.	thick walled, elastic and deep seated.	• inelastic, superficial and thin walled.

3. Blood -

Blood is a connective tissue consists of a fluid matrix called ***plasma*** (nonliving; composed of plasma proteins, organic and inorganic substance). It has three main elements – red blood cells or corpuscles(erythrocyte), white blood cells or corpuscles(leucocyte) and platelets(thrombocytes).

(i) Red blood corpuscles (RBC or erythrocyte)- These are disc shaped, very tiny, red coloured cells. It helps in carrying oxygen to the various parts of the body.

(ii) White blood corpuscles (WBC or leucocyte)- These are colourless cells having no definite shape.

Their function is to protect the body against diseases and infections.

(iii) Platelets- These help in the clotting of blood. Due to injury or a cut, the network of blood vessels damages and the blood flows through it. This leads loss of blood, loss of pressure and thus reduce the efficiency of the circulatory system. Platelets form a mesh which closes (plugs) the ruptured blood vessels (blood clotting) so that the flow of blood stops.

Lymph -

There is another important circulatory system called ***'Lymphatic system'*** that permeates the entire human body and helps in transportation through a fluid called '***Lymph***' or ***'tissue fluid'***.

During blood flow in the capillaries, some amount of plasma, proteins and blood cells filter out into inter cellular spaces in the tissues. These form the tissue fluid or lymph. It is similar to the blood plasma but colourless and contains very less protein. The tissue fluid drains into lymph capillaries. Lymph capillaries join to form large lymph vessels that finally open into larger veins. It flows in only one direction that is from tissues to the heart.

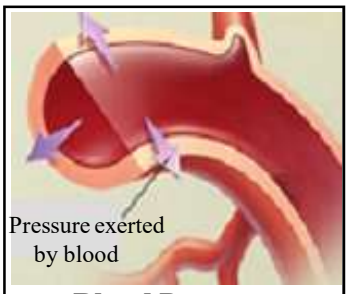
Function -

(i) Lymph carries digested and absorbed fat from intestine.

(ii) Lymph drains excess fluid from extra cellular space back into the blood.

Blood Pressure, Heart Rate and Pulses -

Blood pressure - ***It is the push or force exerted by the blood on the walls of a artery / a blood vessel***. Blood pressure is always greater in arteries than in veins.



Blood Pressure

During a cycle, the muscles of both right and left atrium relax to receive blood and contract to pump out the blood at the same time. Similarly, the muscles of both right and left ventricles expand to receive the blood and contract to pump out the blood at the same time.

(a) Systolic Pressure - Each time when the ventricles contract, fresh blood is pumped into the arteries and the pressure is at its highest level. This blood pressure in the artery during ventricular contraction (systole) is called systolic pressure.

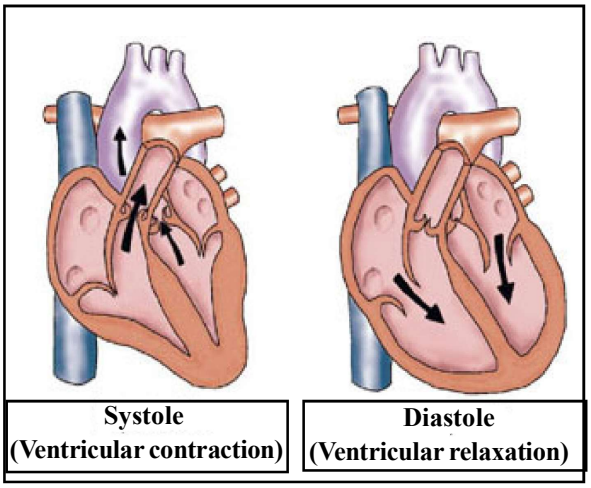
Normal systolic pressure = 120 mm of Hg

Normal range in adults for upper limit =100-140 mm of Hg

(b) Diastolic Pressure - When the ventricles relax, the pressure is reduced and falls to its lowest level. The blood pressure in the artery during ventricular relaxation (diastole) is known as diastolic pressure.

Normal diastolic pressure = 80 mm of Hg

Normal range in adults for the lower limit = 60-90 mm of Hg



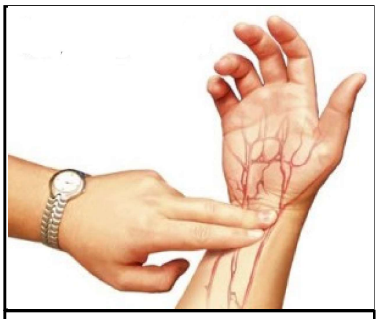
- Blood pressure is measured by noting the mercury level rises in a tube. This instrument is known as ***sphygmomanometer.***
- High blood pressure or hypertension may cause internal bleeding due to rupture of an artery.

Heart Beat -

The regular contraction and relaxation of the heart muscles is called heart beat. In adults, the heart beats on an average of 70-75 times per minute.

Heart Rate or Pulse -

The blood flows in arteries under pressure and in jerks due to pumping action of the heart, is called pulse. The pulse rate is same as the heart rate and averages between 70-90 beats per minute in adults. The pulse can not be felt everywhere as arteries are deep seated.



The pulse is felt on the wrist, just under the thumb.