2 THE TRANSPORT OF MATERIALS IN ORGANISMS

What we have learned earlier

- Heart, blood vessels and blood are parts of the circulatory system.
- Food materials, respiratory gases and excretory products are transported by blood.
- Heart has four chambers. It acts as a double pump, receiving oxygenated blood from the lungs and sending it to the different parts of the body, and receiving deoxygenated blood from the body and sending it to the lungs.
- Arteries carry blood from heart to different parts of the body and veins carry blood to the heart.
- Haemoglobin contained in red blood corpuscles absorbs oxygen. Haemoglobin gives red colour to blood.
- vitamins B_{12} and Folic acid are important in the formation of red blood corpuscles. Vitamin K is essential for the clotting of blood.
- Haemophilia is a hereditary disease.

You have studied how digested food materials from the alimentary canal reach the body cells. In the same way oxygen from the lungs reaches the body cells and waste products of metabolism from the cells reach the excretory organs. This process of transporting materials to the different parts of the body requires a special mechanism. What is this mechanism?

Let us see how materials are transported in simple organisms as well as in complex animals like man. In man, the circulatory system does many other functions in addition to the transport of materials. Let us study in this chapter how the composition of blood is adapted for this and how the blood transports materials. In plants, water and other materials are transported to different parts by special methods.

The transport of materials in plants

You have learned that water from the soil enters the roots of plants by osmosis and is carried up to the leaves through the xylem vessels. Try the following experiment.

Cut out short branches of Balsam, Peperomia and Eupatorium and keeps their lower ends dipped in red ink. After about three hours, take thin cross sections of the stem and examine under the microscope. Compare what you see with figure 2.1.

- In which tissue is red colour seen?
- Which tissue is found outside this?

Examine the sections of the different stems by the same method and record your findings in the science diary.

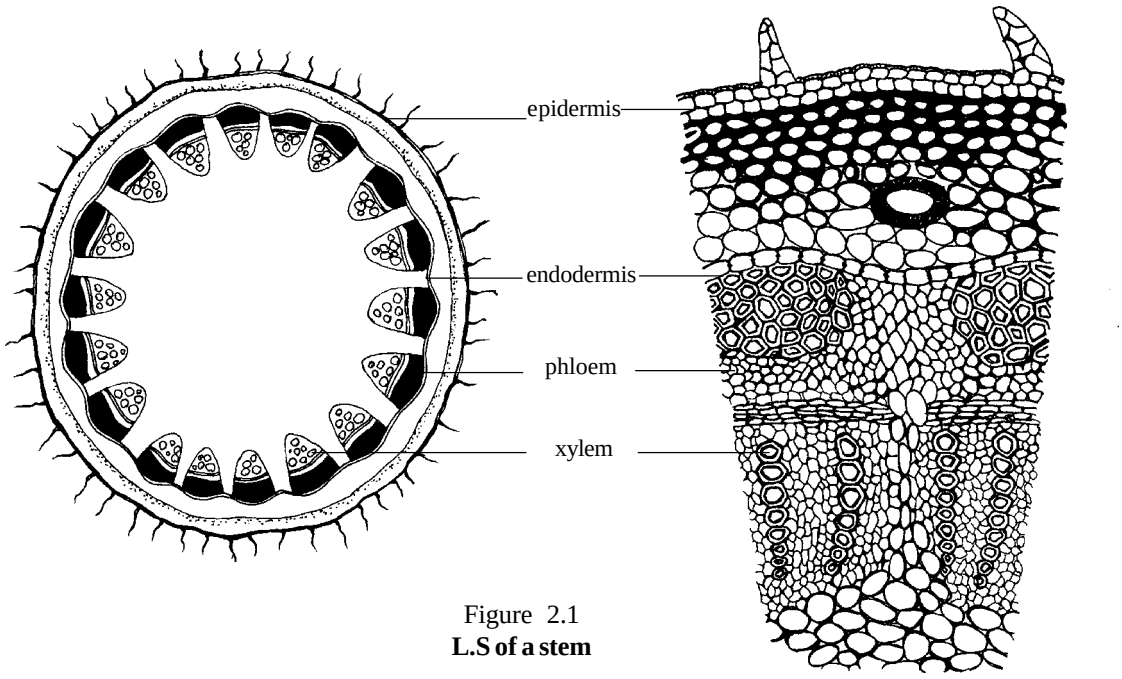


Figure 2.1
L.S of a stem

If longitudinal sections of the stem are examined, the xylem vessels can be seen arranged one above the other in a linear manner as fine capillary tubes (fig 2.2). There are many small passages in the cross walls separating the tubes. What must be their function?

How does the water absorbed by the roots ascend in the xylem vessels?

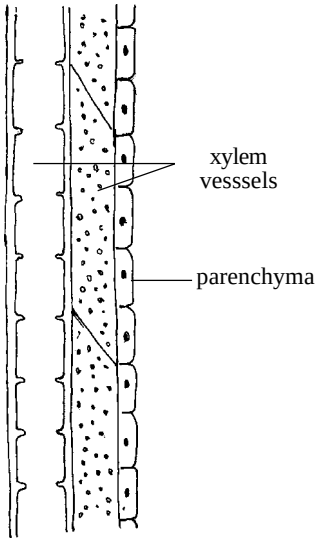


Figure 2.2
L.S. of Xylem

Try to perform the following experiment. Arrange to set up the apparatus as shown in figure 2.3. The plant branches selected should be fixed at the top of the long glass tube filled with water. Before fixing the glass tubes in the glass jars, make sure to admit an air bubble inside the lower end of the tube. Allow the set up to remain for some time. After some time, compare the position of the air bubble in the three glass tubes. You notice

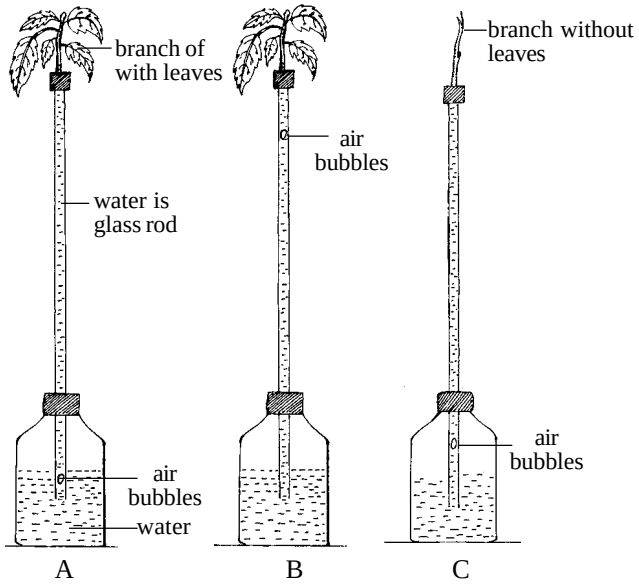


Figure 2.3
Experiment to show the rise of water level due to transpiration

that the position of the air bubble has changed in jar B. How did the bubble rise up in the jar B? You know that the water molecules have the property of sticking together. This is known as the cohesion force. The water in the xylem vessels of the leaves is in contact with the water in the glass tube. Due to transpiration, water is lost from the intercellular spaces of leaves through the stomata. This causes a fall in the pressure of the water in the leaf cells and water from neighbouring cells enters into these cells. What will be the result of this process? A suction force is created in the leaf and this causes water to enter the leaves through the fine xylem vessel to make up for the loss of water. This suction force is transmitted to the water column in the xylem down to the roots. In addition to the transpiration pull, the pressure developed in the roots due to

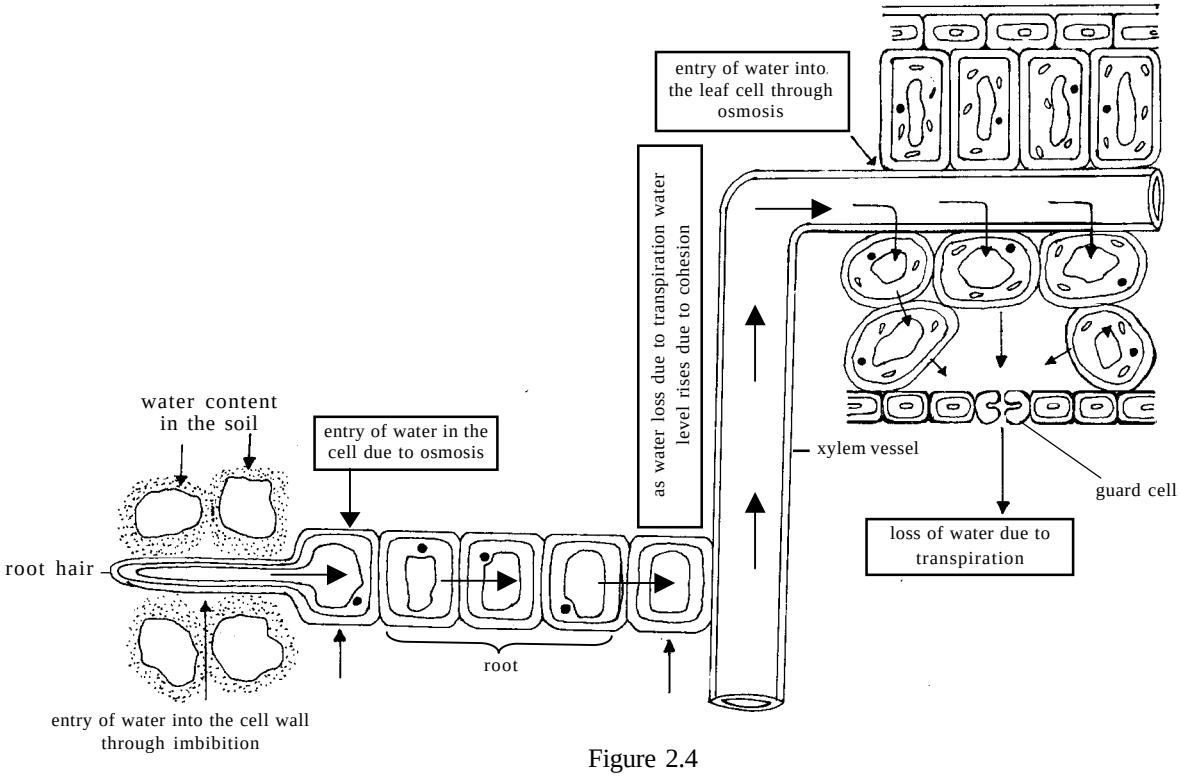


Figure 2.4
Conduction of water in plants

the entry of water from the soil through osmosis also helps to push the water column up the stem. This pressure is called root pressure.

Examine and study figure 2.4 and understand the factors responsible for the water reaching up the stem to the leaves and record these in the science diary.

The transport of salts

You have seen that how water from the soil enter into the roots of plants. Have you considered how salts enter the roots. In the roots, the concentration of salts is often higher than that in the soil. Hence salts cannot pass into the roots by simple diffusion. In this situation the plasma membrane of the root hairs can take in salts in the form of their ions. This is called active transport and energy is required for this. It is by the same process that salts move into the neighbouring cells and finally through the xylem vessels upto the leaves.

The transport of prepared food through phloem tubes

Phloem is another transporting tissue in plants. You also know that prepared food materials are conducted through phloem vessels. How do materials pass through phloem? Examine the longitudinal section of phloem tissue (fig 2.5). You can see that the sieve tubes are placed one above the other end to end. What is the peculiarity of the cross walls between the vessels? It is through

the small openings in the cross wall that the cytoplasm of adjacent sieve tube cells become continuous. The prepared food from the leaves is conducted through the sieve tubes to other parts of the plant.

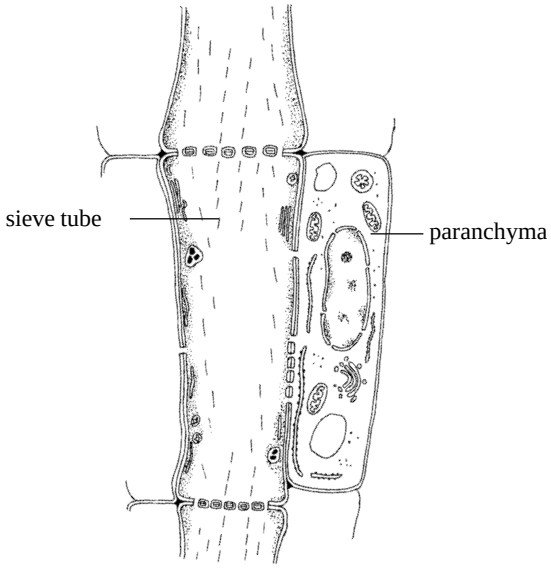


Figure 2.5
L.S. of Phloem

From leaves to roots - a transport pathway

Nearly about 250 kg of glucose per year is conducted from the leaves of a big tree to its roots. It is carried through phloem cells which are as thin as a post card. They are located on the inner layer of the outer skin of stems and roots. Sieve tubes are fine and hair like. This pathway extending from leaves to roots is always functional. Otherwise the very existence of the tree will be risky.

The conduction of materials in animals

As in plants, is it not essential to have transport of materials in animals also? Based on the structural diversity of animals, the transport of materials in their body is also different.

The transport in lower simple organisms

Observe the way in which food materials are transported to different parts of the cell in unicellular organisms like Paramecium. The food vacuoles that are formed during ingestion of food are moving along a circular pathway through the cytoplasm of the cell (fig 2.6). This movement is called cyclosis. But in multicellular organisms there is the need for a special medium for material transport. Let us examine the different methods and media of transport.

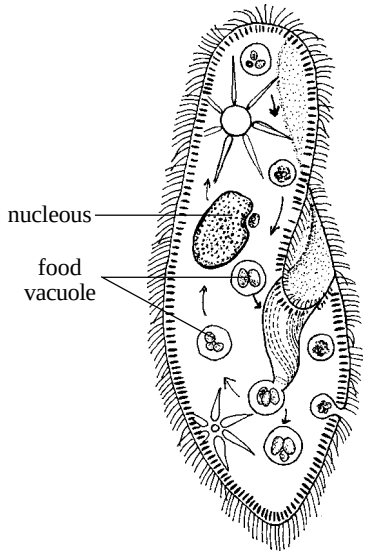


Figure 2.6
Paramecium

Conduction through water

You know how aquatic organisms like Hydra obtain food and other materials. What is their medium of conduction?

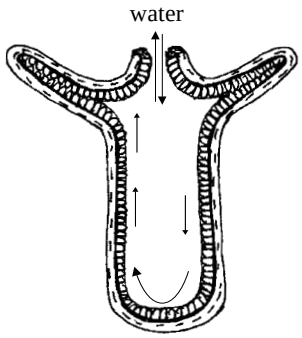


Figure 2.7
Hydra

Examine figure 2.7 and find out what is the medium of transport. In such animals, the cells of the body are all in contact with water and the exchange of materials takes place between the cells and water. Examine the path of the water current maintained in the sponge body (fig 2.8). Find out more examples of animals in which exchange of materials occur between water and body cells.

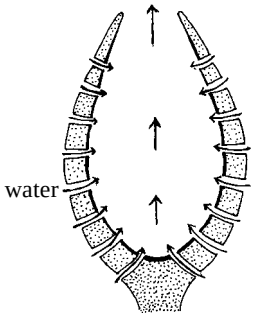


Figure 2.8
Sponge

The conduction of materials in flat worms

Have you noticed the form of the body of Planaria? These animals obtain oxygen directly from the surrounding water (fig.2.9). Their

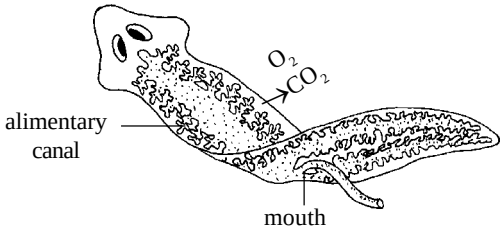


Figure 2.9
Planaria

digestive canal is highly branched and reaches every part of the body. Hence there is no separate medium for the transport of food. However, the parenchymatous tissue which surrounds the internal organs and digestive canals are very helpful in the conduction of materials inside the body.

The transport of materials through body fluids

Don't you know about the fluid that fills the body spaces in cockroach? (fig 2.10) The food digested in the alimentary canal reaches the blood contained in these spaces and from there to the cells. Waste materials from the cells also reach the blood and from there to the malpighian tubules which are the excretory organs. Thus blood acts as the medium for the transport of these materials. The body cells obtain oxygen directly through the respiratory tubules (tracheae). Hence the blood has no

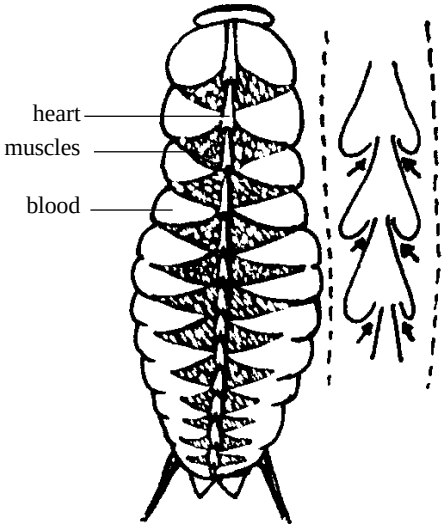


Figure 2.10
Cockroach

function in the transport of oxygen. Is it not clear now why the blood of cockroach is colourless? Can you mention similar examples.

In the earthworm, it is the blood that receives and transports oxygen. It is the blood that carries food to the body cells, and waste materials from the cells to the excretory organs (fig 2.11). The same process occurs

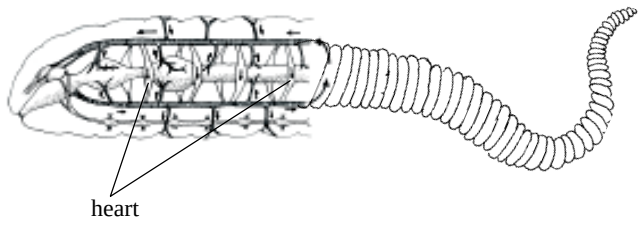


Figure 2.11
Earthworm

in all vertebrates also. These animals have a well developed circulatory system.

The circulatory system in man

You have learned that digested food and oxygen are transported to body cells and that the waste products from the cells are carried to the excretory organs by blood. What are the other functions performed by blood?

- It helps to control body temperature.
- It carries hormones to their target tissues.
- It helps the body to maintain immunity against diseases.

Let us examine how the blood performs all these functions. The blood is made up of different constituents and it is a fluid tissue. What are these constituents?

- Plasma
- Blood cells
- Blood platelets

In a normal healthy man there is about 5 litres of blood. Plasma is the fluid part of blood. Let us examine its composition.

About 55% of blood is plasma. If the corpuscles are all removed, the light yellow coloured fluid that is obtained is plasma. The composition of plasma is given in the following table(table 2.a).

Constituent	Function
Water 91%-92%	solvent
Plasma Proteins 7%-8%	
a. Fibrinogen	Important in the clotting of blood.
b. Globulins	They function as antibodies.
c. Albumin	Controls blood pressure.
Organic Components	
Absorbed food materials	They are important in producing energy in cells, growth and repair of body.
Hormones	Controls body functions.
Inorganic materials	
Sodium, Potassium, Chloride, Phosphate	Maintains osmotic balance of blood.
Calcium ions, etc.	Helps in clotting of blood, working of muscles.

Table 2.a
Constituents of plasma and their functions

- What are the functions of plasma?
- Which constituents help in the clotting of blood?
- Which proteins are helpful in the transport of materials?
- What are the functions of ions?

Record your findings in the science diary.

The blood Cells (Corpuscles)

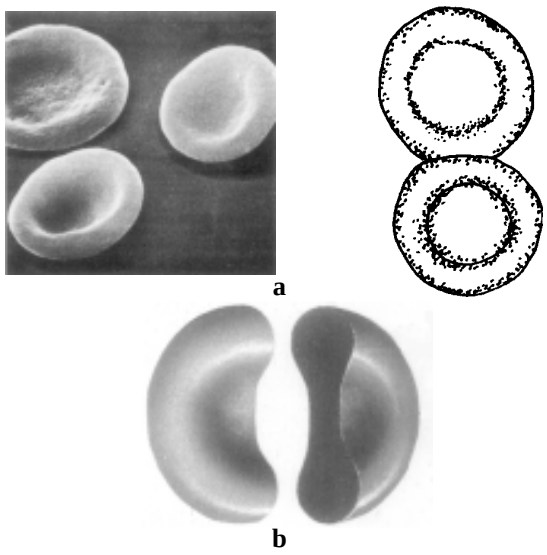
With the help of your teacher, take a drop of blood from your finger tip, spread it on a clean glass slide and examine it under the microscope.

- *Before taking blood, wash your hands with soap and water.*
- *Use spirit to clean the surface of the finger to remove germs.*
- *The needle used for pricking the finger should be sterile.*
- *The blood from one person should not fall on the pricked region of another person.*

Examine the table 2.b and try to distinguish the different kinds of blood cells. Understand the relationship between bone marrow and blood cells.

The red blood cells (Erythrocytes)

The red blood corpuscles are coloured cells (fig. 2.12). What is the pigment they contain?



a

b

Figure 2.12
a. Red blood corpuscles, b. L.S. of RBC

Table 2.b
Different blood cells, their characters and functions

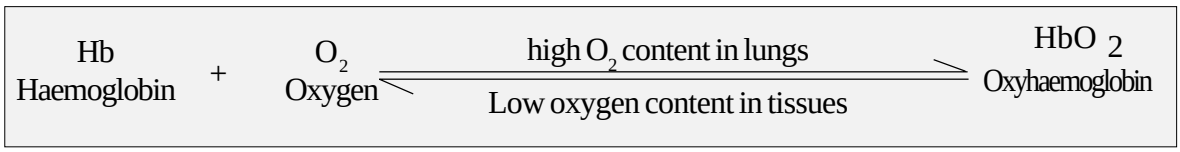
In animals like earthworm, haemoglobin is dissolved in the blood plasma. Haemoglobin is an iron containing protein. Where from are erythrocytes produced? What is their number in a cubic millimeter of blood in man? In women, their number will be a little less than that in men. They are different in appearance and structure from the other blood cells. What are these differences.

- They are circular, disc shaped and biconcave.
- They do not have nucleus, mitochondria, ribosomes and golgi body.

Their biconcave shape increases their surface area and hence can contain more haemoglobin. It is haemoglobin that absorbs oxygen from the lungs. Can you say the compound produced?

Haemoglobin and Myoglobin

Haemoglobin is not only an oxygen carrier but it also helps to carry carbondioxide released from the tissue cells to the lungs. Haemoglobin has an affinity to carbon monoxide nearly 250 times more than it has for carbon dioxide. Hence even if the inspired air contains 1% carbon monoxide it can be fatal to the individual. The haemoglobin of the foetus in the uterus of the mother has greater affinity for oxygen. This helps the foetus in absorbing oxygen easily from the maternal blood. A different form of haemoglobin is present in muscle cells and is called myoglobin. This absorbs oxygen form haemoglobin and releases it to the muscle cells whenever it is required. The ability of the red muscles to contract continuously for a long time is due to this fact.



When oxyhaemoglobin reaches the tissues, reverse reactions occur and oxyhaemoglobin dissociates into oxygen and haemoglobin. Oxygen diffuses through the tissue fluids into the cells. At the same time carbondioxide from the tissues diffuses into the blood plasma and the red blood cells. You know where this carbondioxide is finally reaches.

If carbon monoxide is present in the inspired air, it will readily combine with haemoglobin. The carboxy haemoglobin thus formed does not dissociate. This obstructs the process of oxygen transport. What could be the result? During smoking some carbon monoxide reaches the lungs. Don't you realise the bad effect of smoking?

When haemoglobin content gets reduced?

Haemoglobin can be measured by the blood test. In a normal healthy man there will be 14.5 gms of haemoglobin in 100 ml of blood. In women it will be 13.5 g/100 ml. Can you explain the reasons for this?

What will be the effect if the haemoglobin content in blood is low? This condition is known as anaemia. It is due to deficiency of iron in the food. Vitamins also are important in the formation of red blood cells in bone marrow. Can you say which vitamins?

In such situations what advise can you give to prevent anaemia?

Red blood cells live only for nearly 120 days. The old red corpuscles are destroyed in the liver and spleen. The coloured compounds resulting from their breakdown are called bilirubin (red) and biliverdin (yellow). You can imagine the reason for the yellow colour of feaces.

Short lived, but ...

Red blood corpuscles are short lived - only from 20-120 days. Since they are without a nucleus, they cannot repair their wear and tear. Then how can they live long? New red corpuscles are continuously produced from the bone marrow to replace these lost cells. Now you can understand why blood donation is not harmful. In longevity white corpuscles are different. They live from 1 to 15 days only. However some lymphocytes live up to 15 years.

White Blood Corpuscles (Leucocytes)

The white corpuscles are important in the defence of the body and the development of immunity. Examine their structural diversity (Fig 2.13).

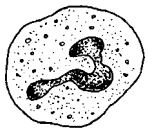
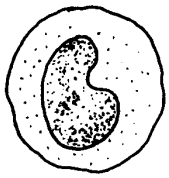
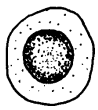
White blood corpuscles	Diversity in cell, nucleus and cytoplasm
Neutrophil	
Eosinophil	
Basophil	
Monocyte	
Lymphocyte	

Figure 2.13
Different types of white blood corpuscles

Based on their differences in structure, their defensive mechanisms are also different. One type of corpuscles ingest and digest

germs. Examine figure 2.14. How do they ingest the germs? Compare their methods with those of amoeba. Those cells that destroy germs are known as phagocytes.

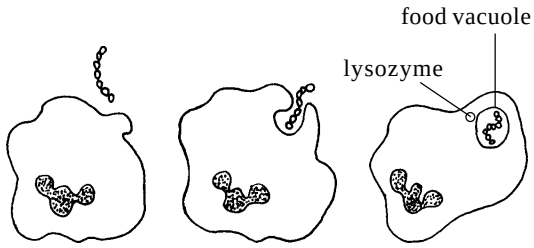


Figure 2.14
Phagocytosis

Lymphocytes are another type of white corpuscles. They attack germs by liberating certain protein molecules called antibodies. What would happen if there are germs that destroy lymphocytes themselves? The virus causing AIDS, called human immuno deficiency virus (HIV) is an example for this.

By examining table 2.b find out the number of white corpuscles in a cubic millimeter of human blood. However, during infections or in the presence of certain antigens, their number shows variations. It will be thus clear that examination of blood cell count in diagnosing diseases is very important. The uncontrolled increase in the number of white corpuscles is a disease known as Leukemia or blood cancer. Lymphocytes live for a long time.

From Chemical Weapon to Suicidal Attacks

Our body has a very powerful defence system with variety of efficiency of methods and defence mechanisms. Disease germs entering the body through small cuts and wounds are destroyed on the spot by neutrophils and monocytes by ingesting and digesting them by powerful enzymes. In emergent situations, basophils produce heparin to prevent clotting of blood. The reconstruction of damaged tissues is speeded up by histamines released by mast cells and basophills. The antibodies produced by lymphocytes neutralise the harmful toxins (antigens) released by disease germs. In order to destroy the enemies, certain cells carry out suicidal attacks. The lymphocytes in the lymph glands can, up to a limit, destroy cancer cells forming in the body by ingesting and digesting them. Certain habits like smoking, alcoholism, chewing pan with tobacco and unhealthy food habits can weaken the defense mechanism of the body. The diseases that are capable of destroying the most powerful immune mechanism are prevalent today and we should be guarded against them. What would be the result if we take an attitude favouring them.

The blood platelets

The platelets are broken pieces of some large cells found in the bone marrow. They do not have a nucleus. Let us examine their function.

When a person gets a cut or wound, the blood that comes out sets into a jelly-like mass called clot which plugs the wound and thus prevents further bleeding. How does the blood clot? Examine the illustration - I give bleow.

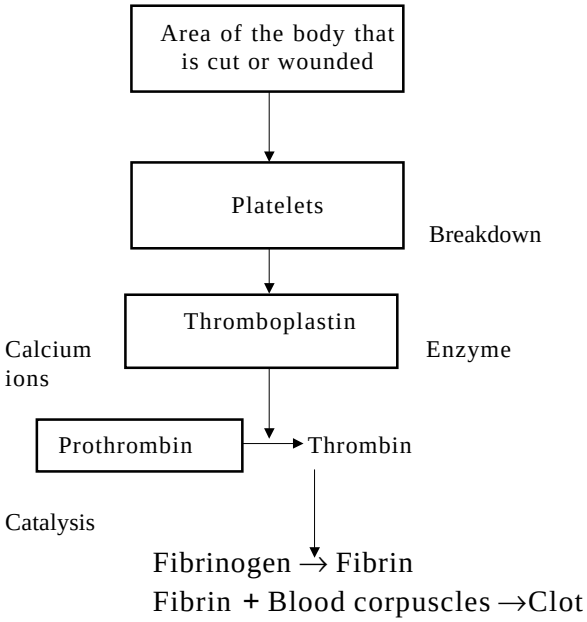
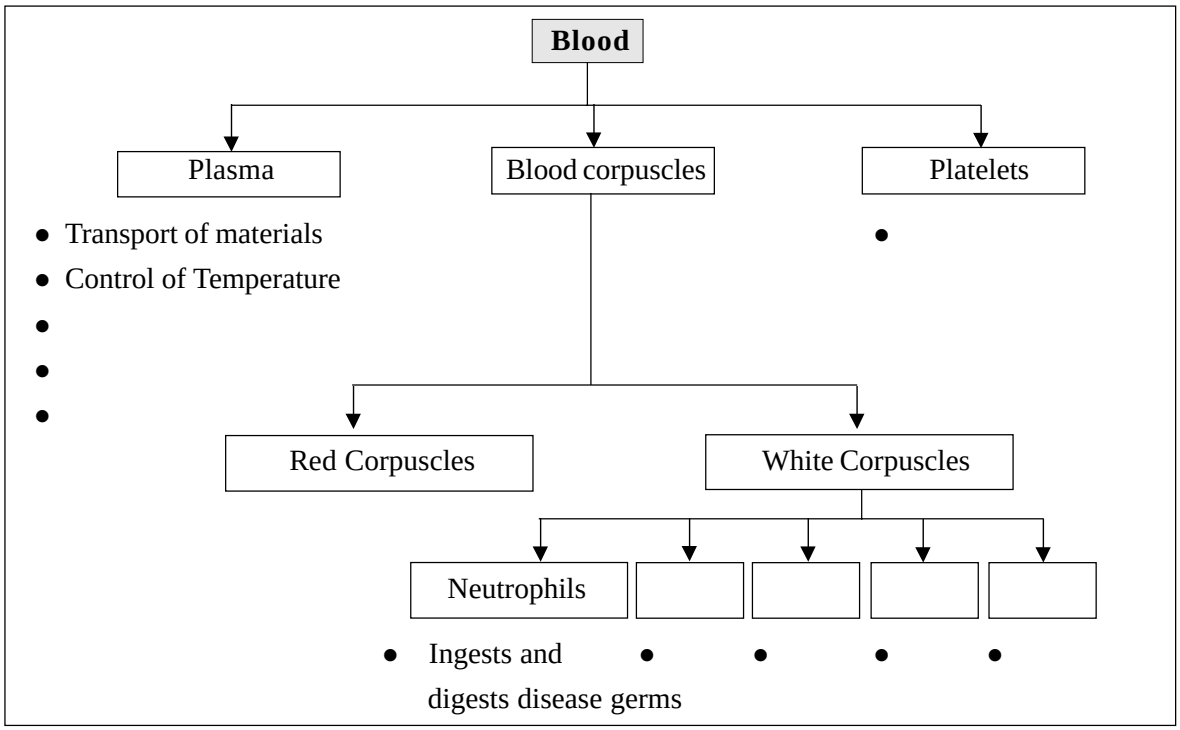


Illustration I

When the platelets come into contact with atmospheric air, they break down. Prothrombin which is produced in the liver (and found in blood) gets converted into thrombin by thromboplastin released from the broken platelets. Vitamin K is essential for the formation of prothrombin. You can now understand the importance of calcium ions and vitamin K in clotting. Can you illustrate these events in a step wise equational form.

What would happen if blood does not clot? This condition is called haemophilia. You have learned that this is a genetic disease.

We have so far learned about the composition of blood and the function of its various components. Prepare a chart on the following model and display it in the class room.



Blood transfusion

Blood transfusion is carried out to a patient in times of emergency. But blood of all people cannot be transfused to all other people. What is the reason for this? The blood of each person contains slightly different proteins. The most important of these are antigens and antibodies. Blood group antigens occur on the surface of red corpuscles and antibodies in the blood plasma. There are two antigens, antigen 'A' and antigen 'B'. The presence or absence of these antigens forms the basis of blood grouping. A person is said to belong to A-group if his red corpuscles contain antigen A. You can now say what will be the antigen in B group people. AB group persons have both the antigens in their red corpuscles. You have also learned that antibodies for blood group antigens are in the plasma. In A group blood, antibody 'b' is present. It cannot contain antibody 'a'. What about B group blood? In AB group no antibodies can be present. But in O group there are no antigens but both a and b antibodies are present. What is your blood group? Which antigen and antibody are present in it?

When the different blood group samples are mixed and examined under the microscope, the change that occurs is shown in the illustration II. Study this and answer the following.

- Which group of blood can be safely transferred to all people?

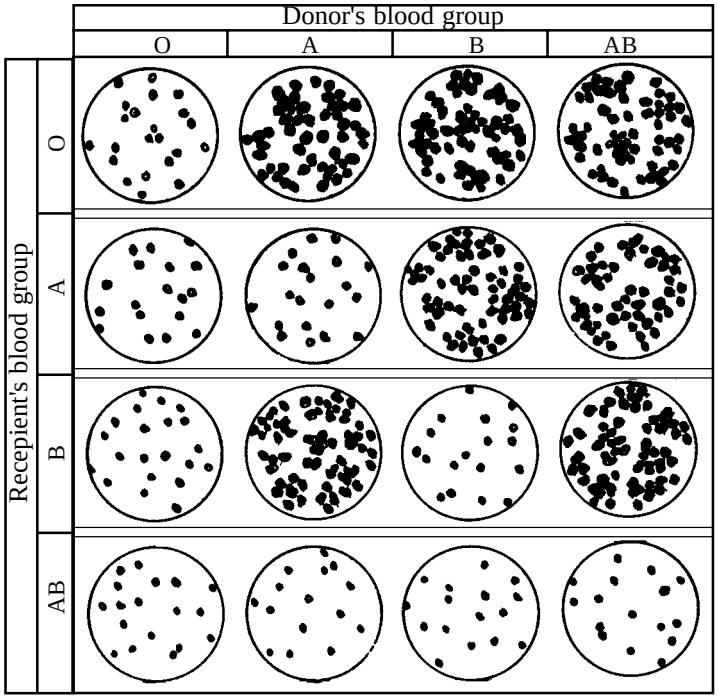


Illustration II

- Which blood group can be received by all other groups?
- During blood transfusion which factors in donor's and recepients blood have to be considered.

You must have understood which blood groups are compatible. Based on this knowledge, prepare a chart showing the blood group, the antigen and antibody present in it and the group that it can receive.

When two blood groups that are not compatible are mixed, the antibody present in the recepient, interacts with the antigen in the donor's blood causing clumping or

agglutination of the corpuscles. What will happen if such clumps of corpuscles pass through the fine capillaries of the recepient?

Rh factor

Have you noticed that when blood groups are determined, they are written as +ve or –ve. What does this mean? There is another antigen present on the surface of red corpuscles called Rh antigen. This was first seen in the blood of the rhesus monkey. Hence the name Rh factor. Those having the Rh antigen are said to be Rh^+, and those who do not have it are Rh^-. Antibody against Rh^- antigen is not present in the blood.

Persons who are Rh^- are not given Rh^+ blood. Why? This is because the Rh antigen in the donor's blood induces the formation of antibodies against the antigen in the recepient's blood. This antibody remains in the body. If on a later occasion this recepient is again given Rh^+ blood agglutination would happen.

Erythroblastosis foetalis

A mother who is Rh^- can have a foetus which is Rh^+. During child birth, there is the possibility of red corpuscles from the child entering the mother's blood through the placenta. What can be its result? The mother's blood will develop antibodies against the Rh antigen. These antibodies can pass into the next foetus and cause agglutination of the corpuscles in the child's blood. This is called erythroblastosis foetalis. One reason for the appearance of jaundice in some new born babies is due to this. Such children can be saved by giving them a full blood transfusion. Often the child dies in the uterus itself due to erythroblastosis foetalis. How can this situation be prevented? If the mother is Rh^- ve and the father Rh^+ve, and the child is born Rh^+ve, then the mother can be given a particular injection to prevent the formation of anti Rh antibodies in her blood.

The donation of Blood is a noble gift

During accidents some times there is great loss of blood. In such situations what is the method of saving the life of the person? Blood donation is the only method to save his life. Which are the other situations that required blood donation?

Blood is a tissue that is continuously formed in the body. Hence blood donation does not seriously affect the donor. Should we not be prepared for this? At a time one can donate about 300 ml of blood. Who are the people best suited for blood donation? Who are those not suitable for this? Prepare a list and and record it in your science diary.

Prepare a short article on the topic "blood donation is a noble gift".

The circulation of blood in animals

You have learned about the functions of blood in animals. In order to carry out these

functions blood has to reach every part of the body. Let us see how this occurs in different animals.

Compare the process of blood circulation in cockroach and earthworm (fig 2.10, 2.11). In cockroach which is the space filled with blood? In this animal contractions of the heart and movements of the body will cause flow of blood. But in earthworm blood is contained not in spaces but in the heart and blood vessels. This is known as a closed vascular system. Here blood always flows through tubes and does not directly come into contact with tissue cells. Such vessels are not seen in cockroach. Blood is found in large spaces of the body cavity and surrounds the internal organs and directly contact the tissues. This is known as open vascular system. Find out more examples for this. From the figure 2.15 say what type of circulatory system is found in man.

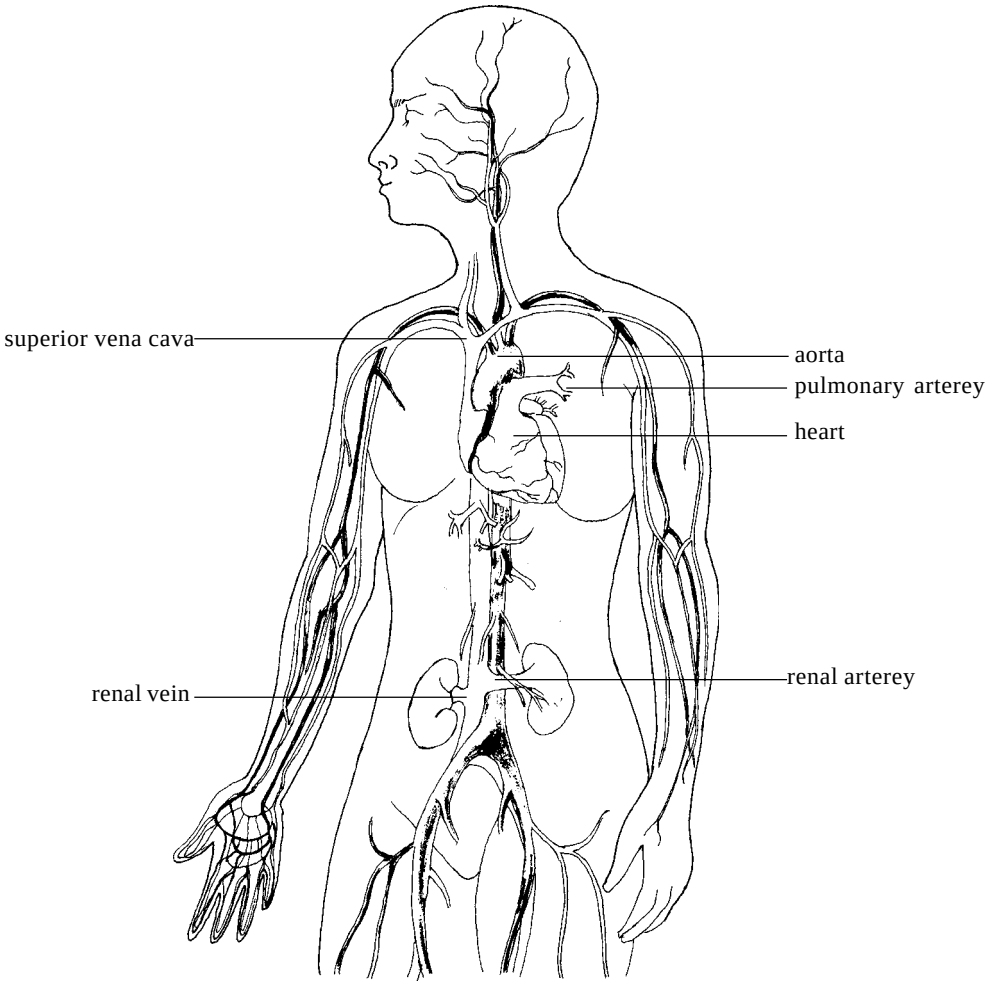


Figure 2.15
Circulatory System

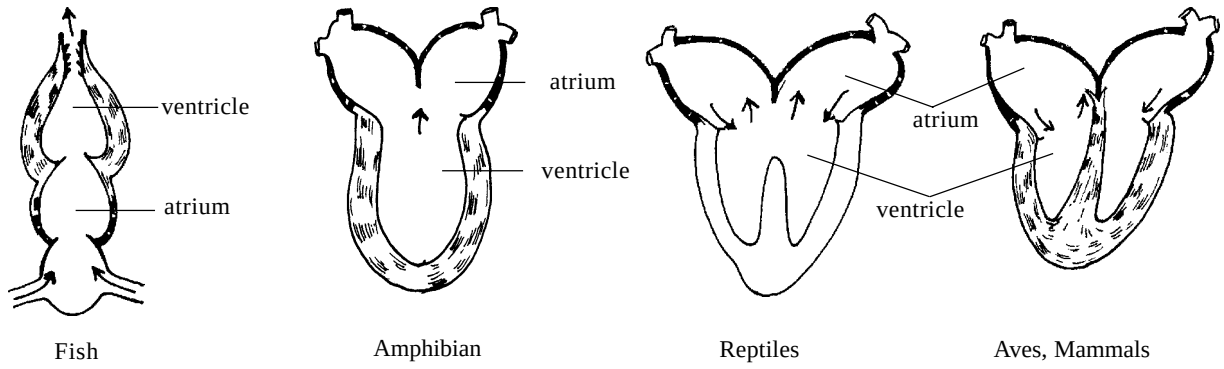


Figure 2.16
Structure of heart in different levels of organisms

The doctor who was deserted by his patients

The doctor who first discovered that the circulation of blood through blood vessels is by the contraction of the heart, was deserted by his patients. Aren't you surprised? William Harvey, (1578-1657) who is considered the founder of modern physiology, was the first person to explain this. He estimated that every hour the heart pumps three times the quantity of blood in his body. Though an English man, he published his findings in Latin. His comparison of the human heart as a pump was entirely new and against all conventional beliefs and patients diserted him. However, during his lifetime itself his findings were accepted. Harvey who described the flow of blood through arteries and veins did not know about capillaries. It was only four years after his death, that the Italian scientist Marcello Malpighi discovered capillaries.

The circulation of blood in man

You know that the flow of blood through the blood vessels is due to the working of the heart like a pump. How many chambers are there for human heart? What about lower animals? This is illustrated in figure 2.16. Study the figuers and record your findings in the science diary.

Human heart

The heart is situated in the thoracic chamber between the two lungs. It is surrounded by a tough double walled membrane called pericardium. This prevents the chambers of the heart getting filled with too much of blood. Between the two pericardial layers is a fluid, the pericardial fluid. It protects the heart not only from external shocks but also reduces the pressure during the expansion of the heart.

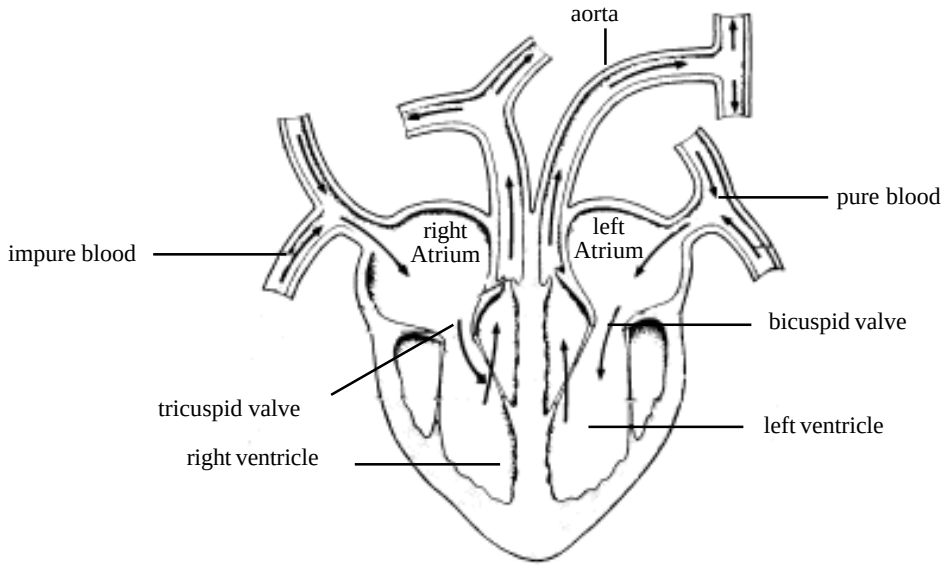


Figure 2.16
Structure of Heart

The structure and working of the heart

Examine the figures of the heart (fig.2.16,2.17). Don't you see the four chambers clearly? Which are the blood vessels that bring blood to the right atrium (auricle)? From where do the pulmonary veins bring blood to the left atrium. These veins carry oxygenated blood. It will be clear that the chambers of the left side contain oxygenated blood. The blood that reaches the right atrium is deoxygenated blood. When the right and left atria get filled with blood they contract together. Where does the blood go from there? Following this, the two ventricles contract together. There is a possibility of the blood going back into the

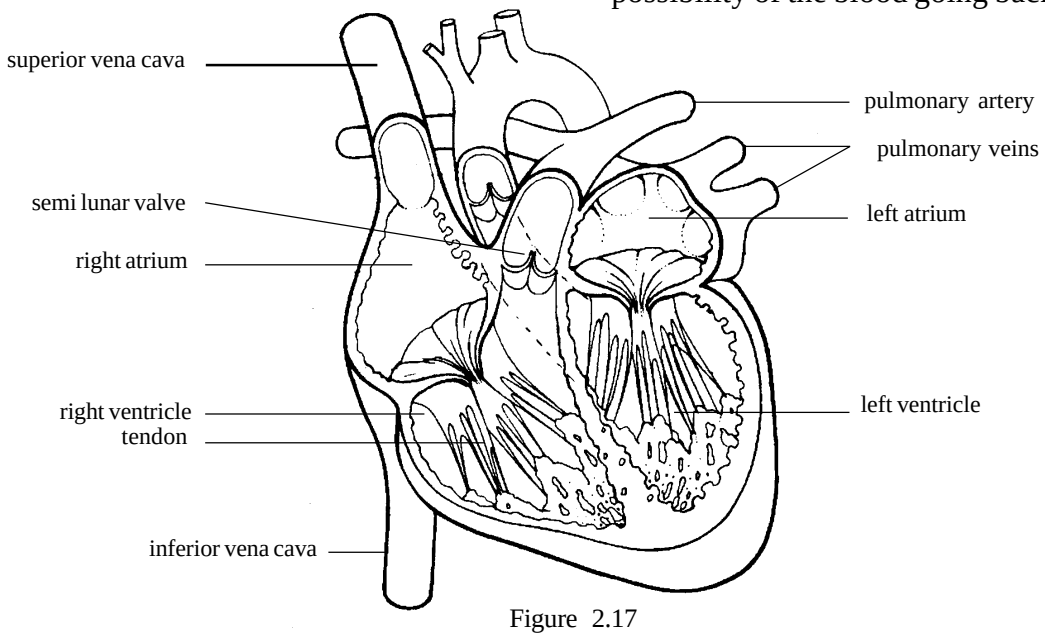


Figure 2.17
Structure of heart - C.S

atria. But this is prevented by two valves, the tricuspid valve on the right side and the bicuspid valve on the left side. The free edges of the flaps of these valves are tied to the walls of the corresponding ventricles by fine cords of tendon.

During ventricular contraction, blood from the right ventricle is pumped into the pulmonary artery and from the left ventricle into the aorta. The backward flow of blood from these arteries is prevented by valves at their bases. These are half moon shaped, pocket like valves, called semilunar valves. The heart has to exert some pressure to pump blood into these arteries. Hence the walls of the ventricles are thicker than those of the atria. After ventricular contraction, the walls of the heart relax.

During ventricular contraction, the tricuspid and the bicuspid valves close. During the relaxation of the ventricles, the semilunar valves close. The sounds produced when the valves close are the heart sounds, the first sound during the closure of the tricuspid and bicuspid valves and the second sound during the closure of the semilunar valves. The time taken for one contraction and relaxation of the heart is 0.8 seconds. Then how many times does the heart beat per minute?

Different types of circulation

Examine the illustration III. From the left ventricle, through the aorta and its branches, to which regions of the body does blood reach? Similarly from the different regions of the body, through which vessels does the blood return to the heart? The pathway of blood from the left ventricle back to the right atrium is known as systemic circulation (Fig.2.18).

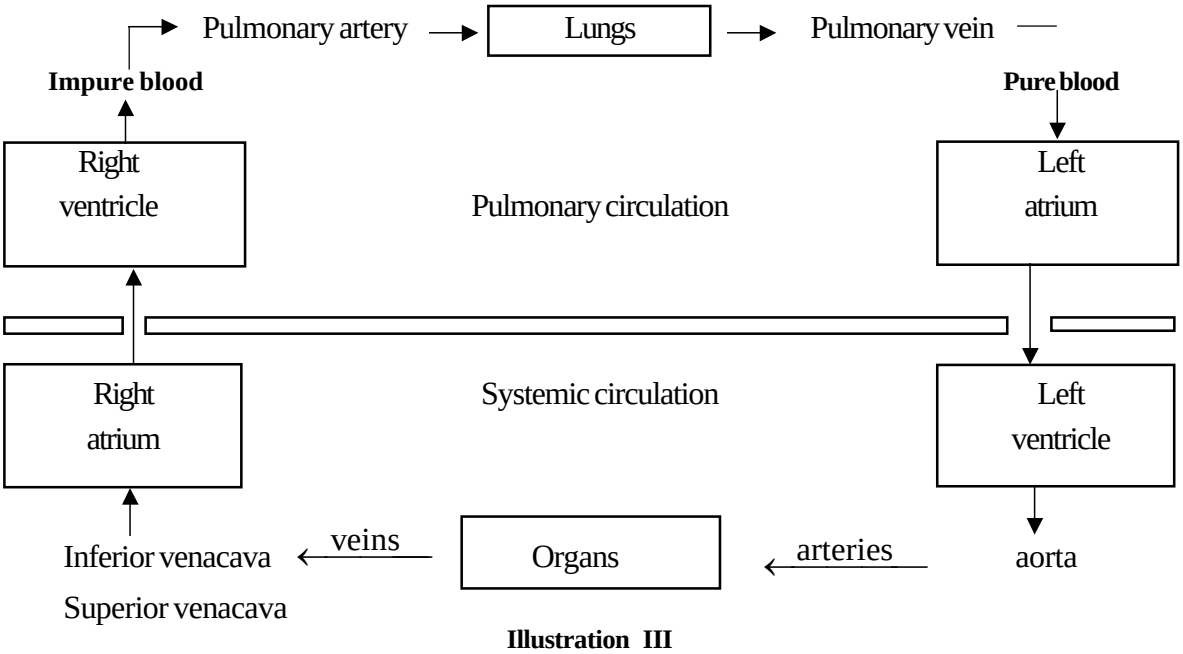


Illustration III

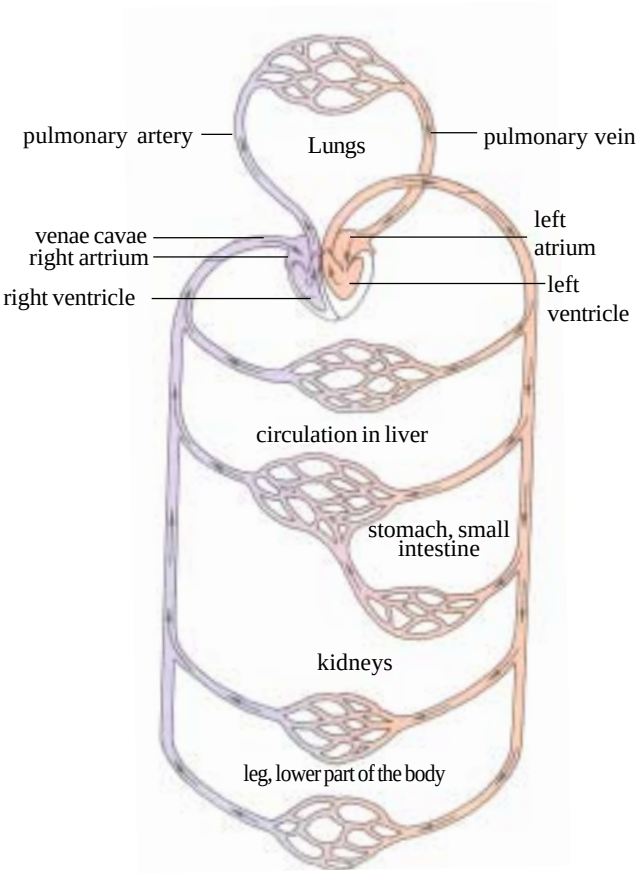


Figure 2.18
Double circulation

From where does the pulmonary artery arise? This artery contains deoxygenated blood. Where does this vessel reach? The blood that reaches the lungs gets oxygenated there and releases carbondioxide to the lungs. This blood, now rich in oxygen and poor in carbon dioxide, is carried to the heart by two veins from each lung called pulmonary veins. To which chamber does this blood reach? Thus the blood leaving the heart from the right ventricle comes back to the heart to the left atrium. This shorter circulation is called pulmonary circulation.

Thus in order to make a complete circuit blood has to pass through the heart twice. This is called double circulation.

The blood supply to the heart muscles is by the coronary arteries. They spread over the heart wall (fig 2.19). Blood from the heart muscles is carried back to the right atrium by the coronary veins. This circulation is called coronary circulation.

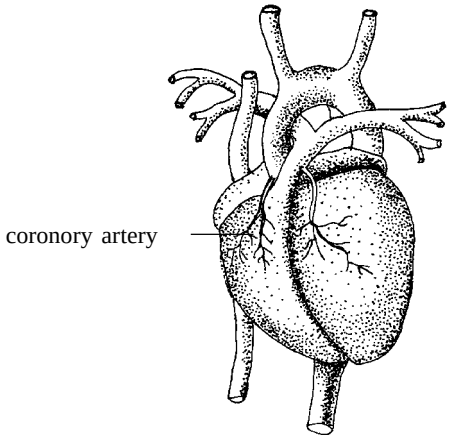


Figure 2.19
Coronory circulation

Blood Vessels

The veins are blood vessels that carry blood to the heart. What is the name given to the vessels that carry blood away from the heart? The fine branches of the arteries

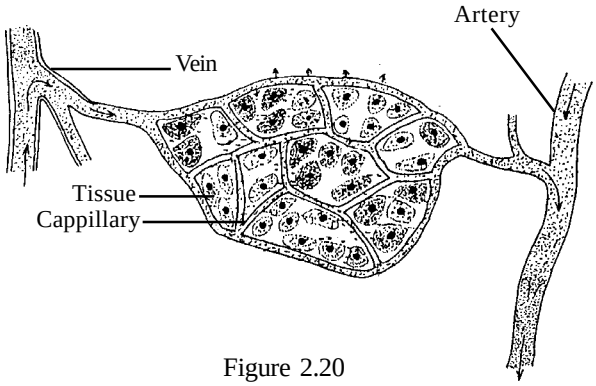


Figure 2.20
Blood capillaries

and veins are connected together by extremely fine vessels called capillaries (fig 2.20).

Compare the walls of arteries and veins (fig.2.21). How many layers are seen on the walls of these vessels? What is the peculiarity of the innermost layer? What is the difference in the thickness of the walls of the vessels? Being thin walled, veins collapse when there is no blood in them. The walls of arteries are not only thick but are also elastic. When

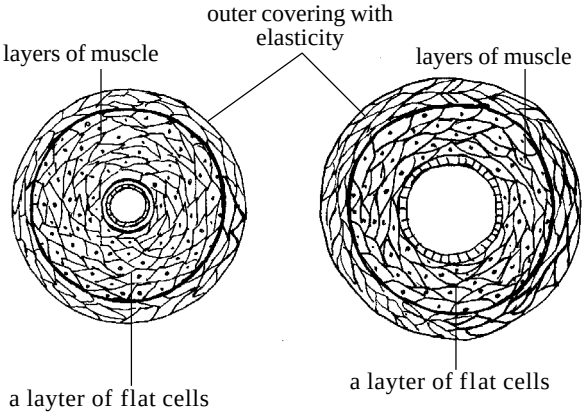


Figure 2.21

the heart contracts the pressure on the blood drives it into the arteries. Being elastic, the arterial wall distends to accommodate the incoming blood. When the heart relaxes, the pressure decreases and returns to its original state. When the heart contracts again what happens? This is repeated regularly and the wave like movement of the arterial wall runs along the entire length of the artery and its branches. This wave like movement is called pulse, which represents the distension and recoil of the arterial wall. What is the pulse rate per minute? Determine this by examining the pulse of your friends. As you move away from the heart along the arterial system, the strength of the pulse becomes less and less.

How are capillaries different from other blood vessels? These are extremely fine tubes whose wall is made up only of a single layer of cells. These capillaries run close to and between the tissue cells. As blood flows through them, the fluid part of blood oozes out into the intercellular spaces. This is called tissue fluid. The capillaries gradually reunite to form small veins.

The flow of blood through the veins

How does the blood flow through the veins? There are valves along the length of veins. These valves allow flow of blood only

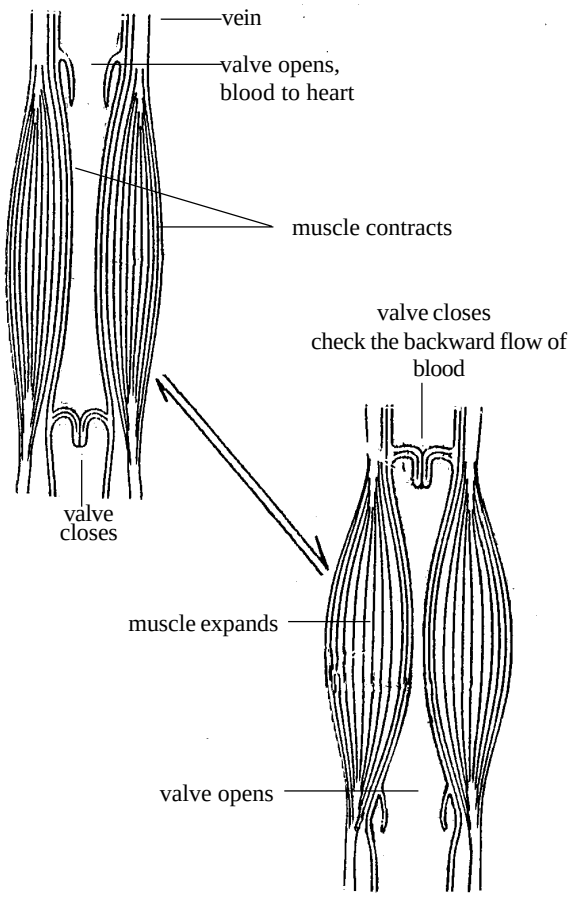


Figure 2.22

Blood flow through veins

towards the heart. As blood flows between the skeletal muscles, the influence of these muscles on blood flow can be understood from the illustration in figure 2.22. It will be clear from this that proper exercise is essential for blood flow.

Blood Pressure

You have seen how the doctor takes the blood pressure reading. The instrument used is called sphygmomanometer. As the heart contracts and pushes the blood, the pressure causes the arteries to distend to accomodate the incoming blood. This pressure is called systolic pressure. When the heart relaxes, the reduced pressure is called diastolic pressure. In an average healthy man, the systolic pressure is about 120 mm/Hg and the diastolic pressure is about 80 mm/Hg. Which region of the body is selected for reading blood pressure? As the distance from the heart increases, the pressure also will be different. In some persons the blood pressure will be more than normal (hypertension). What is the reason for this?

Heart Beat

Do you know when does your heart began to beat? The heart begins to beat at the age of 4 months of the embryonic stage. It will continue till death. Can you say how many times the heart would have beaten in a person of sixty years at the rate 72 per minute? You know that the rate of heart beat is not uniform. Heart beat of a foetus is more than 200 per minute. It will reach 140 per minute at the time of delivery. There are yet other specialities regarding the heart beat. Even though the elephant is bigger in size, its rate of heart beat is only 25 per minute. What is the relation between the size of the body and the working of heart!

Atherosclerosis

If the amount of cholesterol in the food increases, it has a tendency to get deposited inside the wall of arteries. This causes the narrowing of arteries and the condition is called atherosclerosis. What will be its effect?

- The cavity of arteries get narrower and the flow of blood gets reduced.
- The walls of arteries become rigid (Arteriosclerosis).
- Blood pressure increases (Hypertension).

The heart requires to develop greater force to pump blood into such arteries that have become narrow. This increases blood pressure. In addition, mental tensions, smoking, increased use of common salt etc can increase blood pressure. What are the dangers of increased blood pressure? In some people blood pressure will be lower than normal (Hypotension).

Thrombosis

Due to atherosclerosis the inner wall of the arteries becomes rough. Consequently in such areas, blood platelets and red corpuscles may get stuck. This can cause the formation of blood clots in such areas. This clot is called thrombus. The clot may remain there or be carried by blood to other parts of the body. If such clots are formed in the coronary artery or any of its branches what could happen? This is a cause

for heart attack. You must have heard that inorder to protect such patients bypass surgery is sometimes performed. In this process, in place of the blocked vessel, another blood vessel (removed from the leg of the patient) is stiched on and blood is allowed to flow through it.

However, if by some method, the thrombus formed in a vessel could be removed, would that not be more effective? There is a modern method of removing it by using a special equipment. This is called angioplasty. Cerebral thrombosis occurs when a thrombus is formed in the blood vessels of the brain.

Haemorrhage

Due to atherosclerosis, the vessels that have lost their elasticity can rupture when pressure in those vessels increase. This can cause haemorrhage and blood leaks out. Cerebral haemorrhage occuring in the brain can cause stroke. This is due to the fact that blood does not reach the regions of brain, where the vessel supplies blood. This causes the stroke.

What are the precautions we have to take in order to maintain the circulatory system in a healthy condition ? Record these in your science diary.

Lymphatic system

You have learned how tissue fluid is formed in the intercellular spaces. How is this fluid removed?

- It is returned to the capillaries themselves.
- It passes into lymph capillaries arising from the tissues.

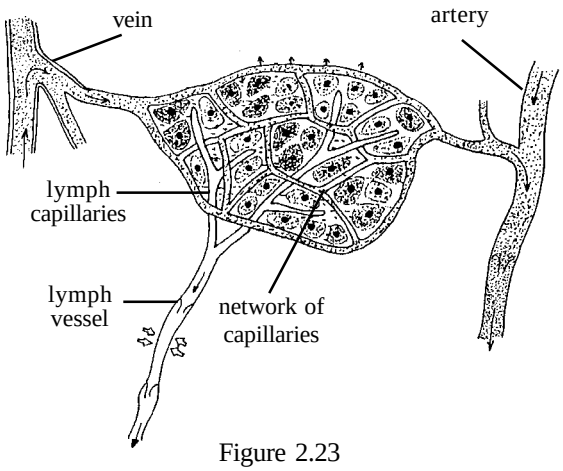


Figure 2.23
Network of capillaries and the origin of lymph capillaries

Lymph capillaries gradually unite to form definite lymph vessels (fig 2.23)

Examine the diagram of the lymphatic system of man (fig 2.24). Which is the largest

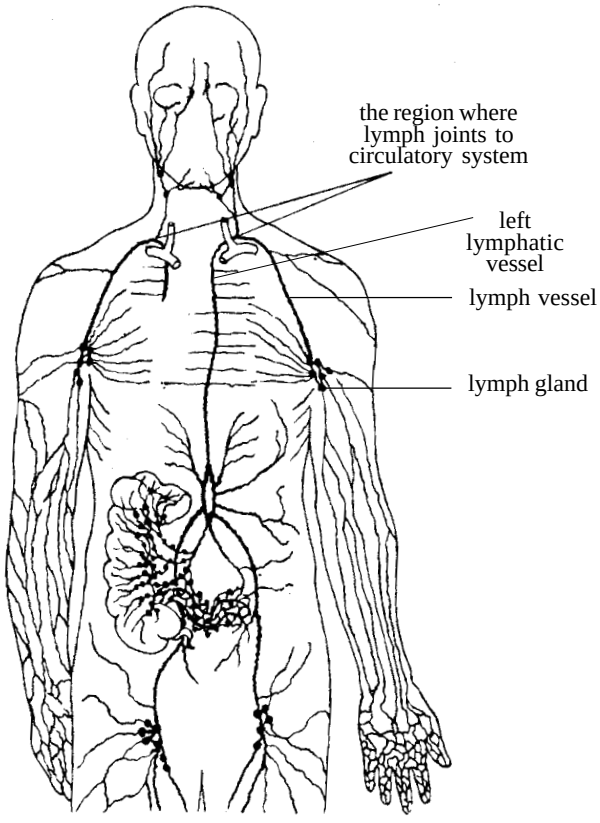


Figure 2.24
Lymphatic System

lymphatic vessel in the body? Where do these lymph vessels finally open? Valves are present in lymph vessels also as in the veins. Thus it will be clear how the lymph originating from blood is returned to blood itself. When flow of lymph is reduced it can cause swelling or oedema.

Along the course of lymph vessels are seen certain swellings called lymph glands. They contain large number of white corpuscles. What are their functions?

- They filter disease germs and destroy them.
- They destroy the antigens.
- They ingest and digest foreign particles.

Lymph glands serve to remove and destroy bacteria and viruses from the transport path way. Supposing you get a wound on your hand, you might have noticed swellings appearing in your armpit within a few days - Can you explain why this occurs?

The filarial parasitic worms live in the lymph glands. They block the flow of lymph. This is called filariasis. You know how this disease is spread?

Modern techniques in the treatment of cardiac diseases

The progress in scientific knowledge and technology has produced many modern methods in the diagnosis and treatment of heart diseases also. Let us examine some of these.

Electrocardiograph

You must have heard of ECG. This is a device to understand the working of the human heart. By using the apparatus called electro - cardiograph we can obtain a graphic record of the hearts' working called electrocardiogram (ECG). The doctor by examining this picture can locate the exact

Figure 2.25

defect and its location and suggest proper treatment. Observe the ECG of a healthy man (Fig 2.25).

Pacemaker

The cardiac cycle starts in the right atrium. It originates from a part of the right atrial wall as an electrical impulse. This initiates a heart beat. This area is called pacemaker. Any defect in the pace maker will affect the normal heart rhythm. For such patients an artificial pace maker can be fitted in the chest wall and connected to the heart.

Echocardiograph

Have you heard about ultrasound scanning? In the same way, by using ultra sound an instrument can be worked and this is connected to a TV screen. By examining the picture in the screen or a print obtained from it, the doctor can locate defects in the heart or associated blood vessels.

What are the services

Blood bag

Sree Chithira Thirunal Institute in Thiruvananthapuram is one of the most famous institution in the field of Medical Science and Technology. It extends outstanding perfor mance in neuro-cardiac field. It developed the PVC bags for the collection and transfu ssion of blood and also developed oxygenerator and reservior which is most essential for open heart surgery. The artificial valve of heart deviced in this institution is used as substitutor in the place of inactive heart valve. In addition to that it deviced artificial blood vessels, membrane for dialysis etc. It also developed remedial measures for deseases related to cardio vascular and nerveous system. Now it continues its research in the service of human patients.

Cardiotemy reservoir

Bubble oxygenerator

Heart transplantation

What is the way to save the life of a man if his heart function reaches a very dangerous state. Have you heard of the surgery inwhich a damaged heart is replaced by stiching surgically a fresh heart from a person who had just died in an accident? In 1967, Christian Bernad, first made a successful heart transplant surgery. In 2003 in Kerala, also a successful heart transplant surgery was carried out. Please collect more information about this surgery.

Figure 2.25
Artificial valves

Today researches are in progress to introduce an artificial heart in the place of the human heart. In addition, the replacement of heart valves (fig 2.25) by artificial valves, has become common. Researches are rapidly progressing not only in the treatment of heart diseases but also in other areas .

SUMMARY

- The suction force due to transpiration and root pressure developed in the roots help in the conduction of water up wards in plants through the xylem vessels.
- In unicellular organism through cyclosis, movement of materials occur in the cell.
- The medium of conduction of materials in simple lower organisms is different from that is found in complex higher animals.
- Plasma, blood corpuscles and platelets are constituents of blood.
- Plasma plays an important role in the conduction of materials as well as in the development of resistance to diseases.
- White corpuscles are important in the defence of the body against diseases, red blood corpuscles in the transport of respiratory gases and platelets for the clotting of blood.
- Blood groups are determined on the basis of the antigens contained in blood.
- There are two types of circulation seen in animals. They are open vascular system and closed vascular system.
- The contraction of the heart muscles and the arrangement of blood vessels and valves causes movement of blood to the required places.
- Changes in life habits affect the circulatory system
- Electro cardio graph, artificial pace maker, Echocardiograph, angioplasty, bypass surgery, heart transplantation etc are modern developments in the treatment of heart diseases.

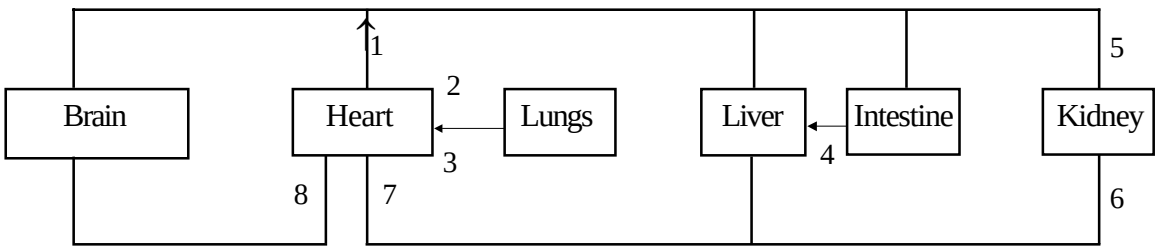
FURTHER ACTIVITIES

- Given below is simple diagram showing the path way of circulation in man.

  a. Name the blood vessels numbered 1-8

  b. From which chamber of the heart does blood pass into the vessel marked '1'.

  c. To which chamber of the heart does the vessel marked '3' take blood.



- What is the reason for the appearance of swelling (oedema) in people who work during the whole day sitting?
- What is difference between the fluid in the clotted blood and that in the normal blood through they appear to be alike?
- William Harvey compared the human heart to a double pump. What is your view?
- "Oxygennated blood flows through arteries and deoxygenated blood through veins" Explain what is your opinion about this statement.
- When a man who had varicose veins on his leg (veins which have become large and irregular) was examined, it was found that the valves in the veins were defective.
  a. What is your explanation for the swollen veins?
  b. The veins on the surface of the leg were more swollen than the veins in the interior. What could be the reason?
- "Lymph brings together into close relation, the cells and blood". What is your reaction to this statement.
- "Plants absorb large amount of water from the soil and the water is wasted through the leaves". What is your opinion about this statement made by a student?
- "In a patient affected by dengue fever, the platelet count becomes very low and consequently he loses lot of blood." What is the reason?