

INCREASING ACCESS TO SECONDARY SCHOOL LEVEL EDUCATION THROUGH THE PRODUCTION OF QUALITY LEARNING MATERIALS

JUNIOR SECONDARY LEVEL

BIOLOGY

Module 5: Transport

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JUNIOR SECONDARY LEVEL SCIENCE - BIOLOGY

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Unit 2 Biological Skills

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Unit 1 Cell Structure and Organisation

Unit 2 Levels of Organisation

Unit 3 Compounds of Life

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Unit 2 Hormonal and Nervous Control

Unit 3 Control and Regulation

MODULE 7 – Continuity of Life

Unit 1 Reproduction

MODULE 8 – Organisms and the Environment

Unit 1 Ecological Principles

Unit 2 Population Growth and Regulation

Unit 3 Human Influence on the Environment

MODULE 5

TRANSPORT

MODULE INTRODUCTION

Once materials have been absorbed, they have to be sent to all the cells of the multi-cellular organism, some of them far away. Otherwise the likely consequence is cell death. We therefore need a system to carry out this task.

This Module looks at this system known as the **Transport System** and explains how movement occurs all along the system in both plants and humans.

MODULE OBJECTIVE

At the end of this Module you should be able to:

- describe and explain different aspects of transport in plants and animals.
- list the parts that make up the transport system
- identify the substances being transported

UNIT 1

TRANSPORT IN PLANTS

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UNIT 1

TRANSPORT IN PLANTS

INTRODUCTION

All living organisms have to exchange materials between their cells and their surroundings. This helps to keep them alive. These materials are:

- (i) oxygen
- (ii) water
- (iii) food
- (iv) waste products

Very small organisms have a large surface area compared to their volume. Because they are so small, they require only small amounts of food and oxygen to live. They produce small amounts of waste products. In such tiny organisms nutrients reach the cell by **diffusion** and **osmosis** across the cell's surface. They get rid of their wastes in a similar way. Examples of such organisms are amoeba, spirogyra, and mucor.

Diffusion and Osmosis have been discussed in Module 2, Unit 4.

In more complex, many-celled organisms like a fish, mammal or flowering plant, the surface area is no longer large enough to carry out these functions. In this case there is a problem of distance between parts of the body, the internal tissues and the environment. Such organisms have therefore a transport system to take food, oxygen and water to all the cells of the body and to get rid of the waste products. This consists of a collection of tubes in which materials in solution may pass from one part of the plant or animal to another. Such tubes are the blood vessels of animals and the xylem and phloem vessels of plants. In this Unit, we concentrate on the transport system in plants.

OBJECTIVES

At the end of this Unit you should be able to:

- list the function of root hair cells
- describe the pathway by which water enters a plant
- describe the structure of xylem vessels
- define transpiration and wilting
- explain how environmental conditions affect the rate of transpiration
- describe the adaptation of the leaf, stem and root to different environments
- describe translocation of sugars (sucrose) and amino acids, pesticides throughout the plant.

1.0 TRANSPORT IN PLANTS

At first glance, a plant may appear fairly idle, but don't be surprised that the inside is the scene of intense activity. Substances are constantly being moved from one place to another. Green plants usually transport two types of materials, these are:

- food substances and
- water which may contain dissolved substances.

This movement of substances within the plant is called **translocation**. To understand how translocation occurs, you must first look at the structures inside the plant.

The parts of a flowering plant mainly concerned with the transport of materials are the vascular tissues or bundles. These are made up of **xylem** and **phloem**. Translocation of substances occurs as follows:

Translocation

- (1) The **root hairs** absorb water and mineral salts from the soil water.
- (2) In the **cortex** of the root hair region, these substances pass to the central cylinder of the stem.
- (3) The **xylem** vessels carry the solution of materials absorbed from the soil to the rest of the plant. This solution is sometimes called sap.
- (4) The **sieve tubes of the phloem** carry food substances made in the leaves to other parts of the plant.

The Root

A plant is fixed firmly in the soil by its roots. At a short distance from the root tip there is a covering of fine projections called root hairs. These root hairs provide a large surface area for absorbing water and minerals from the soil. Water enters a root through its root hairs by **osmosis**.

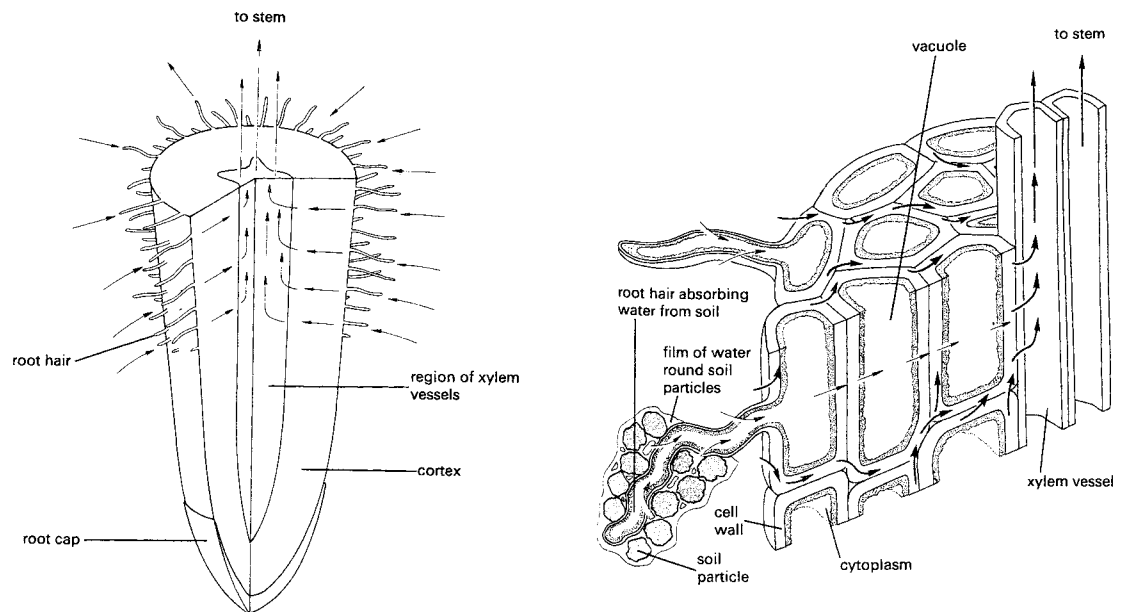


Fig. 1: Passage of Water from the Soil into the Root

The water then moves across the root until it reaches the xylem found at the centre. Water moves from cell to cell by osmosis, across the root. This is shown in the figure below.

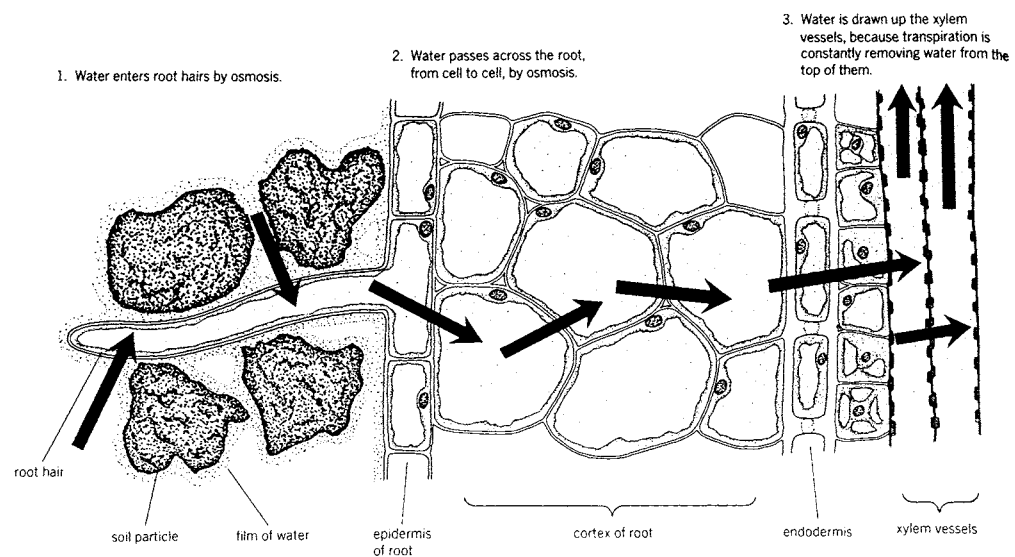


Fig. 2 : Path of Water through a Root

This force of water entering the roots pushes water up the xylem. This force is called root pressure. It can be observed when water continues to come out from a freshly cut stem of a plant. This is a minor force in the upward movement of water.



Before proceeding further, complete the following activity.

ACTIVITY 1

1. (a) Name two types of tissues responsible for transport in plants.
.....
- (b) State the functions of these tissues.
.....
2. (a) What are root hairs?
.....
- (b) Why are root hairs important to plants?
.....
.....
3. (a) How does water move across the root to go into the conducting cells?
.....
.....
- (b) How are xylem vessels adapted to their function?
.....
.....

You will find the answer at the end of the Module.

We can now proceed with the following investigation.



INVESTIGATION 1: To demonstrate root pressure

For each investigation you will require the materials indicated.

You should record your answers in the space provided.

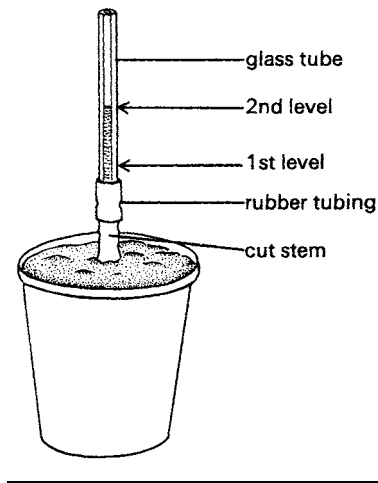


Fig. 3: Root Pressure

Method:

1. Connect a piece of glass tubing by means of a rubber tube to the freshly cut end of a stem of a potted plant.
2. Place a little coloured water in the glass tube and mark its level.
3. Leave for a few hours and observe any change in the level of liquid in the glass tube.

Observation

After sometime the level of liquid in the glass tube rises.

Interpretation

This clearly shows that there is a push from below, at the cut stem. This results in root pressure.

1.1 MOVEMENT OF WATER

Movement of water from roots to leaves is more easily understood if you first consider what happens to the water in the leaves. The cells inside the leaf are covered with a film of water. When this water evaporates into the air spaces in the leaf, it diffuses out through the stomata into the surrounding air. This process is called **transpiration**.

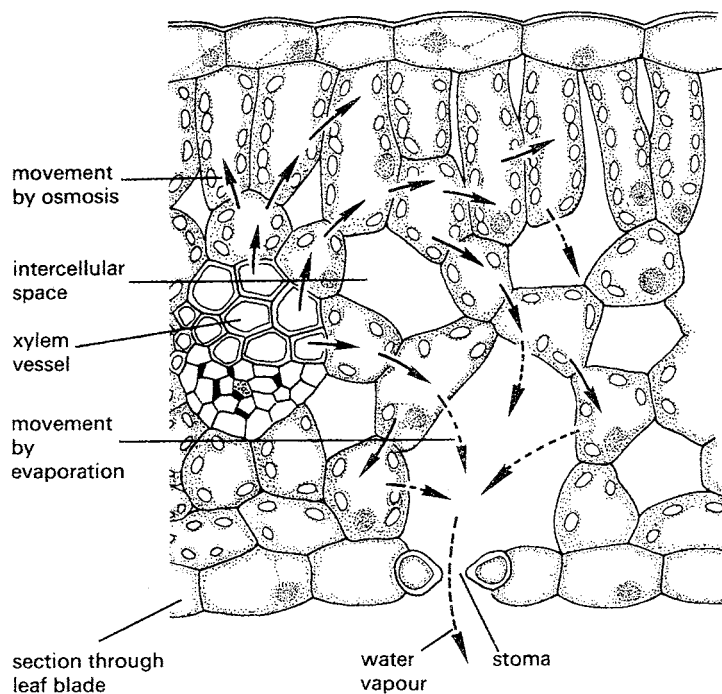


Fig. 4 - ater Loss from the Leaf

The loss of water from the mesophyll cells pulls in water from the neighbouring cells. This creates a tension or pull on the column of water in the xylem vessels. This tension extends all the way to the roots. It pulls the water up to the top of the plant in a continuous column. This is called the transpiration stream.

The following summarises how water passes through a flowering plant:

1. Water is taken by root hair cells by osmosis.
2. Water moves towards the centre of the root by osmosis. It then enters xylem vessels.
3. Water rises up the xylem vessels in the stem by the combined action of root pressure and transpiration stream.
4. Water passes out of xylem vessels into the mesophyll cells of the leaf.
5. Water then evaporates from the surface of the mesophyll cells into air spaces in the leaf.
6. Water vapour diffuses out of the stomata into the surrounding air.

1.2 STRUCTURE OF XYLEM

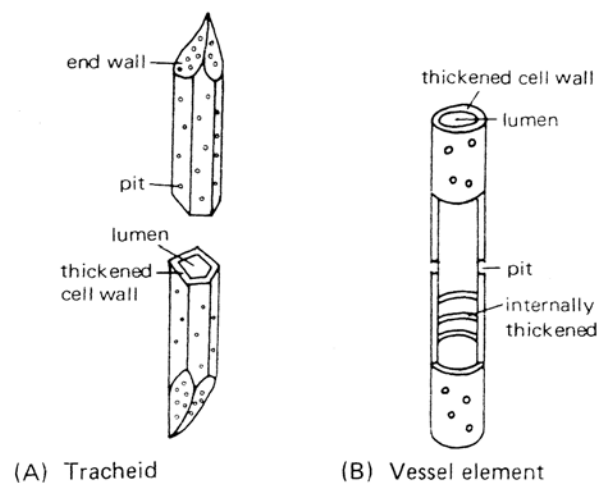


Fig. 5 Xylem Tissue

The xylem is part of the vascular tissue in plants. It consists mainly of xylem vessels. These are long, narrow cells. They are dead cells which are hollow. They are joined end to end and do not have any cross walls between them. Thus they form continuous tubes from roots to stems and into the leaves. This allows them to conduct water and mineral salts from the roots, through the stem to the leaves. They also have thick cell walls which provide support to the part where they are found.

We can now proceed with the following investigation.



INVESTIGATION 2: To examine the internal structure of a dicot stem and a dicot root.

<p>For each investigation you will require the materials indicated.</p>	<p>Materials needed:</p> <ul style="list-style-type: none"> • A prepared slide of transverse section of - dicot stem • dicot root • Light microscope <p>Method:</p> <ol style="list-style-type: none"> 1. <i>Place the prepared slide of transverse section of dicot stem on the stage of the microscope.</i> 2. <i>Examine the section of the stem under low power of the microscope.</i> 3. <i>In the space below, make a labelled line drawing to show the distribution of vascular bundles in the stem.</i> 4. <i>Make a labelled drawing of a single vascular bundle to show xylem, and phloem.</i>
--	---

<p>You should record your answers in the space provided.</p>	<ol style="list-style-type: none"> 5. <i>Now place the prepared slide of transverse section of dicot root on the stage of the microscope.</i> 6. <i>Examine the section of the root under low power of the microscope.</i> 7. <i>In the space below, make a labelled line drawing to show the distribution of xylem and phloem in the root.</i>
---	--

We can now proceed with the following investigation.



INVESTIGATION 3: To demonstrate Transpiration

<p>For each investigation you will require the materials indicated.</p>	<div data-bbox="586 1318 873 1711"> </div> <p><i>Fig. 6 Water Produced in Transpiration</i></p>
--	--

<p>You should record your answers in the space provided.</p>	<p>Method:</p> <ol style="list-style-type: none">1. <i>Enclose the shoot of a recently watered potted plant in a transparent polythene bag.</i>2. <i>Tie the bag tightly round the base of the stem as shown in figure 6.</i>3. <i>Leave the plant for a few hours in direct sunlight.</i>4. <i>Remove the bag and shake all the condensed liquid into a corner.</i>5. <i>Pour a few drops of this condensed liquid on to some anhydrous copper sulphate or a piece of blue cobalt chloride paper.</i> <p><u>Observations</u></p> <p><i>After some time tiny, colourless droplets of a liquid condense on the inner sides of the polythene bag. When tested, this liquid turns the anhydrous copper sulphate blue or the cobalt chloride pink.</i></p> <p><u>Interpretation</u></p> <p><i>The shoot of the plant has released water in the form of vapour by the process of transpiration.</i></p>
---	---

1.3 RATE OF TRANSPIRATION

Transpiration is due to the evaporation of water from the leaves. Thus any change which increases or decreases evaporation will have the same effect on transpiration.

1.3.1 FACTORS AFFECTING RATE

The factors which affect the rate of transpiration are:

- (a) **Temperature** Water evaporates faster on a hot day. Rate of transpiration increases with rise in temperature.
- (b) **Light intensity** Stomata open in response to increase in light intensity. More water vapour is thus lost to the surrounding, through the open stomata. Rate of transpiration increases with increase in light intensity, to a certain extent.
- (c) **Humidity** Humidity is the water content in the air around the plant. Water evaporates faster from the leaves when the surrounding air is drier. That is, the rate of transpiration is high when humidity is low. When humidity is high, the rate of transpiration is low.
- (d) **Air movements** In still air, transpiration is reduced whereas in moving air, it is rapid

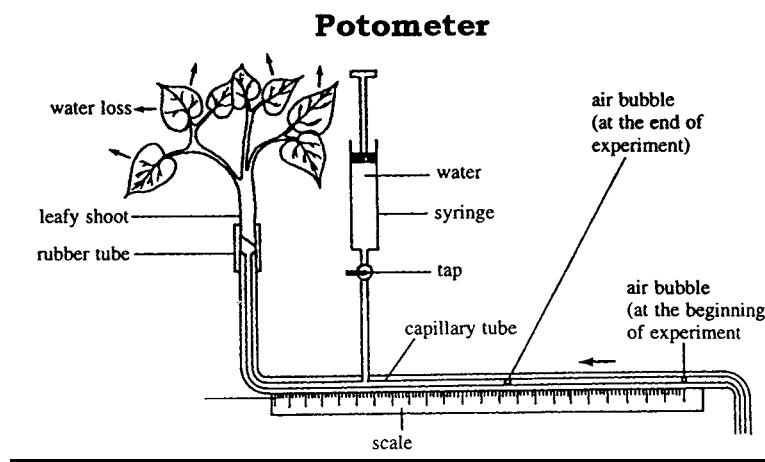


Fig. 7 A. potometer

A potometer is a simple apparatus which can be used to measure the rate of water uptake into a leafy shoot. It can also be used to compare the rates of transpiration under different conditions. Measurement can be made by recording the movement of an air bubble along a capillary tube, as shown in Figure 7. The volume of water uptake at a given time is the difference between readings on the scale, at the beginning and at the end, of the experiment. The rates of transpiration can thus be compared in different situations.

 ***Before proceeding further, complete the following activity.***

ACTIVITY 2

1. (a) What is root pressure?

.....
.....
.....

- (b) What is the importance of root pressure?

.....
.....

2. (a) What is transpiration?

.....
.....

- (b) Name three environmental factors which affect the rate of transpiration?

.....

- (c) Name the apparatus that can be used to measure the rate of water uptake by a leafy shoot?

.....

You will find the answer at the end of the Module.

We can now proceed with the following investigation.



INVESTIGATION 4: Using a potometer to compare rates of transpiration under different conditions

<p>For each investigation you will require the materials indicated.</p>	<p>Method:</p> <ol style="list-style-type: none"> 1. <i>Set up the potometer as shown in Fig. 7</i> 2. <i>Fit the leafy shoot into the simple potometer under water.</i> 3. <i>Smear all the joints with vaseline to make the whole apparatus air tight.</i> 4. <i>Leave the apparatus in the laboratory for the leafy shoot to adjust to the surroundings.</i> 5. <i>Adjust the air bubble so that it is at the end of the scale, as shown in Fig. 7.</i> 6. <i>Record the distance travelled by the air bubble in a given time. (e.g. 10 mins).</i> 7. <i>Turn on the tap to refill the apparatus with water. This helps to drive the air bubble back to the end of the scale, for new measurements to be taken.</i> 8. <i>Now repeat this experiment by keeping the apparatus in a different situation. You could try each of these:</i> <ol style="list-style-type: none"> (a) <i>putting it exposed to the sun outside the laboratory.</i> (b) <i>putting it in a cupboard.</i>
--	--

**You should record
your answers in the
space provided.**

- (c) *putting it in a refrigerator.*
(d) *putting it in a humid surrounding.*

Observations

9. *Under which conditions did the leafy shoot
transpire,*

(a) *most quickly?*

.....
.....
.....

(b) *most slowly?*

.....
.....
.....

Conclusion

10. *State a conclusion from this experiment.*

.....
.....
.....
.....

1.4 WILTING

When plants are exposed to conditions where they lose water faster than they absorb it from the soil, they wilt. The cells lose their turgidity. This is more marked in the leaves and young twigs. That is why you often see leaves and young twigs drooping, on hot summer afternoons. This is due to excessive transpiration. If wilting persists for a long period the plant may die. If water is available soon then the plant may recover.

Xerophytes

Plants living in dry habitats where there is scarcity of water are called xerophytes. Such plants have many structural adaptations.

- (a) The plant surface is covered by a thick waxy cuticle.
- (b) It has fewer and smaller stomata on the leaves.
- (c) Some plants shed their leaves in winter e.g. deciduous trees like the indian almond tree.
- (d) The leaves may roll up so that the stomata are enclosed inside the leaves. This reduces water loss by transpiration.
- (e) In some plants like pine and cactus the leaves are modified into a needle shape to reduce transpiration.

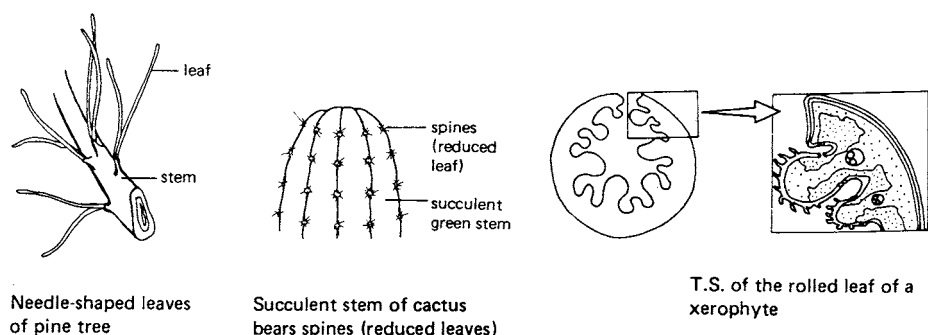


Fig. 8 Xerophytes

1.5 TRANSPORT OF FOOD SUBSTANCES

Leaves make carbohydrates by photosynthesis. They also use some of these carbohydrates to make amino acids, proteins and other organic substances.

Some of the organic food material, especially sugars that the plant makes are transported in the phloem tubes. They are carried from the leaves to other parts of the plant where they are needed. This is called **translocation**. The sap inside the phloem tubes therefore contains a lot of sugars, particularly sucrose.

Using Aphids

The aphid can be used to study the transport of sugars in the phloem sieve tubes.

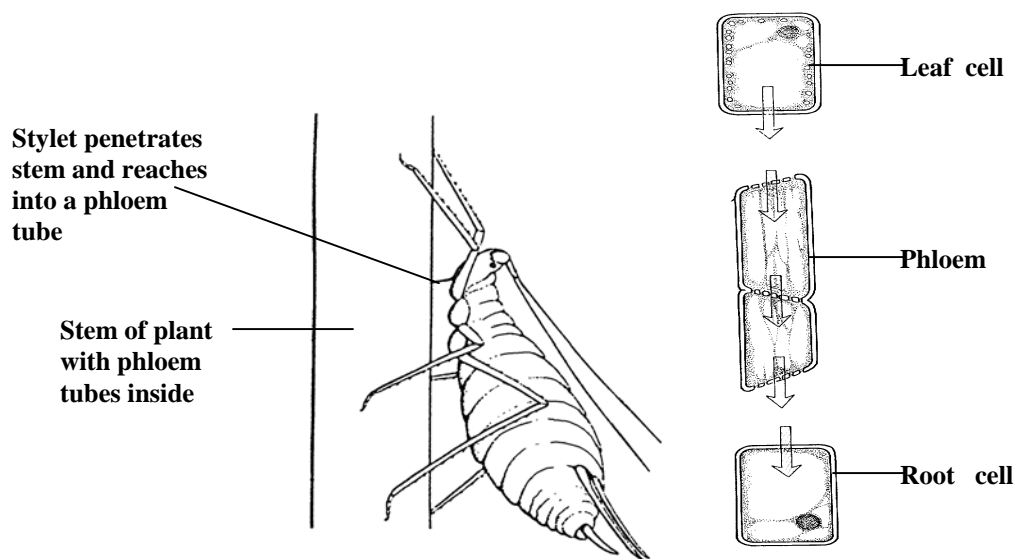


Fig. 9 An Aphid Feeding on Phloem Sap

Aphids feed on plant juices. They have special needle-shaped mouthparts called stylets. They push their stylets into the phloem tubes of a plant and suck the sap from them, because the sap contains the products of photosynthesis on which they feed.

A feeding aphid can be anaesthetised. Then its mouthparts are cut off. The phloem sap keeps flowing out of the phloem tubes through the stylet. The sap is then analysed. It is found to contain sugars and other organic materials.



Before proceeding further, complete the following activity.

ACTIVITY 3

1. (a) What causes wilting in plants?

.....
.....

- (b) What are xerophytes?

.....

- (c) State three ways in which xerophytes reduce their water loss?

.....
.....
.....

2. (a) What is translocation?

.....
.....

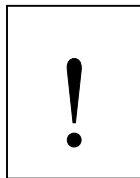
- (b) State the contents of phloem sap in plants?

.....

You will find the answer at the end of the Module.

The Phloems

The phloems are columns of living cells whose horizontal walls are like a sieve. This sieve allows the flow of substances from cell to cell. This is why the aphid with its stylet can feed on the phloem's sap because of the continuous flow of substances.



POINTS TO REMEMBER

- Living organisms have to exchange materials between their cell and their surroundings.
- Small organisms have a large surface area compared to their volume. Exchange of materials occurs directly through the body surface by simple diffusion.
- Large organisms need a transport system to carry substances from one part of the body to another.
- Vascular tissues consisting of xylem and phloem are concerned with transport of materials in plants.
- Root hairs absorb water and mineral salts from the soil.
- Root pressure pushes water up the xylem in stems.
- Transpiration is the loss of water in the form of vapour from the shoot of a plant.
- Transpiration stream pulls water up to the top of the plant.
- Xylem vessels are long, narrow, hollow dead cells with thick walls. They allow easy passage of water and also provide support to the plant.
- The rate of transpiration is affected by temperature, light, intensity, and humidity. It can be measured by using a potometer.
- Wilting occurs when rate of transpiration exceeds rate of water absorption by the roots.
- Xerophytes are plants with structural adaptations to minimise water loss by transpiration.
- Translocation is the transport of organic food material through the phloem in the plant.
- Aphids can be used to study the transport of sugar in the phloem sieve tubes.

UNIT 2

TRANSPORT IN HUMANS

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UNIT 2

TRANSPORT IN HUMANS

INTRODUCTION

Just like plants, we humans also need a transport system. The main transport system of a human is the blood circulatory system. This consists of a network of tubes called blood vessels. There is a pump called the heart which keeps the blood flowing through the blood vessels.

In Module 4 - Unit 2 you learnt how food is digested and absorbed in the small intestine. All these absorbed food substances are carried from the intestine to other parts of the body by the blood system. Similarly oxygen which is taken in by the lungs is carried to all the body cells in the blood. This Unit looks at the transport system in us humans.

OBJECTIVES

At the end of this unit you should be able to:

- Identify the different circulatory systems
- describe the gross structure and function of the heart.
- show that the pulse is a measure of the heart beat rate.
- describe the effect of exercise on heart beat.
- list the causes of heart disease (diet, smoking and stress) and preventive measures.
- describe the structure and function of arteries, capillaries and veins.

2.0 CIRCULATORY SYSTEMS

As we mentioned earlier, the circulatory system consists of tubes and a pump. If we connect all these tubes end to end, they would stretch nearly three times around the world. Heart provides the power to move the blood around.

2.1 DIFFERENT TYPES OF CIRCULATORY SYSTEMS

We shall now look closely at different types of circulatory systems namely:

- Open Circulatory System
- Closed Circulatory System
- Double Circulatory System

2.1.1 OPEN CIRCULATORY SYSTEM

Lowly evolved animals like insects have an open circulatory system which is different from your blood system.

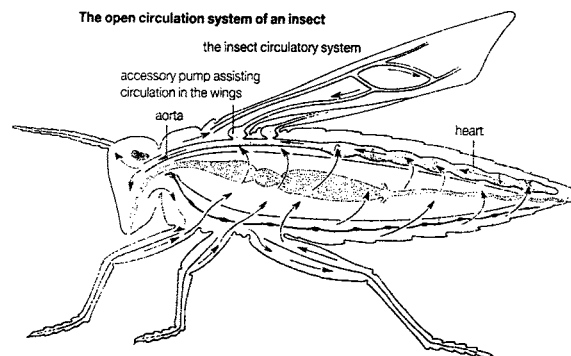


Fig. 10: Open Blood System

In an open circulatory system blood is pumped at low pressure from the heart into spaces in the body. For example, the insect does not have blood vessels like you do. Here the blood is contained in an open blood space. This blood is kept moving by the tubular heart found above the gut. The blood is sucked into the heart through little holes in its sides, as shown in Fig. 10. It is then pumped forward and expelled into the blood space at the front end. Here blood passes only once through the heart in every circulation. Thus it is called a ***single circulatory system***.

2.1.2 CLOSED CIRCULATORY SYSTEM

Your circulatory system is a closed system. In this case the blood circulates in a continuous system of tubes called the blood vessels. This is shown below in Fig. 11.

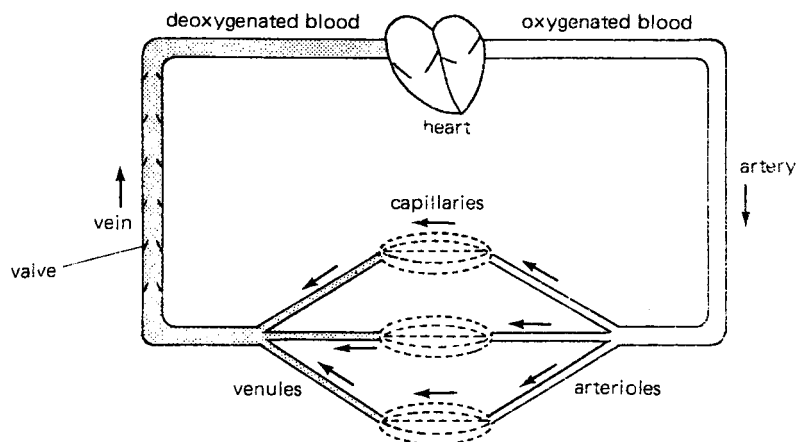


Fig. 11: The Closed Blood System

Blood is pumped out of the heart at a high pressure. This blood passes through arteries and arterioles to the capillaries of the body organs. Then the blood returns through venules and veins back to the heart.

2.1.3 DOUBLE CIRCULATORY SYSTEM

The Figure below shows a plan of your circulatory system.

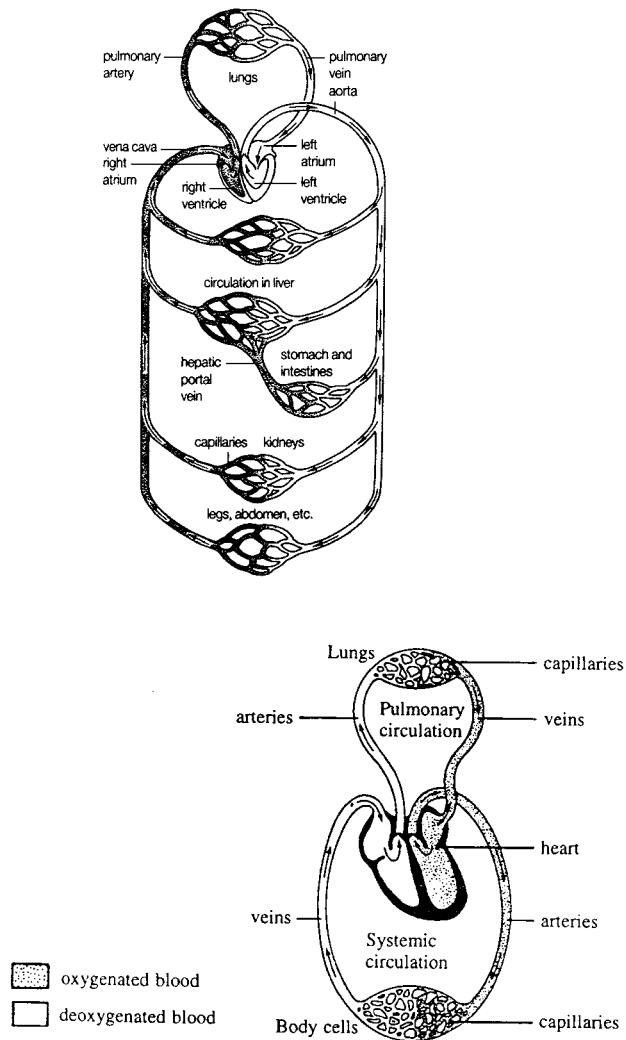


Fig. 12: Plan of Human Circulatory System

Pulmonary Circulation

You have a double circulatory system. Here blood is first pumped from the heart to the lungs through the pulmonary artery. The blood from the lungs returns to the heart through the pulmonary vein. This is called the pulmonary circulation.

Systemic Circulation

This same blood is then pumped by the heart to the body tissues through the aorta. This blood again returns to the heart by way of the vena cava. This is called the systemic circulation.

Therefore the same blood passes twice through the heart in one complete circulation. That is why you are said to have a double blood circulation.

2.2 THE HEART

Your heart is about the same size as your clenched fist. It consists of a special muscle called the cardiac muscle. The heart is found in the thorax, between the two lungs. It is well protected by the sternum (breast bone) and the rib cage.

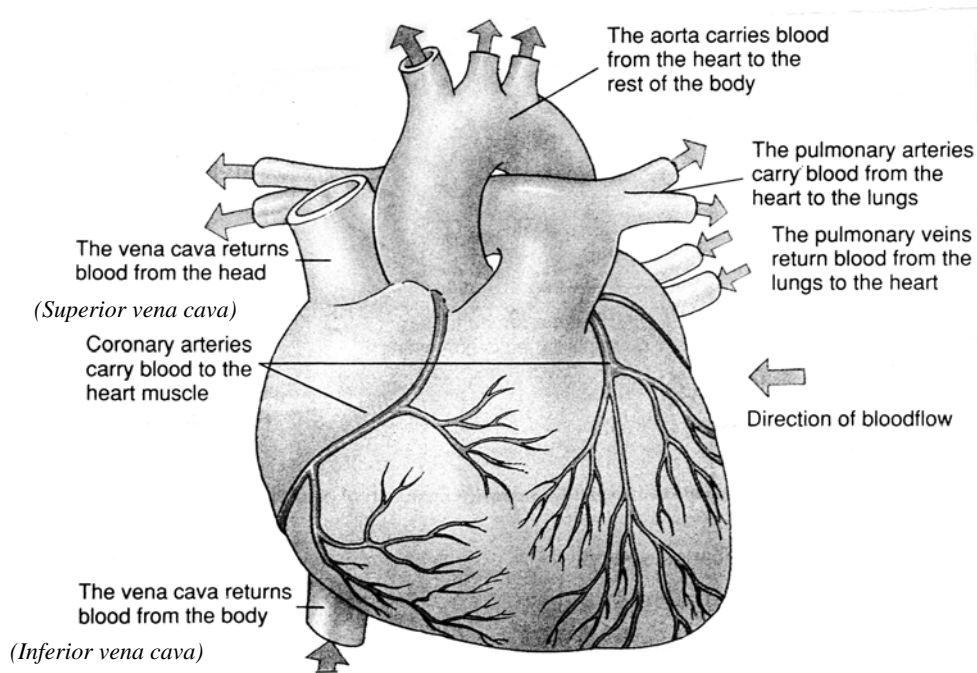


Fig. 13: External Appearance of Heart

If you place your hand on your chest, slightly towards the left, you will feel your heart beating. It has been beating continuously since before you were born. It will continue to beat throughout your life.

You can buy the heart of an ox or of a goat at the market and dissect it to learn more about its internal structure.

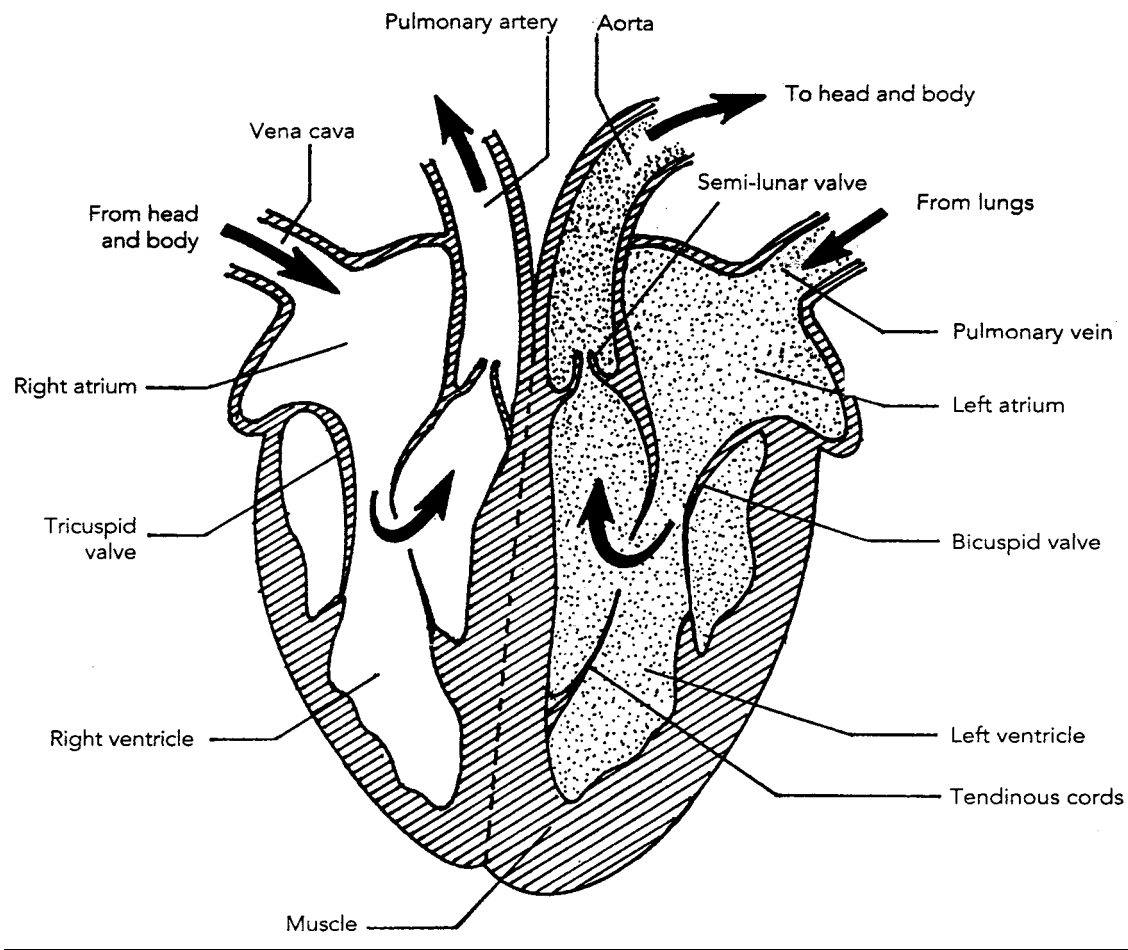


Fig 14: Internal Structure of the Heart

The human heart has four separate chambers. The two top chambers are called atria. The two lower chambers are called ventricles. The atria are smaller and have thinner walls than the ventricles. The right side of the heart is separated from the left side by a muscular partition. Thus these two halves do not communicate with each other. However, the atrium and ventricle of each side communicate by means of an opening guarded by a valve. This valve opens from the atrium into the ventricle. So blood passing through the heart can flow

from the atrium into the ventricle but not in the reverse direction. The valve on the right side is called the tricuspid valve while the one on the left side is known as the bicuspid valve. Thread-like structures attach the tip of these valves to the inner walls of the ventricles. This prevents the valves from turning inside out. The wall of the left ventricle is considerably thicker than that of the right ventricle. This is because the left ventricle has to pump blood round the body (except the lungs), whereas the right ventricle pumps blood a much shorter distance to the lungs. You should note that the heart muscles are supplied with blood by the coronary arteries.

2.2.1 BLOOD CIRCULATION THROUGH THE HEART

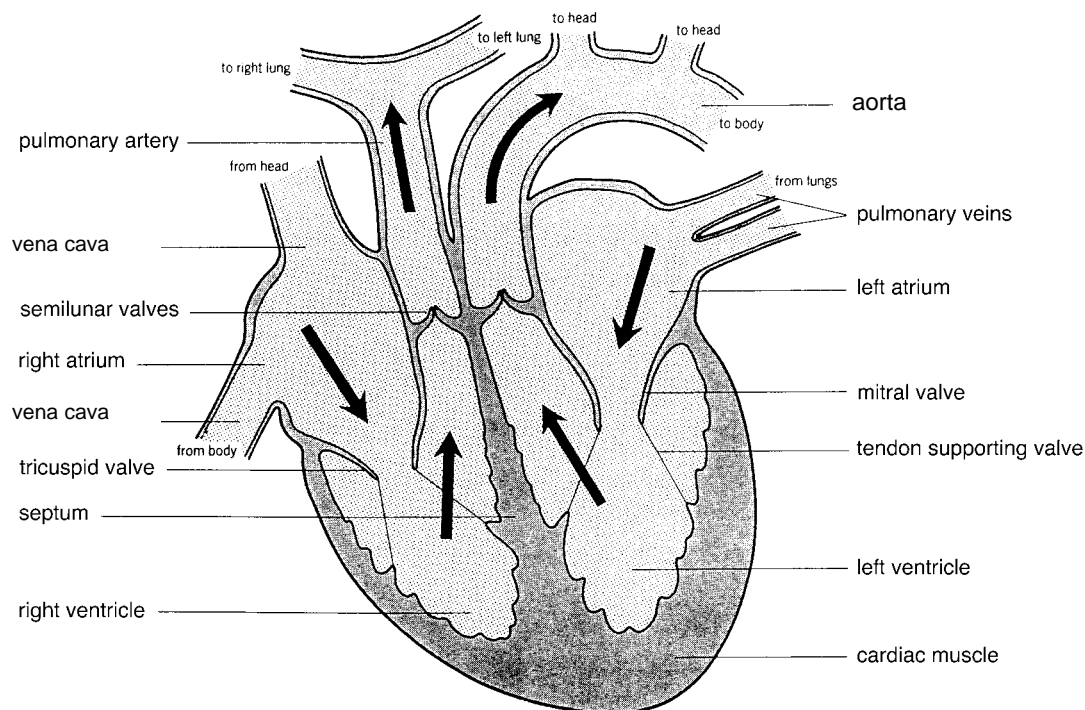


Fig. 15: Blood Flow Through The Heart

- (a) Deoxygenated blood from different parts of the body flows into the heart along the vena cavae. These pour the blood into the right atrium.
- (b) This blood passes then to the right ventricle. It is sent to the lungs through the right ventricle. It is sent to the lungs through the pulmonary artery.

- (c) Oxygenated blood from the lung returns to the left atrium along the pulmonary veins.
- (d) This blood then passes into the left ventricle.
- (e) The blood leaves the heart through the aorta to be distributed around the body.

At the entrance of the pulmonary artery and the aorta are found the semi-lunar valves. You must note that the function of valves in the heart is to prevent the back flow of blood. That is, blood always flows in only one direction through the heart.

We can now proceed with the following investigation.



INVESTIGATION 1: Examination of a mammalian heart.

<p>For each investigation you will require the materials indicated.</p>	<p>Materials needed:</p> <ul style="list-style-type: none"> • a sheep's heart • a pair of forceps, • a seeker • scalpel • a tray <p>Method:</p> <p>1. <i>Examine the external features of the sheep's heart.</i></p> <p><i>Note the size of the atria and ventricles and comment briefly on them.</i></p> <p>.....</p> <p>.....</p> <p>.....</p>
--	---

**You should record
your answers in the
space provided.**

2. *Identify the blood vessels connected to the heart.
Name them.*

.....
.....
.....

3. *Make a large labelled drawing of the external
features of the heart.*

4. *Cut the heart longitudinally. Examine and note the
internal features of the dissected heart.*

5. *Compare the thickness of atrial walls to that of the
ventricles.*

.....
.....
.....
.....

6. *Which heart chamber has the thickest wall? Why?*

.....
.....
.....
.....

 *Before proceeding further, complete the following activity.*

ACTIVITY 1

1. *What is the heart made of?*

.....

2. *Name the upper and lower chambers in the heart.*

.....

3. *Which ventricle has the thickest wall?*

.....

4. *What prevents backflow of blood through the heart?*

.....

5. *State the importance of coronary arteries in the heart?*

.....

6. *Name an organism which has*

(i) an open circulatory system

.....

(ii) a closed circulatory system.

.....

7. *You have a double circulatory system. Explain.*

.....

.....

You will find the answer at the end of the Module.

2.2.2 HEARTBEAT

The heart beats as the cardiac muscle in its walls contracts and relaxes. This alternate contraction and relaxation of the heart muscle gives the impression of a beat. The time of contraction is called **systole** and that of relaxation is called **diastoles**.

During systole the heart becomes smaller to squeeze blood out. During diastole the heart relaxes to allow blood to flow into the atria and ventricles. One complete systole and diastole is called a heart beat. It takes less than a second when a person is at rest. The heart usually beats about 70 times a minute.

2.2.3 PULSE

Every time the heart muscles contract to push blood out into the arteries, there is an increase of pressure on the wall of the arteries. When the heart relaxes, this pressure decreases. This is felt as the pulse. Your pulse rate is an indication of the rate of your heart beat. You can easily feel your pulse by placing a finger over an artery which lies near the body surface. A good example is the radial artery in your wrist.

We can now proceed with the following investigation.



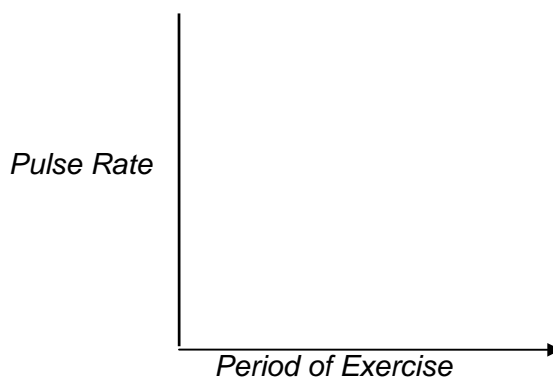
INVESTIGATION 2: To investigate the effect of exercise on the rate of heart-beat.

For each investigation you will require the materials indicated.

You should record your answers in the space provided.

Method

1. Use your forefinger to feel the radial artery in your wrist. (your teacher may help you if necessary).
2. Find your pulse rate (number of beats per minute).
 - (a) at rest (when you are sitting down completely relaxed).
 - (b) after walking for few minutes.
 - (c) after vigorous exercise (running or jumping for five minutes)
 - (d) during the recovery period after each exercise.
3. Plot a graph of your results.



4. What does your graph tell you about the pulse rate?

.....

.....

.....

2.3 HEART DISEASE

There are many different types of heart disease. Here we shall address the most common. It is the Coronary Heart Disease (CHD).

The heart muscle needs a good and constant supply of oxygen from the bloodstream. This comes from the coronary arteries.

With time, in early adulthood, the walls of these arteries can become “furred up” with a fatty deposit called atheroma.

This can cause a narrowing of the arteries. You can guess what happens next. The blood supply to the heart muscles is reduced or even blocked altogether. This is CHD.

A sudden and severe blockage in one of the coronary arteries leads to a heart attack.

2.3.1 COMMON CAUSES OF HEART DISEASE

1. Eating food with high sugary and cholesterol content.
2. Smoking cigarettes.
3. If you are overweight.
4. If you take little or no regular exercise.
5. Stress.
6. Hereditary - this tendency can run in your family.

2.3.2 HEART ATTACKS


Heart attacks can be prevented by taking a few precautions. Here are some important measures:

Dietary

1. cut down on the amount of fat you eat
2. choose lean meat, chicken, fish and vegetables
3. consume less fried foods. Grill them instead
4. use skimmed or semi-skimmed milk
5. cut down on butter or margarine
6. use little oil instead of a hard fat in cooking
7. avoid cakes, pastries, biscuits, chocolates, sweets, soft drink
8. eat more fibre
9. eat less salt

Other Measures

1. Do not smoke.
2. Take exercise regularly.
3. Avoid stressful situations.
4. Take time to relax before you go to bed.
5. Avoid alcohol/drug abuse.

 *Before proceeding further, complete the following activity.*

ACTIVITY 2

1. *What is a heart beat?*

.....

2. *What is (i) systole?*

.....

(ii) diastole?

.....

3. *Name the fatty substance that can block arteries.*

.....

4. *Explain what causes a heart attack.*

.....

.....

5. *State three common causes of heart diseases.*

.....

.....

.....

6. *State three measures you can take to avoid heart disease?*

.....

.....

.....

You will find the answer at the end of the Module.

2.4 BLOOD VESSELS

The tubes that carry blood to all parts of your body are called blood vessels.

There are three types of blood vessels:

- arteries
- veins
- capillaries.

2.4.1 ARTERIES

Arteries always carry blood away from the heart. They have thick, elastic and muscular walls.

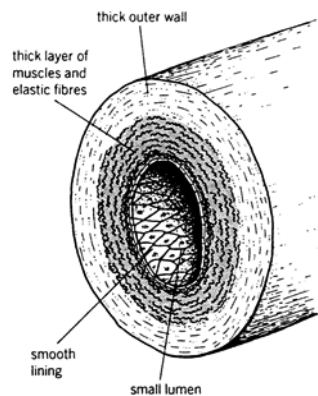


Fig.16: An Artery

They carry oxygenated blood except the pulmonary artery. Blood flows under high pressure in arteries and they do not have valves along their length.

2.4.2 VEINS

Veins always carry blood towards the heart. They have thin walls with little muscles.

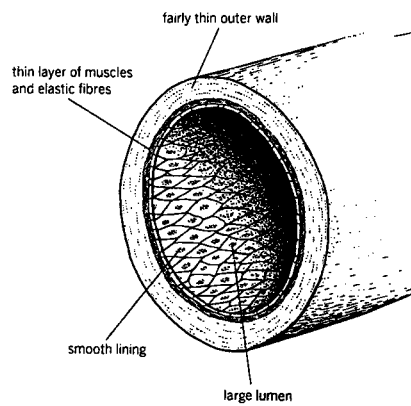


Fig. 17: A Vein

They usually carry deoxygenated blood except the pulmonary vein. Blood flows under low pressure in the veins. Thus they have valves at regular intervals to prevent backflow of blood.

2.4.3 CAPILLARIES

The arteries gradually divide to form smaller and smaller vessels. These are the capillaries.

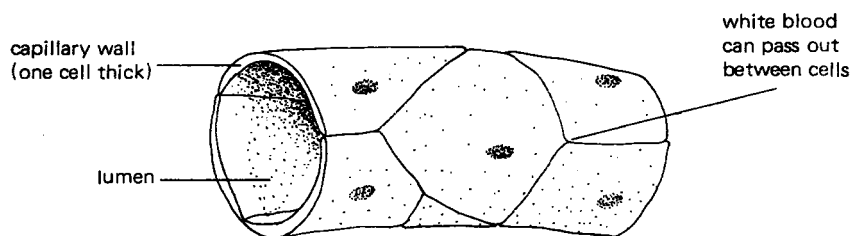


Fig. 18: A Capillary

The capillary is a very tiny blood vessel which lies in between the cells. Its wall is very thin as it consists of a single layer of cells. It has a very small lumen and blood flows slowly through it. It allows exchange of the materials between blood and the body cells.

2.5 BLOOD

Blood is a fluid in which are found blood cells and cell fragments called platelets. The blood cells and platelets make up for about 45% of blood volume and the plasma about 55%. (Figure 19).

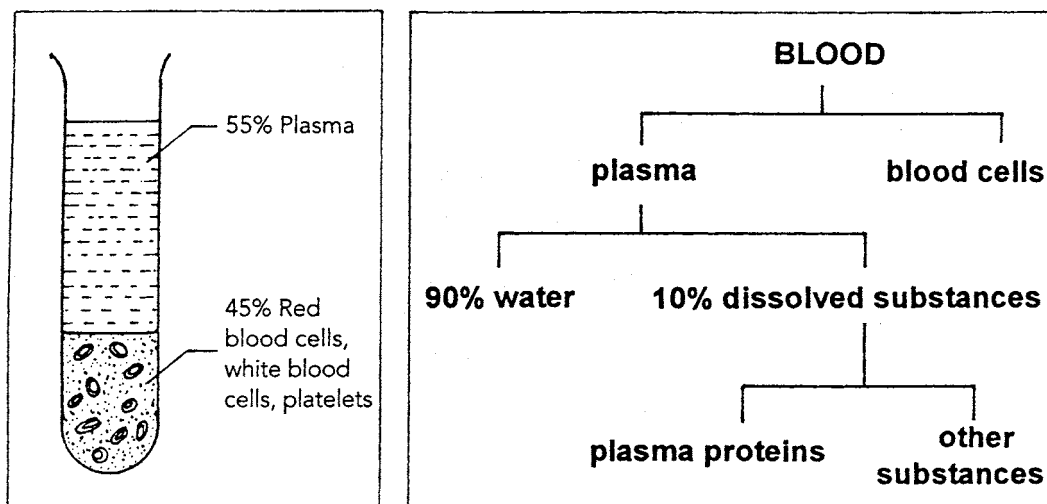


Fig. 19 : Composition of Plasma

2.5.1 PLASMA

Plasma is a yellow liquid containing:

- mineral salts
- blood proteins
- glucose
- amino acids
- fats
- waste products such as urea.

Among the blood proteins there is a substance known as fibrinogen that plays an important role in the clotting of blood.

2.5.2 RED BLOOD CELLS OR RED CORPUSCLES

In humans, there are about five million red blood cells per cubic millimetre of blood. Look at Figure 20, each one of these cells is a flat biconcave disc and is able to squeeze through small blood vessels by changing its shape. Red blood cells have no nucleus and they contain a reddish pigment called haemoglobin.

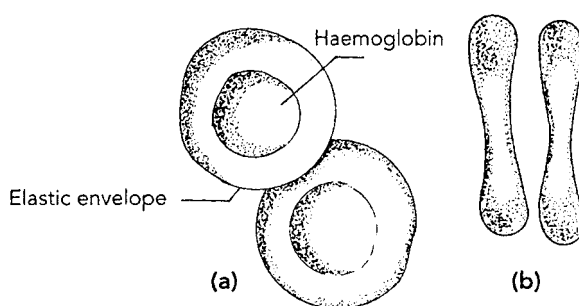


Fig. 20 : Diagram of Red Blood Cells (a) Front View, (b) Side View

Function: *They carry oxygen and carbon dioxide around the body*

2.5.3 WHITE BLOOD CELLS OR LEUCOCYTES

Leucocytes are much less numerous than red blood cells, the ratio is 1:600. While blood cells are much larger than the red ones. They are colourless. Most of them are irregular in shape and they all possess a nucleus.

Function: *They kill germs getting into the body*

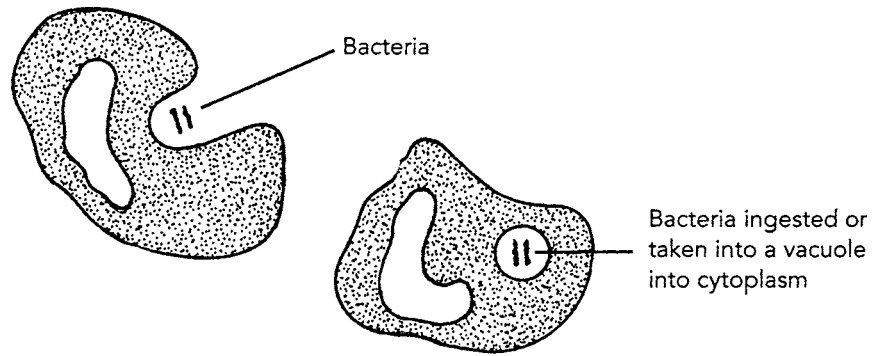


Fig. 21: Human White Blood Cells (Leucocytes)

2.5.4 PLATELETS

These are small fragments of cells about one quarter of the size of a white blood cell. Their number is about 250,000 per cubic millimetre of blood.

Function: *They assist in blood clotting*

We can now proceed with the following investigation.



INVESTIGATION 3: Looking at a prepared slide of blood smear.

For each investigation you will require the materials indicated.

**You should record
your answers in the
space provided.**

Materials needed:

- Permanent slide of human blood,
- light microscope

Method:

Your teacher will show you a smear of human blood under high power of light microscope.

Identify the various types of cells and platelets.

Make a labelled drawing of what you observe.

2.6 FUNCTIONS OF BLOOD

Blood does two jobs. It carries materials round the body and it protects us against disease. Red blood cells are our body's oxygen carriers. They carry oxygen from our lungs to all the cells of the body (as shown in Figure 22).

By carrying substance around the body such as delivering oxygen and nutrients to the tissue fluid and removing excreting unwanted products, the blood does the following too. It maintains a constant internal environment inside the body. This is known as **homeostasis**.

 *Before proceeding further, complete the following activity.*

ACTIVITY 3

1. Give two differences in structure between an artery and a vein.

.....
.....
.....

2. Name the blood vessels which link arteries and veins.

.....

3. State the composition of your blood.

.....
.....

4. State one function of:

(i) red blood cells

.....

(ii) white blood cells

.....

(iii) blood platelets

.....

You will find the answer at the end of the Module.

2.6.1 HOW THE RED CELLS CARRY OXYGEN

Red cells are the body's oxygen carriers. They carry oxygen from the lungs to all the cells of the body.

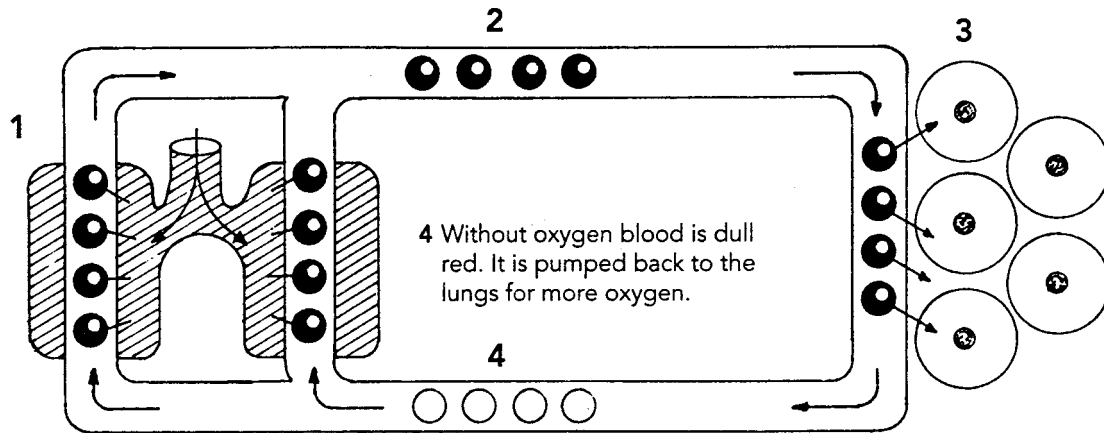


Fig. 22: Carriage of Oxygen by Blood

1. The red cells pick up oxygen as blood passes through the lungs.
2. The oxygen and haemoglobin join to form oxyhaemoglobin. This is bright red.
3. As the blood passes around the body, the haemoglobin breaks down and releases oxygen to the body cells.
4. The red cells return to the lungs for more oxygen.

The table below summarises the other materials carried by the blood.

What it carries	How carried
1. Carbon dioxide from the body to the lungs.	Mainly in plasma (as sodium bicarbonate).
2. Digested food from the gut to the liver and thereafter to the rest of the body.	In the plasma.
3. Wastes from the liver to the kidneys.	In the plasma.
4. Hormones from glands producing them to wherever they are needed.	In the plasma.
5. Heat from liver and muscles to the rest of the body so that the temperature of the body is kept uniform.	Blood.

2.7 PROTECTIVE FUNCTION OF BLOOD

White blood cells called phagocytes ingest bacteria as shown in the diagram below.

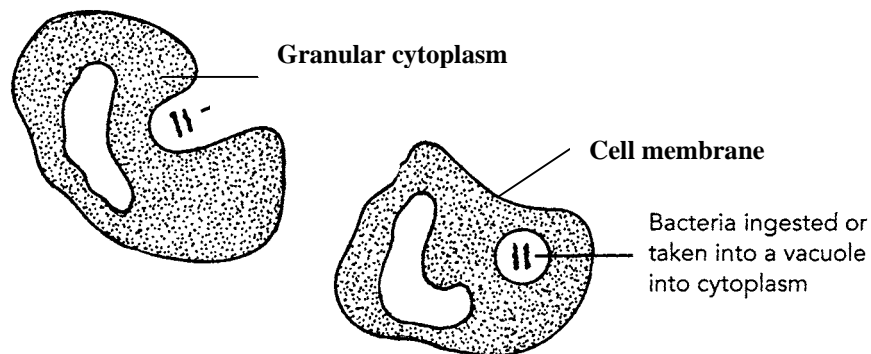


Fig. 23: Diagram Showing A Phagocyte Ingesting Bacteria

Another type of white blood cells called lymphocytes make chemicals called antibodies. These chemicals destroy bacteria that get into the body by making them stick together or by dissolving them. They also destroy toxins (poisons) produced by the bacteria. There is a different antibody for each kind of bacterium.

Blood platelets help to stop bleeding from cuts. The process of blood clotting helps to prevent entry of bacteria through wounds.

Briefly clotting takes place as follows:

1. Bleeding washes out dirt and germs (bacteria) from the cut.
2. The platelets produce tiny fibres.
3. Red blood cells get trapped in these fibres and the blood changes into a thick red jelly called blood clot.
4. The clot hardens to a scab. This keeps the wound clean and white new skin grows. Then the scab breaks off.

Your white blood cells are of different kinds. Some are called phagocytes and they eat germs which enter your body. Other white blood cells produce specific chemicals and antibodies. These antibodies can destroy the poisonous substances which germs make or they destroy the germs that cause disease. The white blood cells therefore form part of your immune system. They help you to fight diseases caused by invading germs. Sometimes the killed or treated germs are injected into your blood in the form of vaccines. Your body then makes antibodies against these germs. This makes you immune to these germs in future.

2.7.1 LYMPHATIC SYSTEM

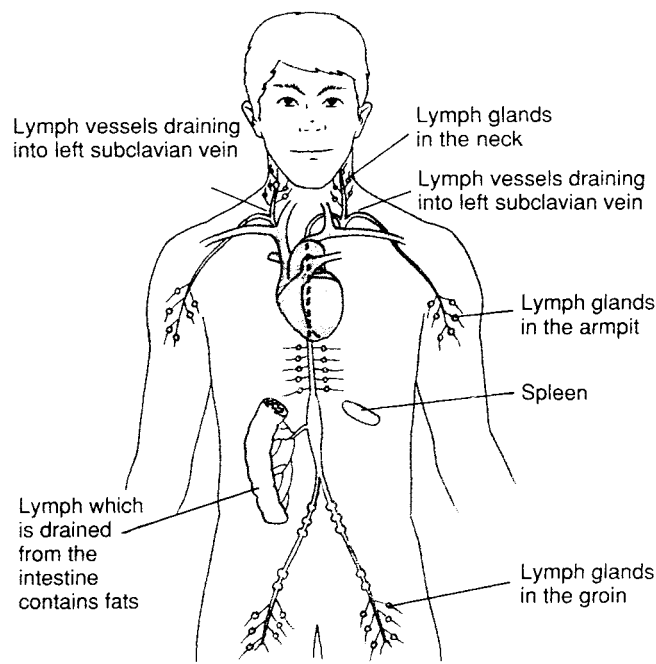
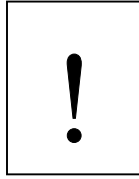


Fig. 24: The Lymph Vessels

A liquid called tissue fluid comes out slowly through the capillary wall into the tiny spaces between the body cells. Most of this tissue fluid diffuses back into the blood vessels. But some of it enters the blind ended vessels found between the tissue cells. Such vessels are called lymph capillaries. The tissue fluid which drains into the lymph capillaries becomes lymph.

The lymph capillaries join to make larger tubes. These tubes drain into lymph glands where the lymph is cleaned up by white blood cells called lymphocytes. These eat the germs and dead cells. They also make antibodies.



POINTS TO REMEMBER

- Lowly evolved animals have an open circulatory system. Here blood is pumped at low pressure from the heart into spaces in the body.
- You have a closed circulatory system in which blood circulates in blood vessels. Here blood is pumped out of the heart at a high pressure. It is also a double circulatory system.
- Your heart
 - consists of cardiac muscles and it is found in your thorax.
 - has four chambers - atria and ventricles
 - pumps blood round the body by alternate contraction and relaxation.
 - has valves to allow blood to flow in one direction only.
 - obtains its blood supply through the coronary arteries.
- One complete systole and diastole is called a heart beat. Your pulse rate is the same as the rate of your heartbeat.
- A blood clot can easily block an artery. This is called a thrombosis. A thrombosis in the coronary artery leads to a heart attack.
- Stress, smoking, unbalanced diet with high fat content and lack of physical exercise lead to heart disease.
- Arteries always carry blood away from the heart and they are thick walled blood vessels.
- Veins are thin walled blood vessels which carry blood towards the heart. They have valves.

- A capillary is a very tiny thin walled blood vessel which allows exchange of materials between blood and body cells.
- Your blood consists of:
 - liquid plasma for carrying dissolved substances.
 - red blood cells which contain haemoglobin. These transport oxygen.
 - white blood cells which protect the body by producing antibodies and
 - ingesting bacteria.
 - platelets which are small fragments and help in blood clotting.
- Some white blood cells are called phagocytes and they eat germs which enter your body. Other white blood cells are called lymphocytes and they produce antibodies.
- Your lymphatic system consists of lymph, lymph capillaries and lymph glands.

ANSWERS TO ACTIVITIES

UNIT 1

Activity 1

1. (a) Xylem; phloem
(b) Xylem - conducts water and minerals up the plant
Phloem - carry food substances in solution form to different parts of the plant
2. (a) These are fine projections of epidermal cells in the roots of plants.
(b) They provide a large surface area for absorbing water and minerals from the soil.
3. (a) It moves from cell to cell by osmosis, across the root.
(b) They have thick walls which provide support and strength. They are joined end to end and do not have any cross walls between them. This allows easy flow of water.

Activity 2

1. (a) It is a force which pushes water up the plant.
(b) It helps to conduct water in the xylem tissue.
2. (a) It is a process by which water in the form of vapour is lost from the aerial parts of the plant.
(b) Temperature, light intensity, humidity.
(c) Potometer

Activity 3

1. (a) This is due to excessive transpiration. It occurs when the rate of transpiration is greater than the rate of water absorbed from the soil.
(b) These are plants which live in dry habitats.
(c) It has fewer and smaller stomata on the leaves. The leaves roll up and the stomata are enclosed inside the leaves.

2. (a) It is the transport of dissolved food substances in the phloem of the plant.
- (b) Sucrose, water, amino acids.

UNIT 2

Activity 1

- (a) It is made of the cardiac muscle.
- (b) Atria and ventricles.
- (c) Left ventricle.
- (d) Valves.
- (e) They supply blood carrying food and oxygen to the heart muscles.
- (f) (i) Insects – the cockroach.
(ii) Mammals – humans.
- (g) The same blood passes twice through the heart in one complete circulation. This consists of pulmonary circulation and systemic circulation.

Activity 2

1. It is the alternate contraction and relaxation of the heart muscles to produce a systole and a diastole.
2. (i) When heart muscles contract, it is a systole.
(ii) Diastole is when the heart relaxes.
3. Cholesterol.
4. When the coronary arteries are blocked it leads to a heart attack.
5. Eating food with high content of cholesterol, smoking cigarettes, stress.
6. Consume a balanced diet. Avoid smoking. Take exercise regularly.

Activity 3

1.

Artery	Vein
(i) carries blood away from the heart	carries blood towards the heart
(ii) blood flows under high pressure	blood flows under low pressure
2. Capillaries.
3. It consists of 45% blood cells and 55% blood plasma. Blood cells include red blood cells, white blood cells and blood platelets.
4.
 - (i) They carry oxygen from the lungs to all the cells of the body.
 - (ii) They produce antibodies to fight harmful bacteria.
 - (iii) Blood platelets help to clot blood and prevent its loss.

