Transportation in Animals and Plants

Body Fluids and their Functions

What is blood and what are its functions?

Blood is a fluid connective tissue that flows in blood vessels. Its main function is to transport substances such as digested food and oxygen (from the small intestine and lungs respectively) to all parts of the body. It also takes part in the removal of waste materials from the body. **How does blood perform all these functions? Does it have some special components that perform these functions?** Blood is made up of various types of cells that are suspended in a fluid part called **plasma**. Plasma is a yellowish colour fluid, made up of water (~90%) and some dissolved nutrients, proteins, hormones and waste products. Let us study the various components of blood.

Blood consists of three types of cells. These are as follows.

- **Red Blood Cells or Erythrocytes -** They contain a red pigment called haemoglobin, which transports oxygen to all cells of the body by combining with oxygen to form a compound called oxyhaemoglobin. The mature erythrocytes do not have a nucleus.

- **White Blood Cells or Leukocytes -** They are larger than RBCs and do not have haemoglobin. They fight against germs that enter the body. Thus, they protect the body from diseases.

- **Blood Platelets or Thrombocytes -** You must have noticed that when you get injured, bleeding stops after some time. This happens because of the activity of platelets. Platelets help in the clotting of blood during an injury. The platelets are smaller than the RBCs.

Some interesting facts:

After blood donation, the fluid gets replaced in few hours and the red blood cells within four weeks. It takes around eight weeks to restore the iron lost after donation. Platelets are produced at the rate of 200 billion per day in the human body.

Functions of blood:

- It transports nutrients and oxygen to the different parts of the body

- It also carries waste materials (from the different parts of the body) to be removed by the excretory organs.
- Chemical messengers like hormones are transported by the blood.
- Protects the body from disease carrying germs.
- Helps to maintain a constant body temperature.

Blood Clotting

- Clotting is an important character of blood, which helps in preventing blood loss at the time of any physical injury.
- The blood clot is formed with the help of platelets.
- When any physical injury damages a blood vessel, the platelets release an enzyme that help in production of a protein, thrombin.
- Thrombin protein converts fibrinogen protein present in the blood into fibrin.
- These fibrin proteins form a fine mesh work around the wound, in which the blood cells get trapped.
- This fibrin network then contracts along with the blood cells, and results in the formation of a solid clot which plugs the cut.

Lymph

Lymph is a watery clear fluid. It is blood minus RBCs. The cellular part of lymph constitutes only leucocytes. This fluid distributes immune cells and other factors throughout the body. It also interacts with the blood circulatory system to drain fluid from cells and tissues. The lymphatic system contains immune cells called **lymphocytes**, which protect the body against foreign antigens (viruses, bacteria, etc.) that invade the body. Lymph also help in transporting nutrition and oxygen to various body parts.

Tissue Fluid (Intercellular Fluid)

As blood flows through the capillaries, the plasma and some leucocytes can escape out from the capillary walls. This fluid then fill in the intercellular spaces and bathes the surrounding cells. Thus, it is known as tissue fluid or intercellular fluid.

Blood transfusion and blood groups

Sometimes when we get seriously wounded and lose a lot of blood, this lost blood is replaced by blood taken from another person but we cannot just take blood from any

person and hence the characteristics of the blood are to be studied before. The process of transfer of blood from one person to another is called **blood transfusion**.

Blood groups

Based on the presence or absence of certain substances called **antigens** on the surface of the RBCs , the blood of human beings can be divided into four blood groups, they are A, B, AB and O.

- Blood group A has A antigen
- Blood group B has B antigen
- Blood group AB has both A and B antigens
- Blood group O has neither A nor B antigens.

> **Do You Know?**
>
> Blood group O is known as the **universal donor** since it can be transfused into any person with any blood group
> Blood group AB is known as the **universal acceptor** since it can receive any blood group

Blood Group Compatibility

During blood transfusion, we have to take special care of blood compatibility. If the blood group of donor is not compatible to that of patient's blood, the patient's body refuses to accept it and can react with the transfused blood. This can create a life-threatening situation for the patient.

Let us see what type of blood groups are compatible to each other.

Blood Group of Donor	Blood Group of Recipient
A	A, AB
B	B, AB
AB	AB

O	A, B, AB, O

Rh-factor

There is another antigen present on the surface of the RBCs which is known as the Rh- factor. About 85% of the people have Rh factor and are called Rh positive and those who do not have the Rh factor are known as Rh negative.

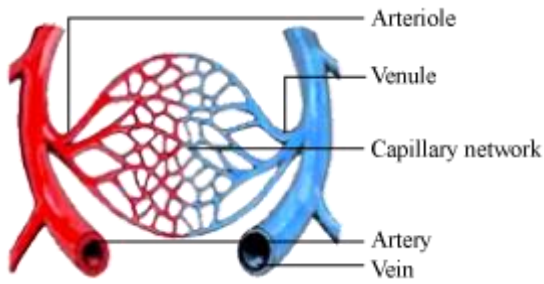
Before blood transfusion, the Rh factor as well as the blood group of the donor and the recipient have to be matched or it may lead to serious illness.

Heart and Blood Vessels

We know that blood flows inside the blood vessels and it performs functions such as transporting oxygen and nutrients to all cells of the body. We also know that it helps in removing waste materials, including carbon dioxide, from the body.

How does blood perform these functions without getting the food and nutrients and the waste materials mixed up? Let us study how this is possible.

Blood Vessels



Arteries: They are tough, elastic tubes that carry blood from the heart and supply it to various organs of the body. Blood flows under high pressure in the arteries. As the arteries move away from the heart (i.e. on reaching organs and tissues), they divide into smaller vessels. The smallest vessels called **capillaries** have very thin walls. Arteries are red in colour because they carry oxygenated blood.

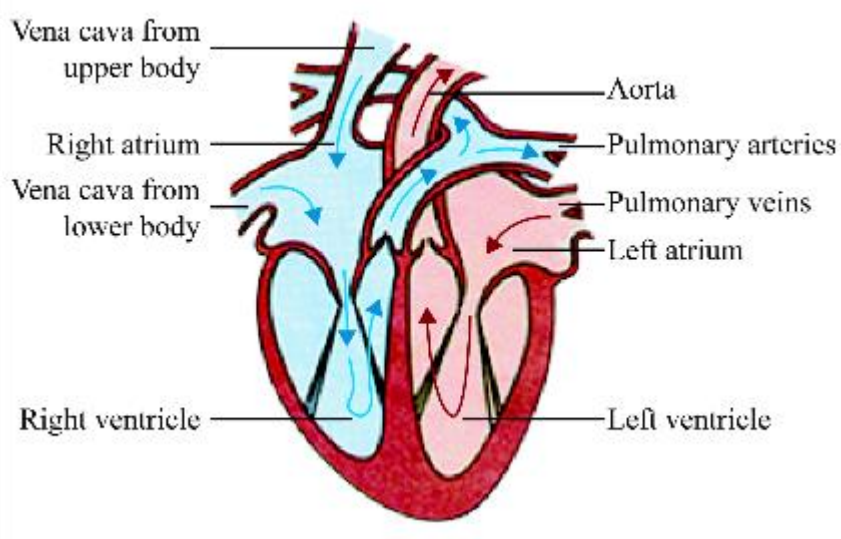
Capillaries (in organs and tissues) join together to form **veins**.

Veins collect blood from different organs and tissues. Veins are thin-walled as compared to arteries. This is because, they bring back blood from the organs to the heart and blood is no longer under pressure. These veins carry deoxygenated blood into the heart.

The pulmonary artery is the only artery that carries carbon dioxide-rich blood, while the pulmonary vein is the only vein that carries oxygen-rich blood.

Heart

In human beings, the heart is a muscular organ. The walls of the heart are made up of a special muscle called **myocardium**, which contracts continuously and rhythmically to distribute blood to all the body cells.



It is enclosed by a double membrane known as the **pericardium** filled with a fluid known as the **pericardial fluid**. It is divided into four chambers − the right auricle, the right ventricle, the left auricle, and the left ventricle. The auricles are thin-walled and receive blood from the different parts of the body.

The lower two chambers (ventricles) have thick walls and they pump blood out of the heart. The flow of blood is from the auricles to the ventricles, but blood cannot flow from one auricle to another or from one ventricle to another because a muscular wall separates the left side from the right side.

Valves in the Heart

Tricuspid valves: The right auricle is separated from the right ventricle by the tricuspid valve, which opens in only one direction i.e., from right auricle to the right ventricle.

Bicuspid valve: The left auricle and the left ventricle are separated by the presence of the bicuspid valve, which allows the flow of blood from the left auricle to the left ventricle.

Blood Vessels of the Heart

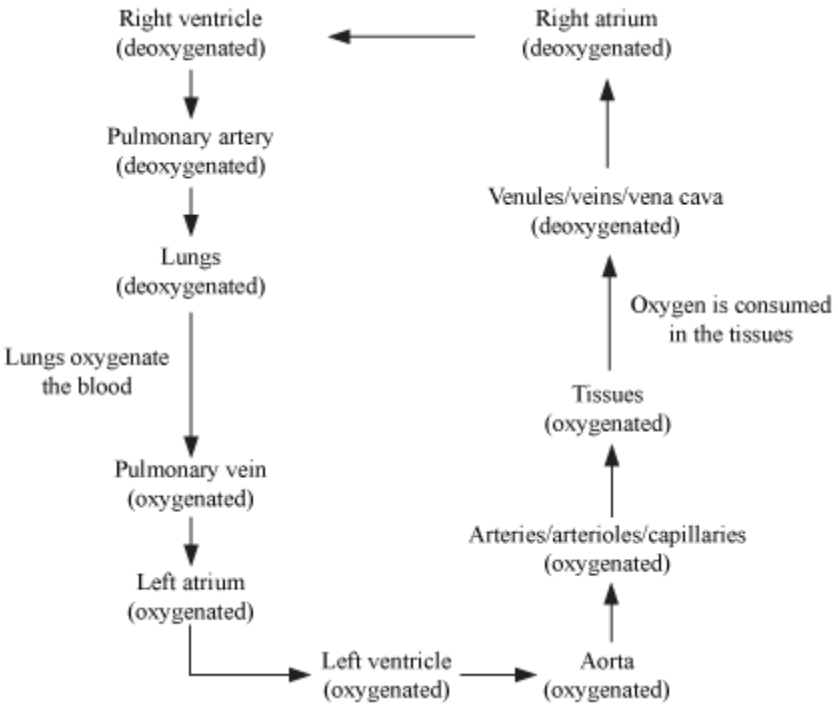
Vena cavae: These are the large veins that carry deoxygenated blood from the whole body to the heart. Superior vena cava bring deoxygenated blood from the upper parts of the body, whereas inferior vena cava bring deoxygenated blood from the lower parts of the body. Both these veins open into the right auricle.

Pulmonary artery: It carry deoxygenated blood from the right ventricle of the heart to both the lungs for oxygenation.

Pulmonary vein: It carries oxygenated blood from lungs to the left auricle of the heart.

Aorta: It is a large artery that carry oxygenated blood from the left ventricle of the heart to the whole body.

Circulation of Blood



The heart pumps blood to all parts of the body. The superior vena cava and inferior vena cava bring in deoxygenated blood from the anterior and posterior parts of the body respectively into the right auricle. From the right auricle, the blood passes on to the right ventricle and then to the lungs through the pulmonary artery. The blood gets oxygenated in the lungs and is transported back to the heart via the pulmonary vein into the left auricle. Then it is passed to the left ventricle.

Do You Know?

The pulmonary artery is the only artery in the human body, which carries deoxygenated blood; and the pulmonary vein is the only vein, which carries oxygenated blood.
The aorta is the largest artery in the human body.

From the left ventricle, the blood is carried by the aorta from where it is supplied to the rest of the body.

Pulse

The pulse rate!

The heart muscles contract and relax at regular intervals and this can be heard as two sounds (lub, dub). Doctors listen to this using a stethoscope. When the left ventricle

contracts, the blood is forced into the arteries under high pressure; and when they relax, the pressure goes down. This stretching and relaxing of the arteries is felt as a throbbing called the **pulse.**

Place your middle and index fingers on the inner side of the right hand and record your pulse rate per minute. Tell your classmates to do the same. Now, compare the obtained values. **Is there any difference between your pulse rate and that of your classmates? What is the normal range of pulse rate?**

The normal pulse rate is 72 beats/min.

Do You Know?

The human heart continues to beat even after it is taken out of the body or cut into pieces!
William Harvey was an English physician who discovered the circulation of blood.

Blood Pressure

The average pressure produced in the ventricles when they contract and when the blood is pumped into the aorta and the pulmonary artery is known as the **systolic pressure**. It is equal to the pressure exerted by a column of 120 mm of mercury. The average pressure produced in the ventricles when they relax and are filled with blood is known as the **diastolic pressure**. It is about 80 mm of mercury. Hence, the value of blood pressure in an adult is about **120/80**. The blood pressure is measured by an instrument known as the **sphygmomanometer**. If the blood pressure rises above 140/90 mm, it is known as hypertension, or high blood pressure. The blood pressure below the normal level causes hypotension, or low blood pressure.

Heartbeat

If you place your hand on the left side of your chest, then you will feel your heartbeat. **What causes a heartbeat?** We know that heart is a muscular organ and its walls are made of muscles. The periodic contraction and relaxation of these muscles causes a heartbeat.

Stethoscope

Have you ever seen doctors using a stethoscope? What is the use of a stethoscope?

Doctors use stethoscopes to listen to heartbeats. They draw conclusions about the condition of the heart from the sound of the heartbeats.

Don’t skip a beat!

Take a small funnel and fix a rubber tube to its stem. Stretch a rubber sheet over the mouth of the funnel and fix it tightly with a rubber band. Now, put the open end of the tube in one of your ears and place the mouth of the funnel on your chest.

Listen to your heartbeat and record its rate

- at rest
- after running for 4–5 minutes

Similarly, record your pulse rate (using your fingers)

- at rest
- after running for 4–5 minutes

Disorders of Circulatory System

- **Hypertension**

- Normal blood pressure − 120/80 [120 mm Hg − systolic and 80 mm Hg − diastolic]
- If blood pressure of an individual comes out to be equal to or more than 140/90, then we say that he suffers from high blood pressure or hypertension.
- It affects heart, kidneys, brain, and other vital organs.

- **Coronary Artery Disease (CAD)**

- Blood vessels supplying blood to heart muscles are blocked by deposits of calcium, fat, cholesterol, or fibrous tissues.
- Common term used − Atherosclerosis

- **Angina (Angina Pectoris)**

- Enough oxygen does not reach heart muscles.
- Main symptom − Acute chest pain

- Can occur at any age but common in middle aged and elderly

- **Heart Failure**

- Pumping of blood is not enough to meet the requirements of body.
- Common term − congestive heart failure since congestion of lungs is one of the main symptoms

- **Heart attack**

- Situation when the heart muscles get damaged due to short supply of blood

- **Cardiac Arrest**

  It is a serious medical emergency which occurs when the heart suddenly stops pumping blood around the body. It mostly occurs due to any coronary artery disease, however, major blood loss, lack of oxygen or potassium, or intense physical exercise can also be a reason. The main symptoms of a cardiac arrest are loss of consciousness, abnormal breathing, chest pain and nausea.

  A cardiac arrest must not be confused with a heart attack. A heart attack is a situation of sudden interruption of blood supply to any part of cardiac muscle. It causes chest pain and permanent damage to the heart. It may also result in causing cardiac arrest in the patient.

  > Both cardiac arrest and heart attack are life-threatening medical emergencies and thus immediate medical treatment must be given to the patient. Some immediate emergency steps can be taken to increase the chances of patient's survival, which include chest compression and mouth-to-mouth resuscitation.

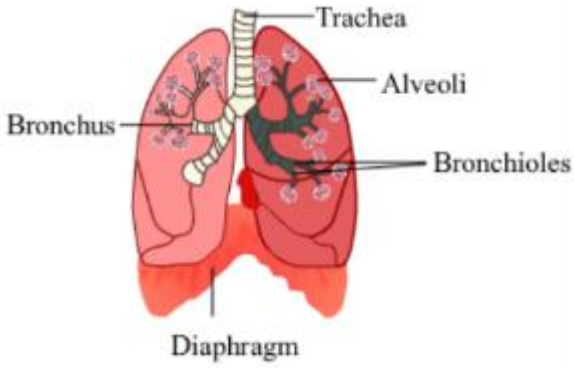
Excretion and Its Importance

Excretion and Its Importance

Excretory system consists of groups of organs that are responsible for excreting waste materials such as, harmful chemicals and other impurities from the body. The major excretory organ is kidney. However, there are some other organs also that perform the function of excretion.

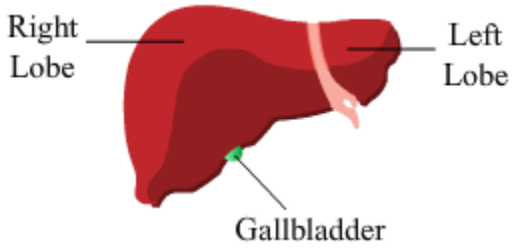
Let us understand the function of the following organs as excretory organs.

Lungs



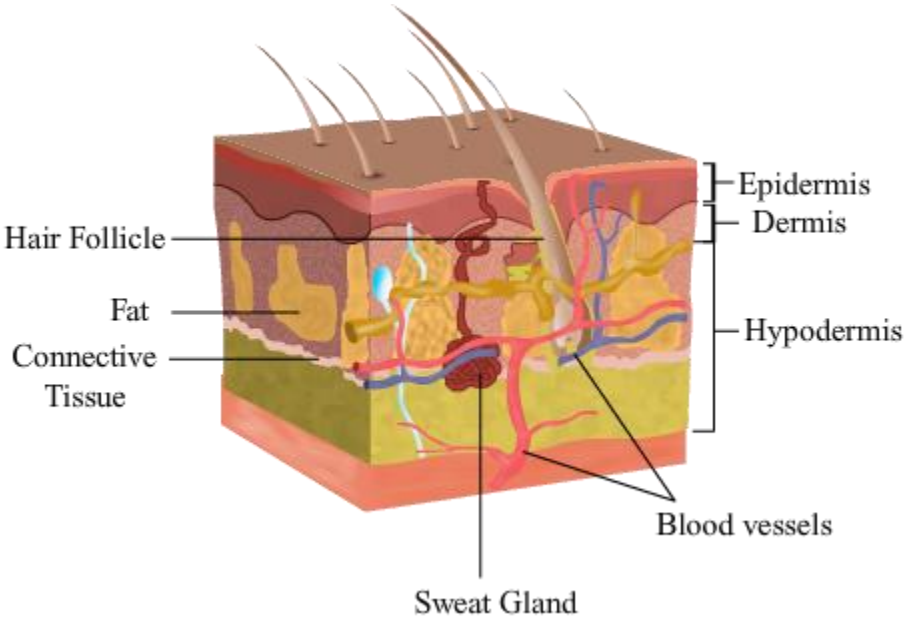
Respiration is a necessary process that provides energy for cellular activities. During respiration, carbon dioxide gets accumulated in the cells, from where it diffuses into the bloodstream and is finally transported to the lungs. From lungs, this carbon dioxide leaves the body every time we exhale.

Liver



Liver helps in the excretion of various unneeded substances in the body. It converts toxic ammonia into urea, a harmless fluid, by the process of deamination. This urea is then filtered by the kidney into urine. It does not directly eliminate excretory substances.

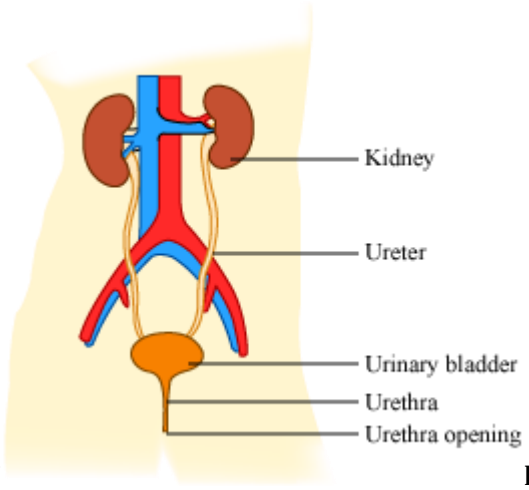
Skin



Skin also acts as an excretory organ. It possesses glands, namely, sweat glands and sebaceous glands. Sweat is a watery fluid that consists of metabolic wastes like water, sodium chloride, lactic acid, amino acids, urea, glucose, etc. Besides excreting metabolic wastes from the body, sweat also has a cooling effect on the body. On the other hand, sebaceous glands help in excretion of sebum which consists of lipids, fatty acids, etc.

How the other kinds of waste materials removed from the body? Is there a particular organ system that functions to remove waste materials from the body?

The organ system that performs the function of excretion is known as the **excretory system**. The excretory system removes the waste materials present in the blood.



Which organs are involved in this process? What mechanism is required for filtering blood?

The primary components of the excretory system are the kidneys, the ureter, the urinary bladder, and the urethra.

When blood reaches the kidneys, useful substances are absorbed back into blood, while the waste materials are dissolved in water and removed from the body in the form of **urine**.

The urine enters a long tube-like structure called the **ureter**. The ureter then passes the urine into the **urinary bladder**, which stores it until it is passed out of the body. Urine is passed out of the body through a muscular tube-like structure called the **urethra**.

Waste materials are also removed from the body through sweat. During sweating, water and salts are removed from the body.

Transportation of Water and Minerals in Plants

Transport system is the organ system in living organisms that transports various materials from one part to the other part of the body.

It transports the useful materials like nutrients, oxygen, enzymes and hormones from the various parts of the body to different tissues and cells. The waste materials like carbon dioxide, urea etc produced in the body are also transported to the excretory organs for their removal from the body.

The transport system differs in the different living organisms depending on the complexity of their body structure.

Let us study and compare the transport system in simple organisms and higher organisms.

Transport system in simple organisms

In unicellular organisms like *Amoeba* food and gases are directly taken from the surroundings and wastes are thrown out through the cell membrane. The movement of food and gases inside the cell takes place by the movement of cytoplasm.

In simple multicellular organisms like *Hydra*, the transportation of material from cell to cell takes place through simple diffusion.

Transport System in Higher Organisms.

In higher organisms due to complex body structure and large size, a complex transport system is present that helps to transport materials across the body.

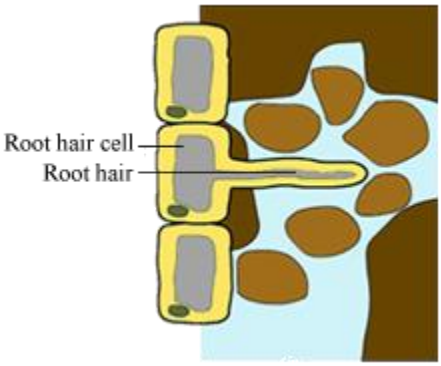
Let us find out how transportation takes place in higher organisms like plants.

Animals have various organs to carry out the transportation of substances; but how does the transportation of substances take place in plants? Let us find out.

Transportation of water and minerals in plants

Roots absorb water and minerals from the soil and transport them to the leaves. **How is water absorbed by the roots?**

Roots have numerous root hairs that increase the surface area for the absorption of water and minerals. More the surface area, greater is the absorption of water. These root hairs are in contact with the water present in the soil. These water molecules move into the root hairs through the process of osmosis. **Osmosis** is the movement of water from a region of its higher concentration (or from a dilute solution) to a region of its lower concentration (or to a concentrated solution) through a semi-permeable membrane. A **semi-permeable membrane** is the one that allows only some selective substances to pass through it.
In plant cells, the cell wall is fully permeable, i.e. it allows free movement of all sorts of substances across it. Thus the water molecules can easily pass through the cell wall by the process of diffusion. **Diffusion** is the movement of molecules (solid, liquid or gases) from a higher concentration to a lower concentration. However, the plasma membrane is semi-permeable in nature. Since, the root hairs have a **concentrated cell sap** inside them, the water molecules present in the soil tend to move inside the root hairs through osmosis. This is how the absorption of water takes place through roots. The absorption of minerals, however, takes place through a different mechanism. The root hairs have a higher concentration of minerals than that in the surrounding soil. This means that minerals have to be absorbed from a region of their lower concentration to the region of their higher concentration, which can not be achieved through osmosis. Such movement of molecules require energy and is called **active transport**. The minerals are thus absorbed by the root hairs through active transport.



How is the absorbed water transported to leaves?

Plants have tube-like vessels to transport water and nutrients to other parts of the plant. These vessels are made up of special type of cells and are known as the **vascular tissues**. The vascular tissue that transports water and minerals in plants is known as the **xylem**. It forms a network of channels that

connects the root to the stem and the leaves of the plant. Hence, water is transported to various plant parts.

Transportation of food in plants

You know that plants manufacture their own food through photosynthesis by using carbon dioxide, water, and sunlight. This process takes place in the leaves.

How is the food produced in the leaves distributed to other plant parts?

This is done by another type of vascular tissue called the **phloem**. The phloem also forms a network of channels that transports food to the stem and to the roots of the plant.

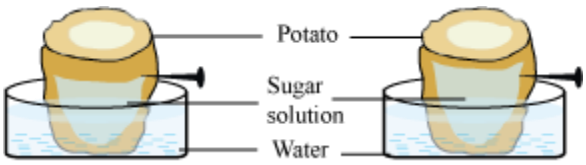
Thus, **xylem and phloem are the vascular tissues in plants that transport water and food respectively to all plant parts.**

When vegetables such as lady fingers become a bit dry, they are kept in water for sometime.

This is done because when dry vegetables are kept in water, water enters the vegetables through the xylem tissue and helps the vegetables regain their lost moisture.

Water in potato!

Take a large potato and peel its skin. Then, cut one of its ends to make the base flat, while on the other end, make a deep and hollow cavity.



Fill this cavity with a small amount of sugar solution and mark the level of water in the potato by inserting a pin in the wall of the potato.

Now, place the potato in a dish containing a small amount of water and make sure that the level of water in the dish remains below the level of the pin. Leave the setup undisturbed. After a few hours, you will observe that the level of water inside the

potato has risen. **Do you now know the reason behind the rise in the level of the water?**

This happens because for short distances water can travel from one cell to another like it travels in the xylem vessels.

Transpiration

We know that plants absorb water from soil through their roots. **Does all the water absorbed by plants get utilised?**

The entire amount of water absorbed by plants does not get utilised. A major amount of water is lost by plants through the process of **transpiration**. In this process, water evaporates through stomata, which are tiny openings on the surface of leaves.

Is losing water an advantage? Is there any particular use of transpiration?

The loss of water through transpiration helps in keeping plants cool. It especially helps them survive in hot weather conditions.
Transpiration also helps in maintaining the concentration of cell sap inside the plant cells. If the excess water is not evaporated out through transpiration, the cell sap of the root hairs will become dilute. This will prevent the absorption of water from the soil through osmosis.

How does water reach the leaves from the roots against gravitational force? How does water reach the topmost branches of tall trees? Let us explore.

When we draw juice out of a can with the help of a straw, juice is pulled up with a force.

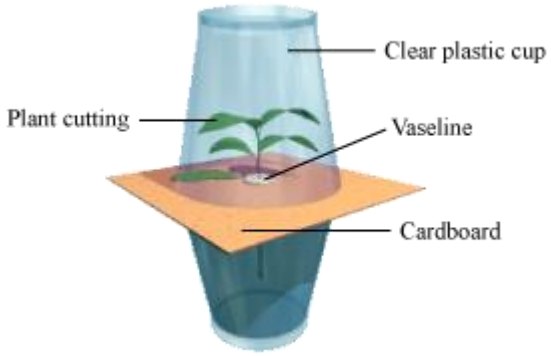
A similar action occurs in plants, where the stomata create a suction force. This causes water to rise and reach the topmost branches of tall trees. As water gets lost, more water is absorbed through the roots. When water is lost at a higher concentration than it is absorbed by the roots, the leaves, stem and flowers will droop. This process is known as **wilting.**

Do You Know?

Do you know that only 1% of the water absorbed by plants is used in photosynthesis? The rest 99% is lost through transpiration.
In one growing season, a corn plant transpires more than 200 litres of water.

Transpiration experiment:

Take a cardboard and make a small hole in its centre. Place a small plant in the hole and seal the hole using Vaseline.



Then, fill a cup with water and put the cardboard containing the plant on its top. Now, place an empty cup on the top of the cardboard and keep the apparatus under the sun.

After 15-20 minutes, you will observe that some water droplets accumulate on the sides of the inverted cup.

Explanation of the activity: Stomata remain open during the day. Excess water absorbed by the roots is transported to the leaves. The plant loses water through transpiration through these pores.

Factors Affecting Transpiration

Transpiration process is affected by a number of atmospheric factors. Let us know about them as well.

- **Sunlight**: The stomata remain open during the daytime, and close at the night time. This the rate of transpiration is much higher during daytime than at night.
- **Temperature**: More is the temperature, faster is the transpiration.
- **Wind**: More is the air velocity, faster is the transpiration.
- **Humidity**: High humidity corresponds to higher amount of water molecules in the air. The humid air cannot hold more water molecules, and thus the rate of transpiration decreases.