Transport in Plants

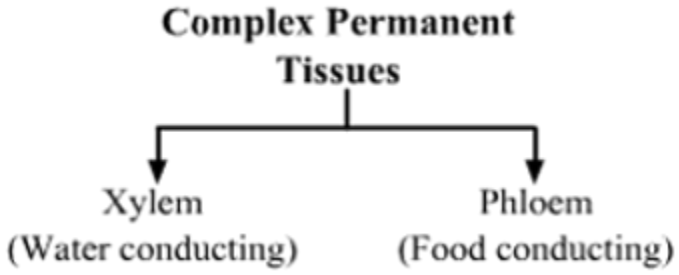
Complex Permanent Tissues

Complex permanent tissues are made up of more than one type of cells. All these cells work in a coordinated manner to perform one common function.

These tissues are conducting tissues that take part in the transport function of plants.

They are of two types—**xylem (**which transports water) and **phloem (**which transports food materials**).**

The presence of this vascular tissue is an important feature of all complex terrestrial plants.



Solved Examples

Medium

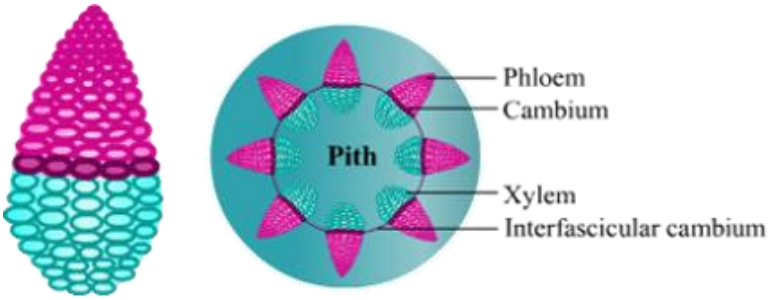
Example 1: **Give some points of difference between meristematic and permanent tissues.**

Solution:

Meristematic tissue	Permanent tissue
The cells of the tissue divide repeatedly.	The cells are formed from meristematic tissues and do not have the power of division.
The cells are always living.	The cells may be living or dead.

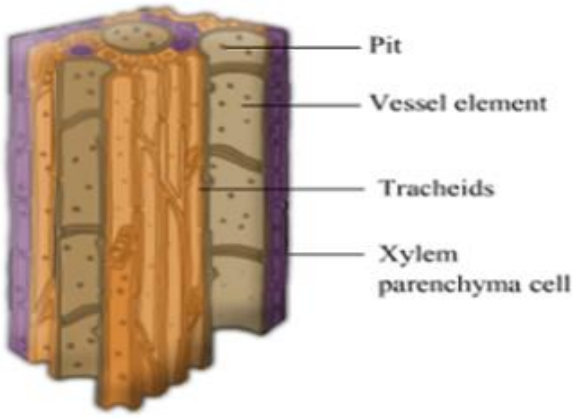
These cells usually do not contain vacuoles.	These cells contain a large centrally located vacuole.
It is restricted to certain parts of the plant body.	It is found throughout the plant body.
It is responsible for the growth of plant.	It performs functions such as storage, conduction, protection, photosynthesis, etc.

Xylem



Xylem and phloem are conducting tissues and constitute a **vascular bundle**. Vascular or conductive tissue is a distinctive feature of complex plants. This tissue makes possible their survival in the terrestrial environment.

Xylem

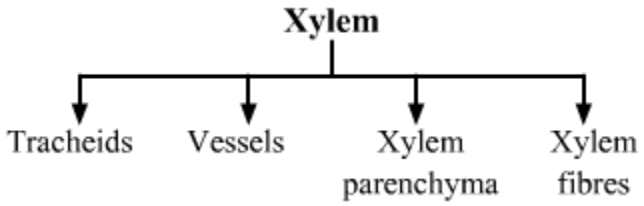


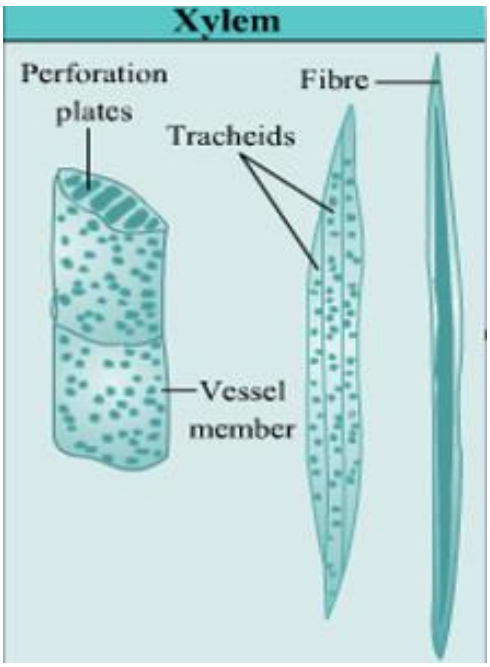
Xylem is mainly concerned with the conduction of water and minerals. It also provides

mechanical support to a plant. It forms a continuous channel through the roots, stems, leaves and other aerial parts. The cells of xylem have thick walls, and many of them are dead cells.

Parts of Xylem

The different parts of xylem are as follows:





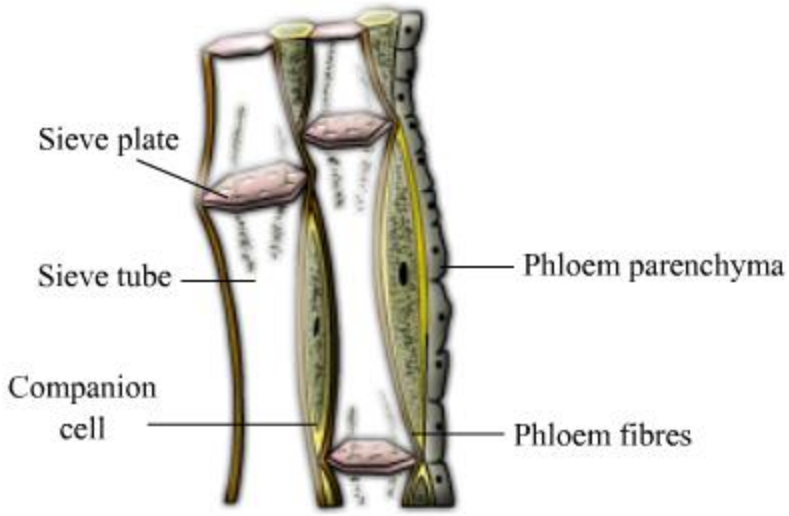
Functions of different parts of xylem are :

Tracheids and vessels allow the transport of water and minerals vertically.

Xylem parenchyma cells store food and help in the sideways conduction of water.

Xylem fibres are mainly supportive in function.

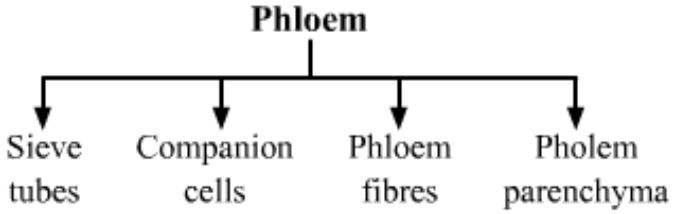
Phloem



Phloem is the chief food-conducting tissue of plants.It is responsible for the **translocation** of organic solutes. It is present in the innermost layer of the bark in a tree.

Parts of Phloem

The different parts of phloem are as follows:



Functions of different parts of phloem are :

- **Sieve tubes** are tubular cells with perforated walls.
- **Companion cells** are elongated cells that are always associated with sieve tubes. They helps to control the metabolic activities of sieve tubes.
- **Phloem parenchyma** cells are associated with the phloem tissue. They pack other types of cells together.
- **Phloem fibres** are non-living cells and are supportive in function.
- Sieve tubes and the companion cells are involved in the translocation of organic substances.
- **Phloem parenchyma and phloem fibres play only a supporting role in the process.**

Solved Examples

Medium

Example 1: **Give some points of difference between xylem and phloem.**

Solution:

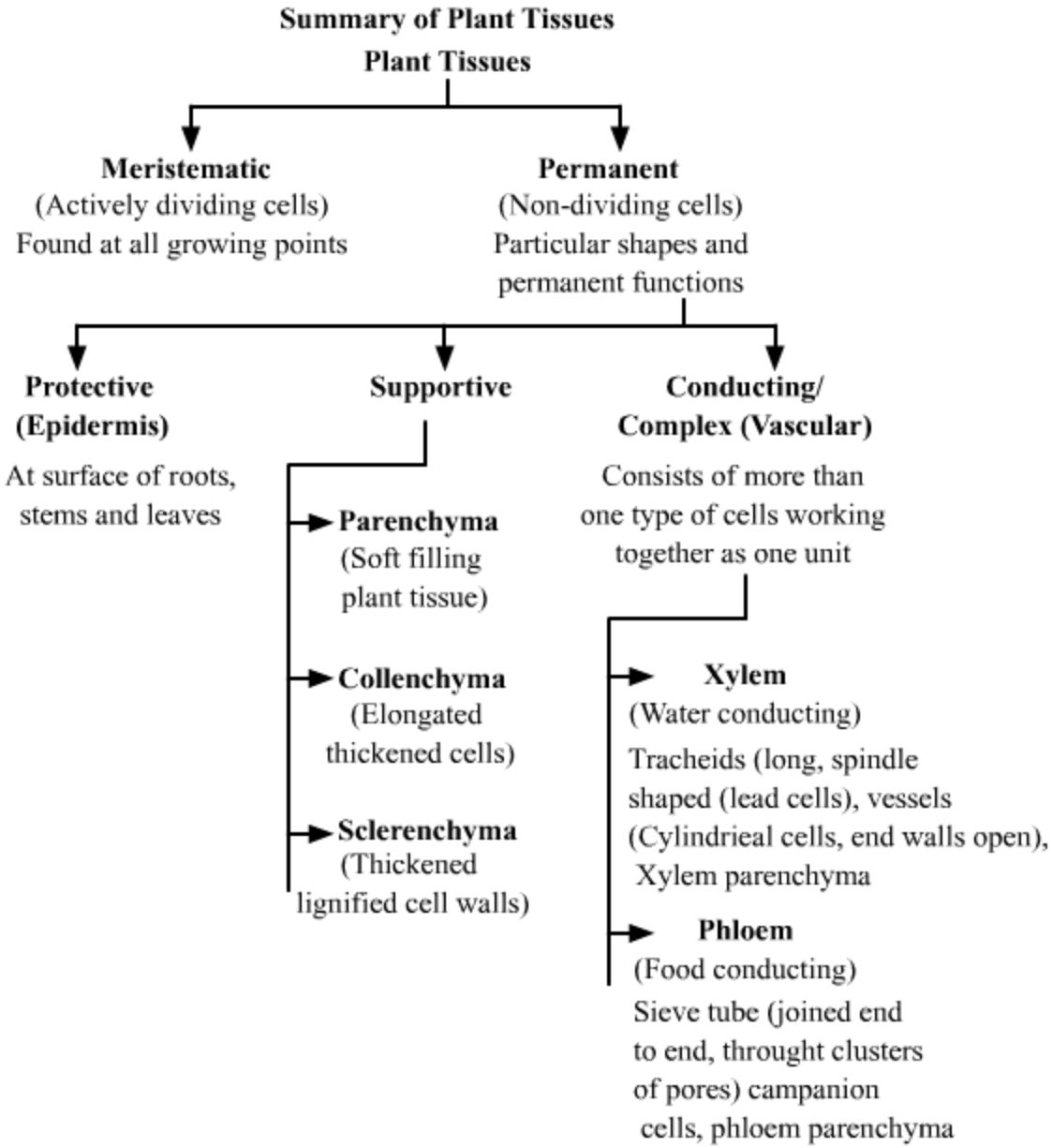
Xylem	Phloem
It is composed of tracheids, vessel elements, xylem parenchyma and xylem fibres.	It is composed of sieve tubes, companion cells, phloem parenchyma and phloem fibres.
Most of the components of xylem tissue are dead (tracheids, vessels and fibres).	Most of the components of phloem tissue are living (companion cells, parenchyma and seive tubes).
It transports water and minerals from the roots to the aerial parts of a plant.	It transports food and nutrients from the leaves to the storage organs and the growing parts of a plant.
In its case, the movement of materials is unidirectional (i.e., from the roots to the other plant parts).	In its case, the movement of materials is bidirectional (i.e., both up and down the stems).
It also gives mechanical strength to a plant due to the presence of lignified cells.	It is made up of soft-walled cells; so, it does not provide mechanical strength.

Did You Know?

Sieve tubes and the companion cells are called **essential elements**. This is because they are directly involved in the translocation of organic substances.

Phloem parenchyma and phloem fibres are called **associated elements** as they are not directly involved in this translocation.

Different Types of Plant Tissues



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.

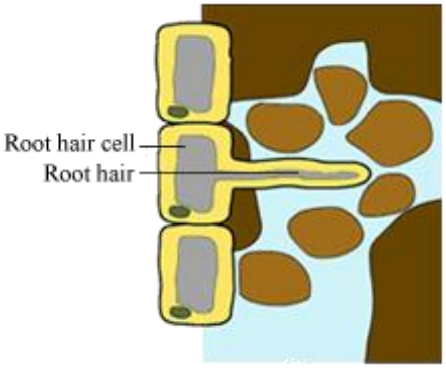
These water molecules move into the root hairs through the process of osmosis. **Osmosis** is the movement of water from a region of its higher concentration (or from a dilute solution) to a region of its lower concentration (or to a concentrated solution) through a semi-permeable membrane. A **semi-permeable 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.

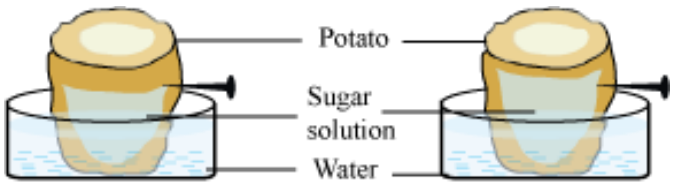
Thus, **xylem and phloem are the vascular tissues in plants that transport water and food respectively to all plant parts.**

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.

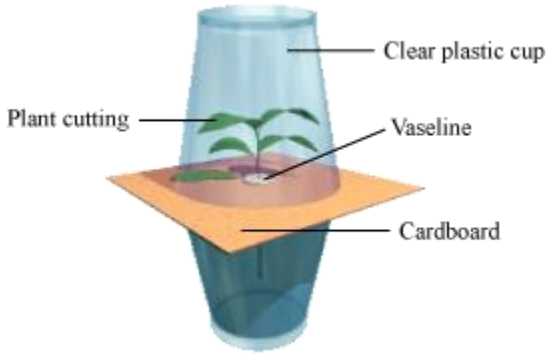
A similar action occurs in plants, where the stomata create a suction force. This causes water to rise and reach the topmost branches of tall trees. As water gets lost, more water is absorbed through the roots. When water is lost at a higher concentration than it is absorbed by the roots, the leaves,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

Transportation In Plants

Transportation is a life process where substances synthesised or absorbed in one part of the body are carried to other parts of the body**.**

Water absorbed by roots is to be transported to the rest of the plant body. Food produced in the leaves is to be transported to its place of storage. Therefore, there is a requirement for a transport system in plants. How does the transport system in plants function?

The transportation system in plants moves the energy stored in leaves to different parts. It also helps in moving raw materials absorbed from the roots to various organs of the plant. However, these are entirely different pathways.

These two pathways are explained in the following discussion.

The transportation system in plants consists of two different types of conducting tissues.

Xylem conducts water and minerals obtained from soil (via roots) to the rest of the plant. **Phloem** transports food materials from the leaves to different parts of the plant body.

Transport of water

Components of the xylem tissue (tracheids and vessels) of roots, stems, and leaves are interconnected to form a continuous system of water-conducting channels, which reaches all parts of the plant.

Root hair with adhering soil particles

Roots absorb water and mineral salts from the soil. Each soil particle is surrounded by a continuous film of water, loosely held to it by a force known as capillary force. This is known as **capillary water**. Therefore, water molecules adhere to soil particles with the capillary force. The capillary water is also present in spaces between the soil particles. This capillary water, along with the minerals dissolved in it, is absorbed by the cells in the root hair.

Absorption of water from the soil

The cells in the root hair are deficient in water because they continuously supply the absorbed water to the stems and leaves. Thus, the concentration of water in the root hair is less than the water present in soil particles.

This creates a concentration gradient, which allows the root hair cells to uptake water actively. As a result, there is a steady movement of water into the root xylem creating a column of water, which is steadily pushed upwards. This upward movement of water and minerals is called **ascent of sap**.

Due to the continuous inflow of water, a pressure is developed inside the root cells. This **root pressure** helps in pushing the plant cell sap upwards through xylem vessels.

However, this pressure by itself cannot move the water over greater heights. In order to fulfil this requirement, plants utilise some other stronger force such as **transpiration pull** or **suction pressure**. Let us explore what transpiration pull is.

Some interesting facts:

- 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.

The water thus absorbed by the roots and transported into the plant body plays various vital functions, some of which are:

- transportation of soluble substances from one plant part to the other,
- production of food through photosynthesis,
- cooling the plant through transpiration.