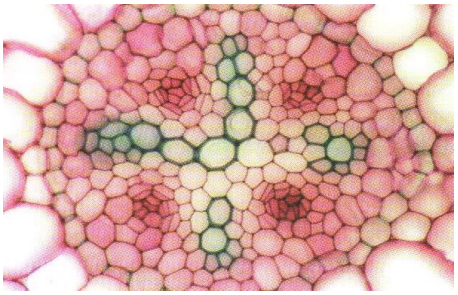
# 2.10 Xylem and Phloem

The structure and function of xylem and phloem transport tissues in plants

Simply put, every living organism needs to take in substances from its environment, and dispose of waste substances back into its environment. The transport system in a plant which does this moves substances around the plant in special tissue called **vascular tissue**. There is **xylem** tissue which transports water and soluble minerals *upwards*, and there is **phloem** tissue which transports sugars *upwards and downwards*. Phloem and xylem tissues are found together in **vascular bundles**. These bundles may often contain some other tissue types to give the plant extra support.

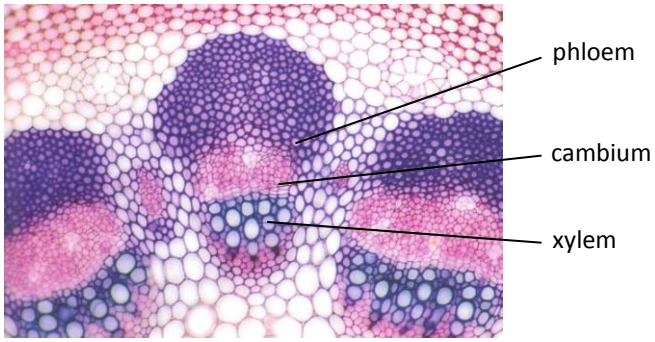
## Arrangement of Transport Tissues in Plants



Vascular bundles are arranged very differently in the different parts of a plant. In the root, the xylem (stained green-blue in the photo) are arranged in some sort of star or cross-shape. The phloem tissue are arranged in smaller groups in between each spike of the xylem cross-shape.

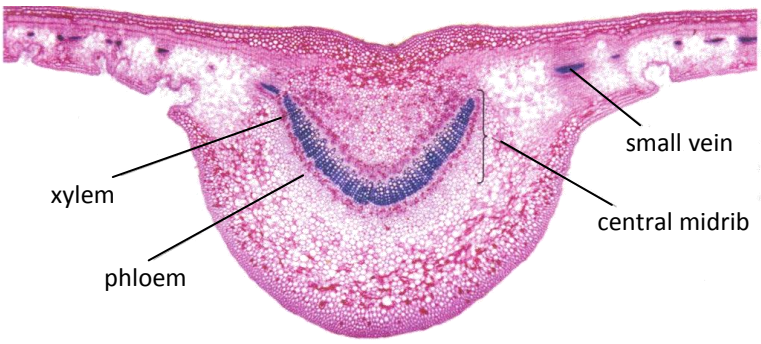
Around the bundle is a special layer of cells called the **endodermis**. This has a key role in getting water to the xylem vessels. Inside the endodermis is a layer of **meristem** cells called the **pericycle**.

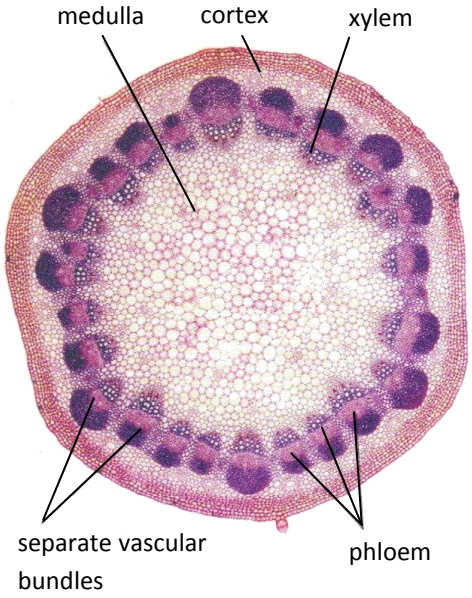
The vascular bundles are found near the outer edge in the stem. The xylem is found towards the inside of each vascular bundle (see the diagram), and the phloem towards the outside. In between the xylem and the phloem vessels there is a layer of **cambium**. This is a layer of meristem cells which can divide to produce more phloem or xylem.



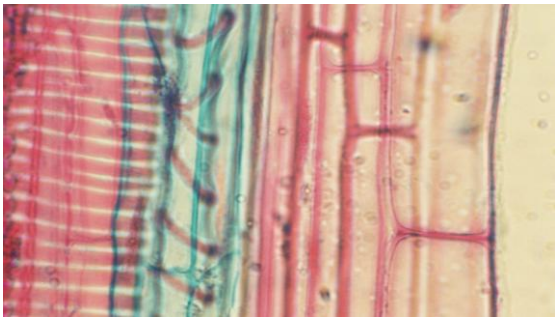

The diagram to the right (top) shows a vascular bundle in close detail. The below diagram shows a transverse section of a stem, where you can see the entire outer ring of vascular bundles.

In a leaf, however, the vascular bundles form the midrib and veins of the leaf. Usually, the pattern tends to be veins branching away from the midrib, forming a network which gradually gets smaller and thinner with distance from the midrib. Within each vein, the xylem can be seen on top of the phloem.



## XYLEM

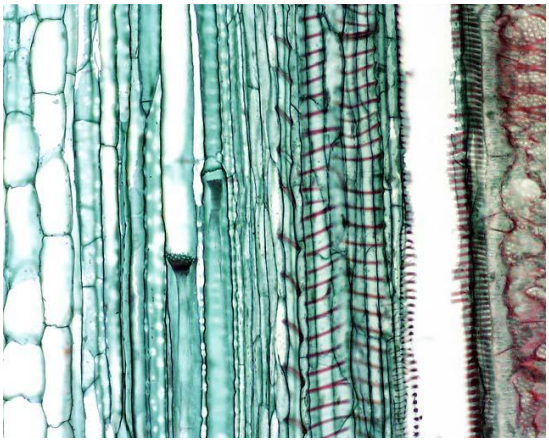


Xylem tissue consists of the xylem vessels to transport water and dissolved minerals; fibres to help support the plant and living **parenchyma** cells. The xylem vessels are the main feature. These are long cells with thick walls impregnated with **lignin** (see 1.14 Tissues and Organs). The lignin makes the cells waterproof, and this causes the cells to die, so their contents and end walls decompose, leaving a hollow tube of dead cells. The lignin strengthens the tube and prevents the vessel from collapsing.

Because of its adaptations, xylem tissue can carry water and minerals from roots to the very top of the plant:

- It is made from dead cells end-to-end to form a continuous hollow column
- The tubes are narrow so the water column does not break easily and capillary action can be effective
- Lignin deposited in the walls in spiral, annular (circles) or reticulate (broken rings) patterns allows xylem to stretch as the plant grows and enables the stem or branch to bend

## PHLOEM



The function of phloem is to transport sugars from one part of the plant to another. This can be upwards or downwards. Phloem tissue consists of two types of cell: **sieve tube elements** and **companion cells**.

The sieve tube elements are not true cells as they contain very little cytoplasm and no nucleus. They are lined up end-to-end to form a tube, which transports the sugars (usually sucrose). The sucrose is dissolved in water to form **sap**. Unlike xylem, this tube contains cross-walls at intervals, perforated by many pores to allow the sap to flow. Hence the cross-walls are called sieve plates and the tubes sieve tubes.

Between the sieve tubes are small cells, each with a large nucleus, and dense cytoplasm. These are companion cells. Because of their many active processes, they have large numbers of mitochondria to produce the required amount of ATP. These cells carry out the metabolic processes using the ATP energy, such as loading the sucrose in the tubes.