Cheatography

9.2 Transport in the Phloem of Plants Cheat Sheet

by Arsh.b via cheatography.com/179523/cs/38007/

Active Translocation

Translocation is the movement of organic compounds from sources to sinks.

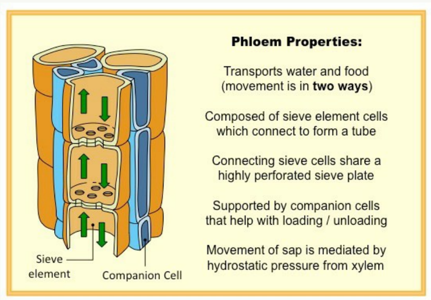
The **source** is where organic compounds are made or stored, while the **sink** is where the organic compounds are consumed.

Translocation occurs in the vascular tube system called the **phloem**.

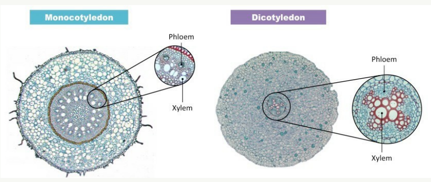
Glucose is stored and transported as sucrose because it is soluble but metabolically inert.

The fluid in the poem is called the plant sap.

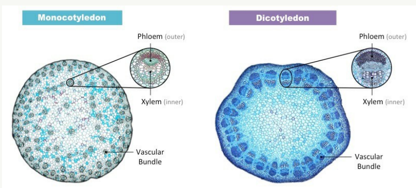
Phloem structure



Xylem and Phloem in Roots



Xylem and Phloem in the Stem



Phloem Loading

Active transport is used to load organic compounds into phloem sieve tubes at the source.

Organic compounds produced at the source are actively loaded into phloem sieve tubes by companion cells.

Symplastic loading occurs when materials pass into the sieve tube via the interconnecting *plasmodesmata*.

Apoplastic loading occurs when materials are pumped across the intervening cell wall by membrane proteins.

Aploplastic loading of sucrose into the phloem sieve tubes is a form of active transport.	Hydrogen ions (H+) are actively transported out of phloem cells by proton pumps.
	The concentration of hydrogen ions consequently builds up outside of the cell, creating a proton gradient.
	Hydrogen ions passively diffuse back into the phloem cell via a co-transport protein, which requires sucrose movement.
	This results in a build up of sucrose within the phloem sieve tube for subsequent transport from the source.

Mass Flow

High concentrations of solutes in the phloem at the source lead to water uptake by osmosis.

Incompressibility of water allows transport along hydrostatic pressure gradients.

At the source

Mass Flow (cont)

The active transport of solutes (such as sucrose) into the phloem by companion cells makes the sap solution hypertonic.

This causes water to be drawn from the xylem via osmosis.

Due to the incompressibility of water, this build up of water in the phloem causes the hydrostatic pressure to increase.

This increase in hydrostatic pressure forces the phloem sap to move towards areas of lower pressure (mass flow).

Hence, the phloem transports solutes away from the source (and consequently towards the sink).

Raised hydrostatic pressure causes the contents of the phloem to flow towards sinks.

At the sink

The solutes within the phloem are unloaded by companion cells and transported into sinks.

This causes the sap solution at the sink to become increasingly hypotonic.

Consequently, water is drawn out of the phloem and back into the xylem by osmosis.

This ensures that the hydrostatic pressure at the sink is always lower than the hydrostatic pressure at the source.

Hence, phloem sap will always move from the source towards the sink.

When organic molecules are transported into the sink, they are either metabolised or stored within the tonoplast of vacuoles.

Phloem structure

Structure-function relationships of phloem sieve tubes.

Phloem serve tubes are primarily composed of two main types of cells:

Phloem structure (cont)

Sieve element cells	Sieve elements are long and narrow cells that are connected together to form the sieve tube. - They are connected by *sieve plates* at the transverse ends. - They have no nuclei and reduced number of organelles. - They have thick and rigid cell walls to withstand the hydrostatic pressures which facilitate flow.
Companion cell	Provide metabolic support for sieve element cells and facilitate the loading and unloading of materials at the source and sink. - Possess an infolding plasma membrane which increases SA:Vol ratio to allow for more material exchange. - Have many mitochondria to fuel active transport of materials in the sieve tube. - Contain appropriate *transport proteins* within the plasma membrane to move materials into and out of a sieve tube.

Sieve elementals are unable to sustain independent metabolic activity without the support of a companion cell. **Plasmodesmata** exist between sieve elements and companion cells in relatively large numbers. These connect the cytoplasm of the two cells and mediate the symplastic exchange of metabolites.

Identification of xylem and phloem in microscope images of stem and root.

Phloem structure (cont)

Xylem and phloem vessels are grouped into bundles that extend from the roots to the shoots in vascular plants.
Differences in distribution and arrangement exist between plant types and differences in the diameter of the cavity can be used to identify the different vessels.

Roots	In monocotyledons, the stele is large and vessels will form a radiating circle around the central pith. Xylem vessels will be located more internally and phloem vessels will be located more externally.
	In dicotyledons, the stele is very small and the xylem is located centrally with the phloem surrounding it. Xylem vessels may form a cross-like shape ('X' for xylem), while the phloem is situated in the surrounding gaps.
Stem	In monocotyledons, the vascular bundles are found in a scattered arrangement throughout the stem. Phloem vessels will be positioned externally (towards outside of stem) – remember: phl*o*em = *o*utside
	In dicotyledons, the vascular bundles are arranged in a circle around the centre of the stem (pith). Phloem and xylem vessels will be separated by the cambium (xylem on inside ; phloem on outside).

Translocation Rate

Analysis of data from experiments measuring phloem transport rates using aphid stylets and radioactively- labelled carbon dioxide.

Aphids are a group of insects, (order *Hemiptera*) which feed primarily on sap extracted from the phloem.
They have a long, protruding mouthpiece (stylet) which pierces the plant's sieve tube to extract sap. This is aided by directive enzymes that soften tissue layers.
When the stylet is severed sap continues to flow from the plant due to the hydrostatic pressure within the sieve tube.

Measuring phloem transport

Aphids can be used to collect sap at various sites along a plant's length and thus provide a measure of phloem transportation lengths.

Process

A plant is grown within a lab with the leaves sealed within a glass chamber containing radioactively-labelled carbon dioxide.

The leaves will convert the CO_2 into radioactively-labelled sugars (via photosynthesis), which are transported by the phloem.

Aphids are positioned along the plant's length and encouraged to feed on the phloem sap.

Once feeding has commenced, the aphid stylet is severed and sap continues to flow from the plant at the selected positions.

The sap is then analysed for the presence of radioactively-labelled sugars.

The rate of phloem transport (translocation rate) can be calculated based on the time taken for the radioisotope to be detected at different positions along the plant's length.

Factors affecting translocation rate

The rate of phloem transport will principally be determined by the concentration of dissolved sugars in the phloem. This concentration is impacted by:
- rate of photosynthesis
- trade of cellular respiration
- rate of transpiration
- diameter of the sieve tubes