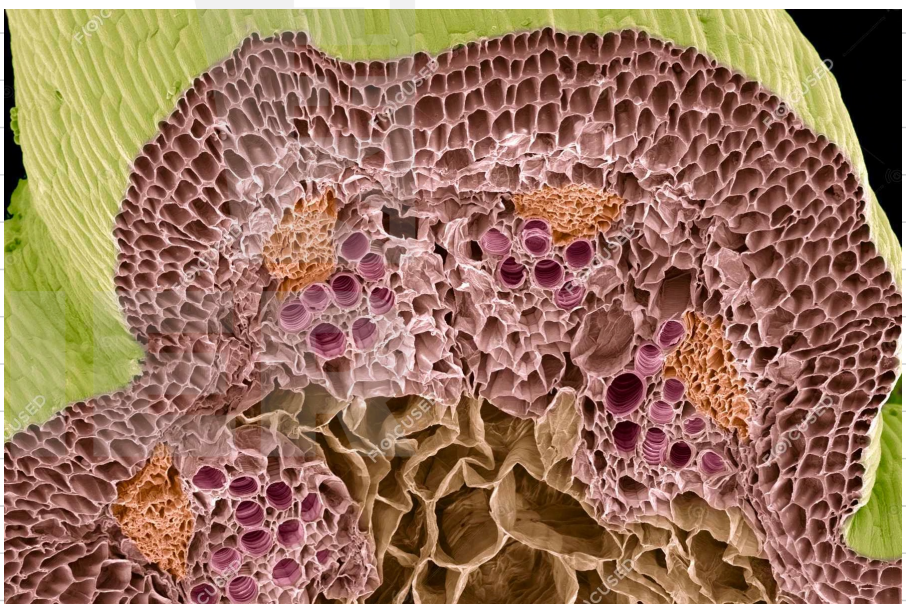
Plant Biology

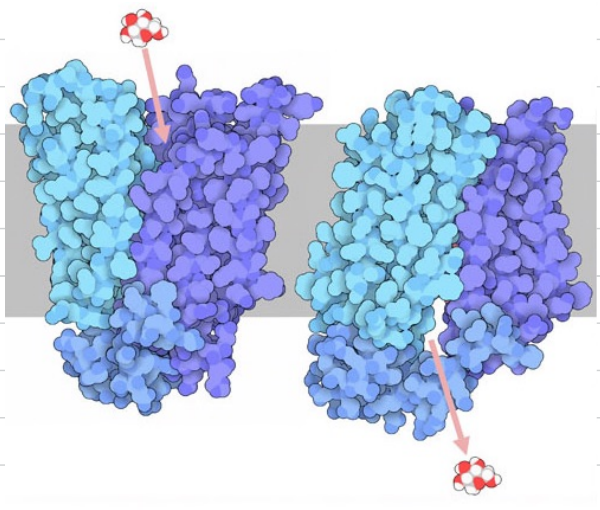
Learning outcomes

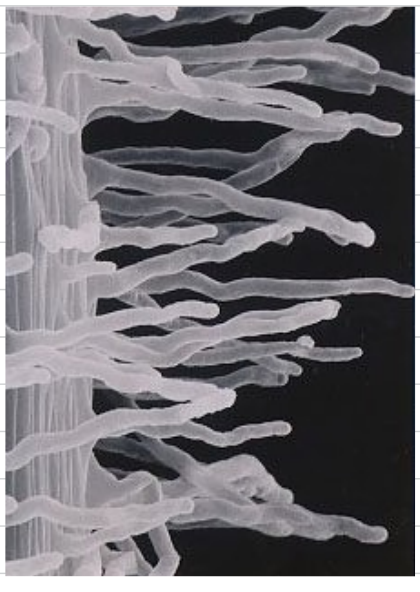
- [x] understand how particles move across membranes passively including: simple diffusion, facilitated diffusion, and osmosis
- [x] understand how particles move across membranes actively including: primary and secondary active transport
- [x] understand the process of transpiration including: active transport in roots, transpiration stream in xylem and gas exchange in leaves via stomata
- [x] understand how capillary action is the result of adhesion and cohesion
- [x] understand how organic compounds are moved in translocation from source to sink using passive and active transport
- [x] understand how transpiration and bulk flow is the result of pressure differences
- [x] draw and label a flower and understand the role of each part
- [x] understand the stages of plant sexual reproduction

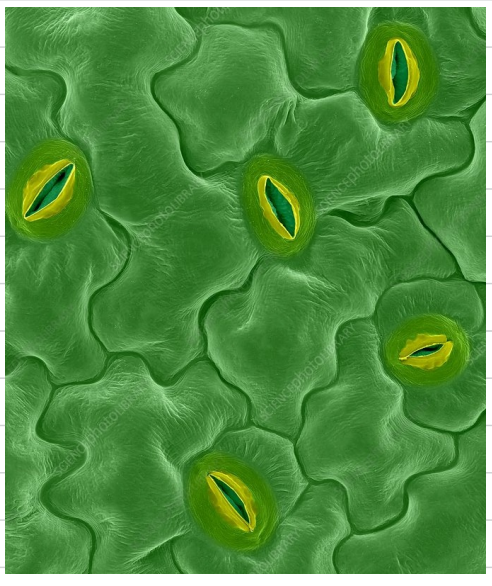
Key terms

- selective permeability
- passive transport
- active transport
- simple diffusion
- facilitated diffusion
- osmosis
- primary active transport
- secondary active transport
- transpiration
- cohesion
- adhesion
- translocation
- stigma
- style
- ovary
- sepal
- petal
- anther
- filament









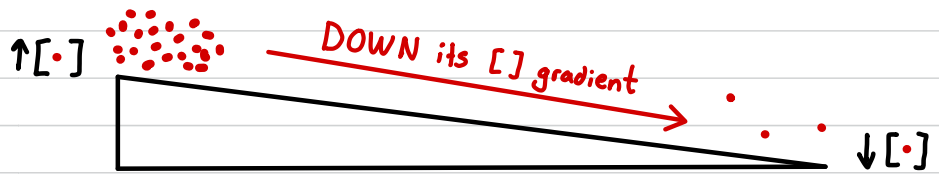
Membrane Transport

The plasma membrane enclosing cells is **selectively permeable:** controlls the passage in and out of substances, allowing some to enter/exit but not others

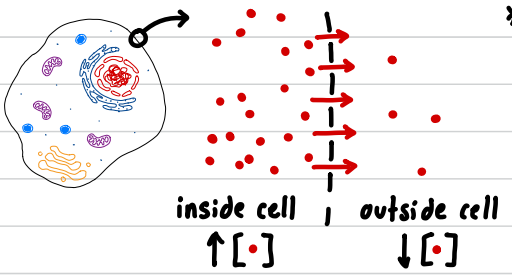
↳ transport across membranes can be either: passive or active

Passive transport: movement of particles from an area of high concentration ↑[ ] to low concentration ↓[ ]

* Does not require energy
* Will occur until concentration gradient equalizes, i.e. no gradient

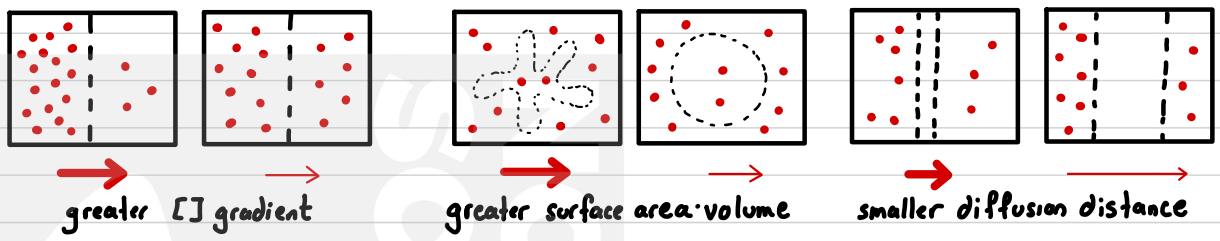


↳ **Simple diffusion:** passive net movement of particles down their concentration gradient without the aid of membrane proteins



* usually small, uncharge molecules (O_2, CO_2, ethanol)

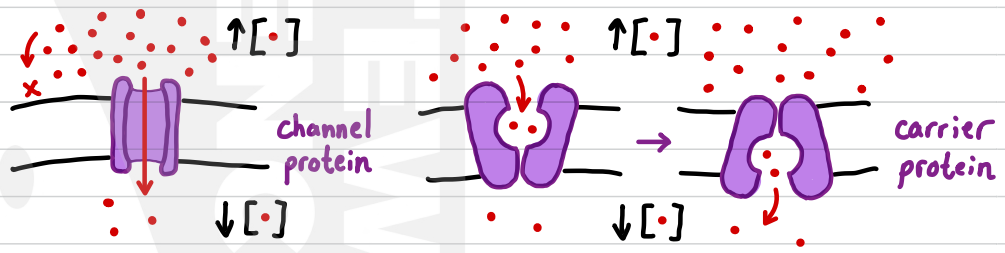
How can rate of diffusion be ↑ ?



↳ **facilitated diffusion.** passive net movement of particles down their concentration gradient with the aid of membrane proteins

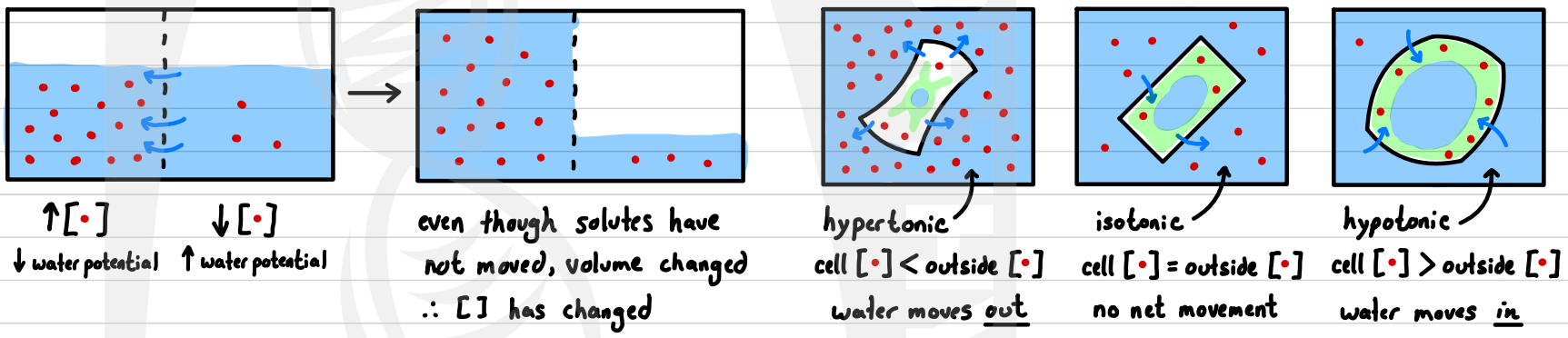
Even with a large concentration gradient, some particles cannot pass through a plasma membrane
↳ large, polar, charged (glucose, ions like H^+, Na^+, Cl^-)

Solution: membrane proteins specific to certain particles provide passage



↳ **osmosis:** passive movement net of water from an area of ↓ [solute] or ↑ water potential to ↑ [solute] or ↓ water potential

If solutes cannot pass through membranes, water will move in order to equalize [ ]

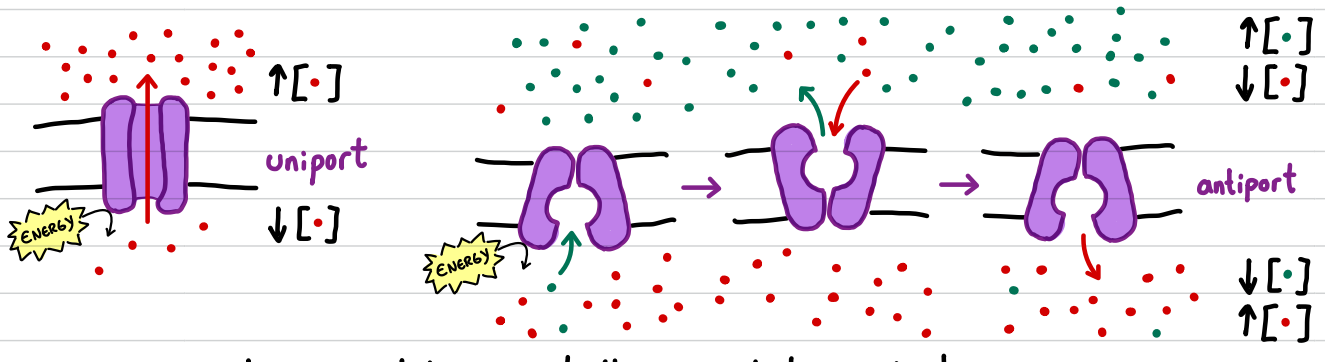


Active transport: movement of particles from an area of low concentration ↓[ ] to high concentration ↑[ ]

* requires energy!
* will occur only as long as energy is used

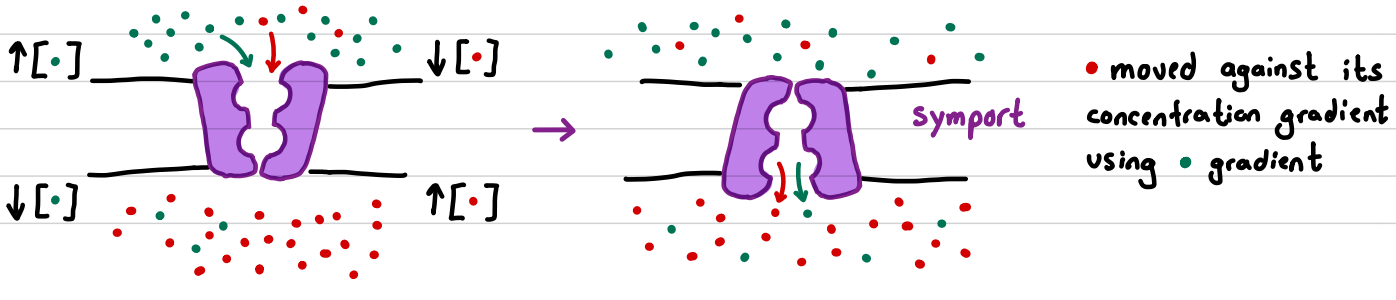
↳ **Primary active transport:** direct use of energy in order to move particles against their concentration gradient

* energy is 'spent' directly in order for a protein (pumps) to move particles against their concentration gradient



↳ **Secondary active transport:** indirect use of energy in order to move particles against their concentration gradient

* particles move against their gradient using stored energy in the form of a gradient of another particl

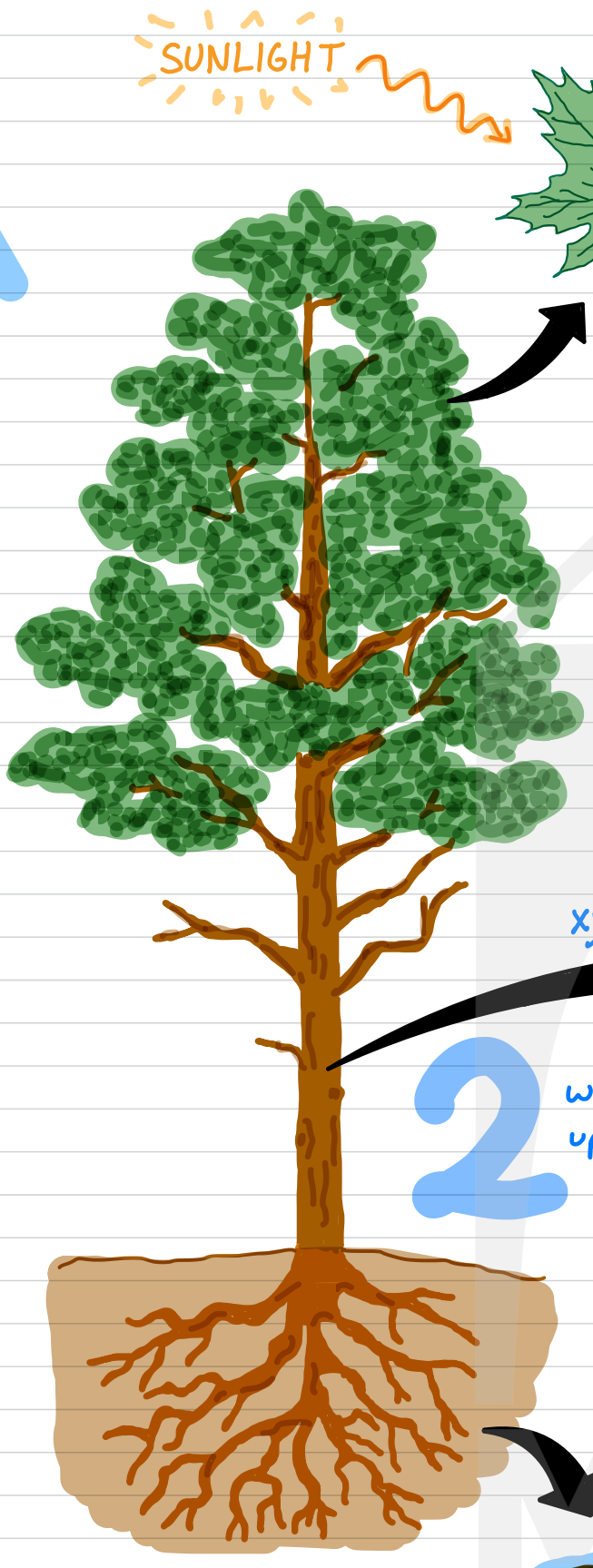


Transpiration

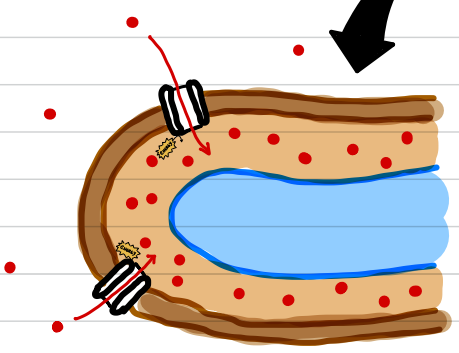
Transpiration: the process of water moving through a plant and its loss via leaves through evaporation

* more than 99% of water taken into plants is lost via transpiration and not used for metabolism

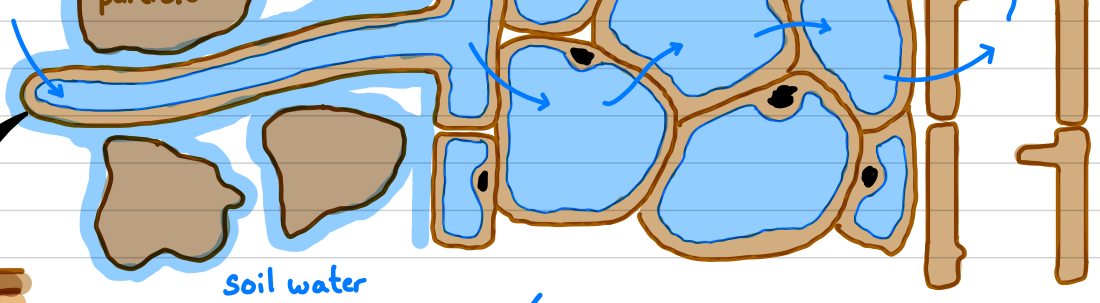
Why do it? → the water loss keeps the plants cool, prevents them for overheating
→ maintains cell shape and turgidity
→ allows nutrients/minerals to move throughout plant



1 water moves into root hair cell via osmosis

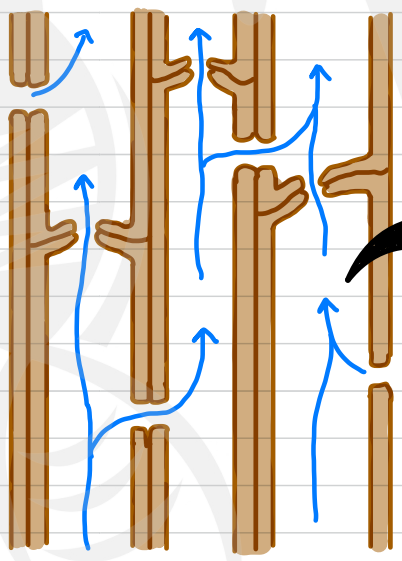


root hair cell actively pumps ions (•) into cell
→ creates ↑ [gradient]



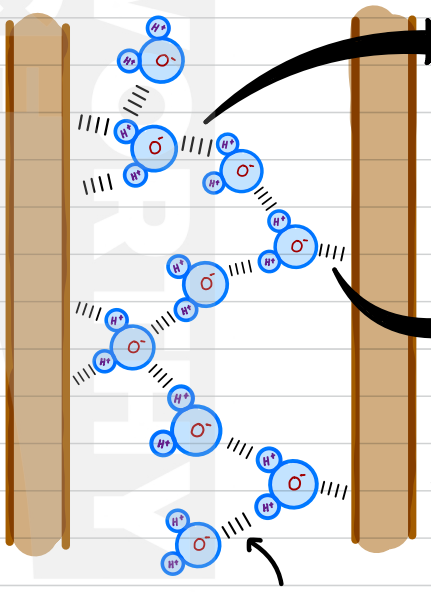
↑ water potential outside cell than inside → water moves in

2 water moves up xylem



water can also move across xylem through pits

Transpiration stream - capillary action



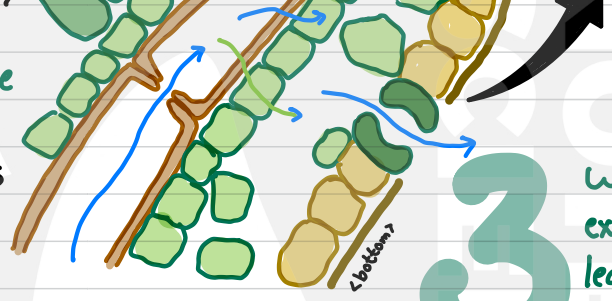
Cohesion: the attraction of water molecules with each other

$\delta^+H\cdots\delta^-O$

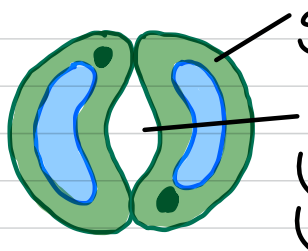
Adhesion: the attraction of water with another polar/charged molecule → surface of xylem

hydrogen bond

3 water vapour exits bottom of leaves via opening → stomata



CO_2 shortage / light - photosynthesis

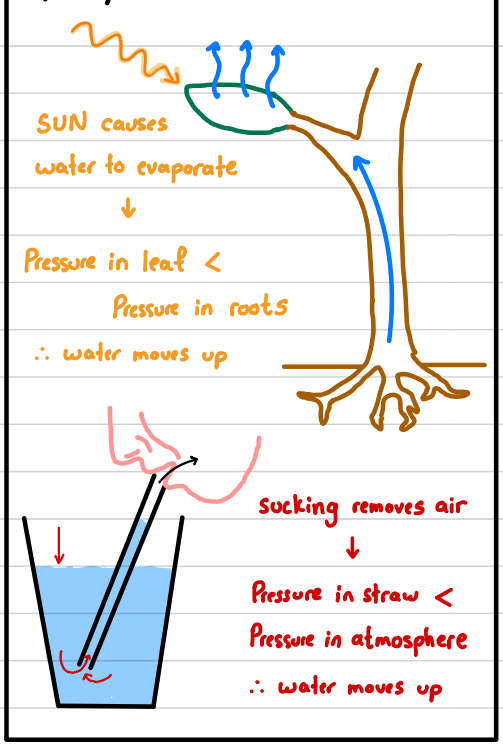


guard cells filled with water → turgid
Stoma open
→ water + O_2 diffuse out
→ CO_2 diffuses in

water shortage / darkness

guard cells lack water → flaccid
Stoma closed
→ low gas exchange
→ low transpiration

Transpiration is due to pressure differences



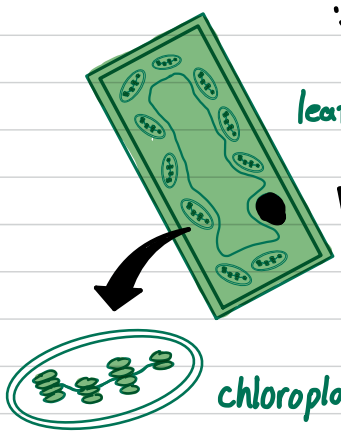
Translocation

Translocation: the process of transporting products of photosynthesis (sugars) throughout the plant via phloem

why is this important?

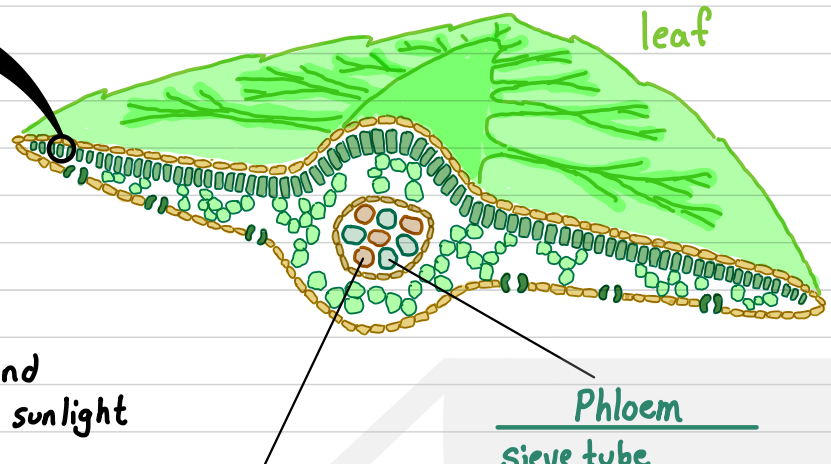
→ sugars 'food' is only produced in leaves but is needed everywhere for growth and cellular respiration

∴ need a way to transport this energy source to other tissues (stems, roots, shoots)



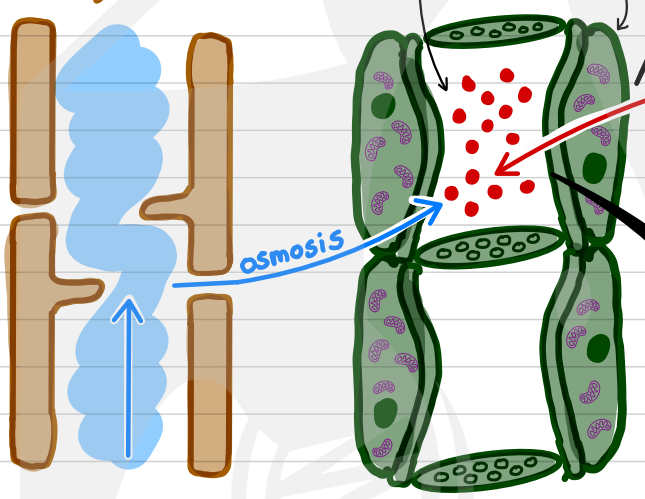
Site of **photosynthesis:** the conversion of CO_2 and water into sugars using sunlight

glucose + fructose → sucrose



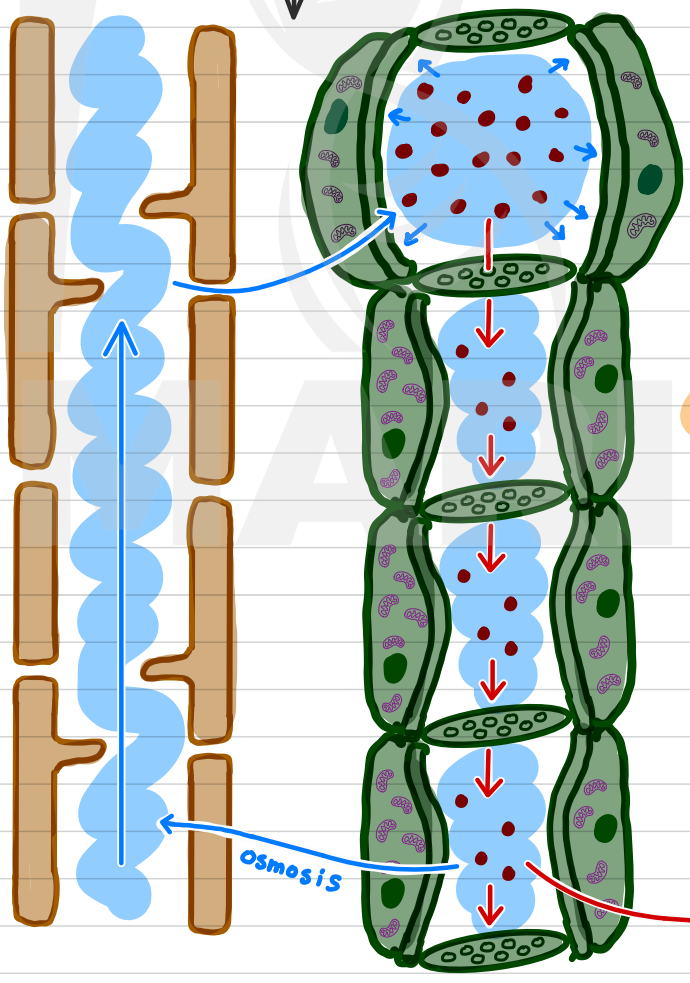
2 Osmosis at source

As phloem has a ↑[sucrose] and ↓water potential, water flows from xylem into phloem via osmosis

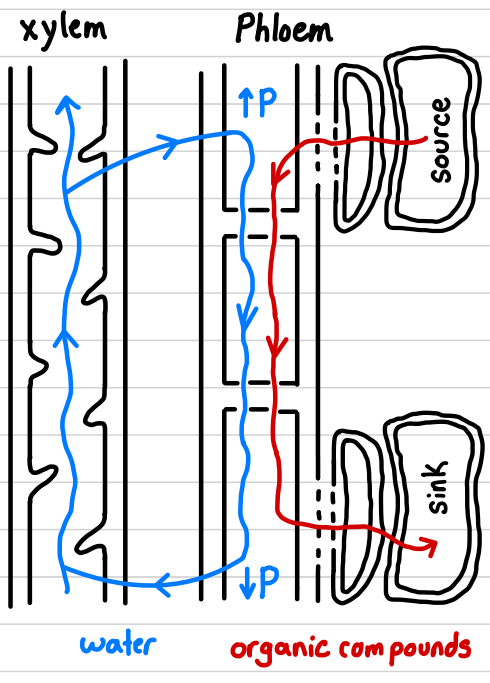


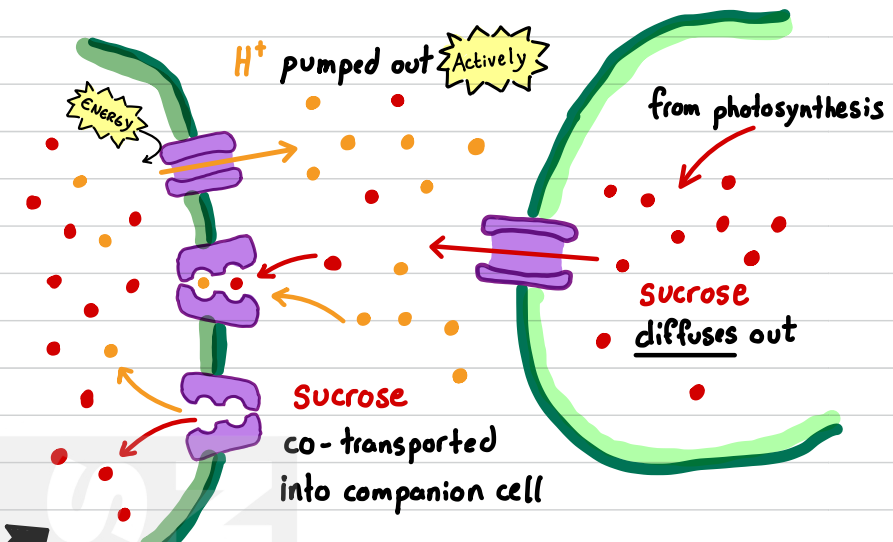
3 Build up of Pressure

Walls of sieve tubes are rigid and water is incompressible ↑hydrostatic pressure



Summary





1 Phloem loading

(a) sucrose is (Actively) transported from source cell into companion cell of phloem

(b) sucrose diffuses from companion cell into sieve tube of phloem

sucrose diffuses through gaps in cell walls called plasmodesmata

4 Bulk flow

Sucrose (and other solutes) solution i.e. sap, will flow down a pressure gradient from an area of high pressure (SOURCE) to an area of low pressure (SINK)

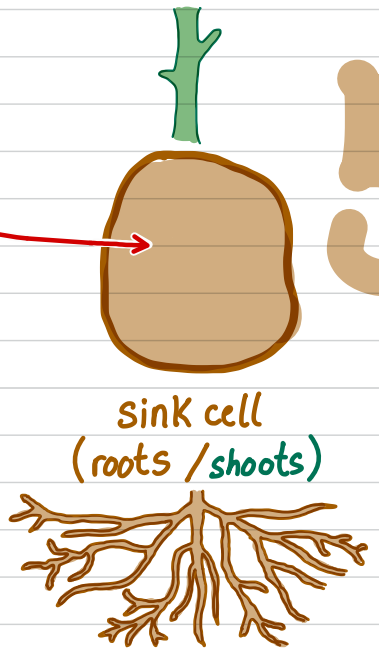
*this can be up or down

5 Source unloading

In order to maintain low pressure, sucrose is (Actively) unloaded into sink cells:

(a) Sucrose diffuses from sieve tube into companion cell

(b) Sucrose (Actively) transported into sink cell via secondary active transport (like at source)

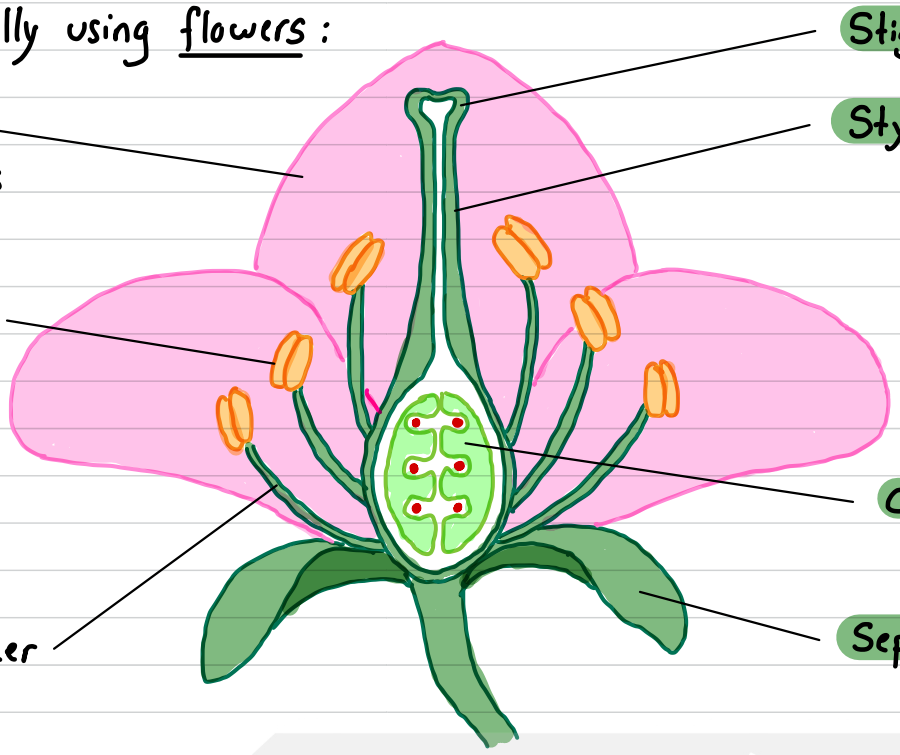


6 Osmosis at sink

as sucrose is unloaded into sink, water potential increases, causing water to return to xylem via osmosis

Plant Reproduction

flowering plants reproduce sexually using flowers:



Petal: attracts pollinators

Stigma: pollen landing site

Style: pollen tube grows down here connecting stigma to ovary

Anther: contains pollen
contains sperm

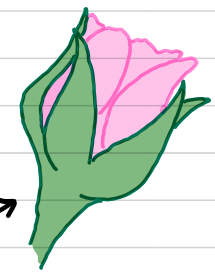
Stamen (male part)

Filament: supports anther

Carpel (female part)

Ovary: contains ovules
contains ova

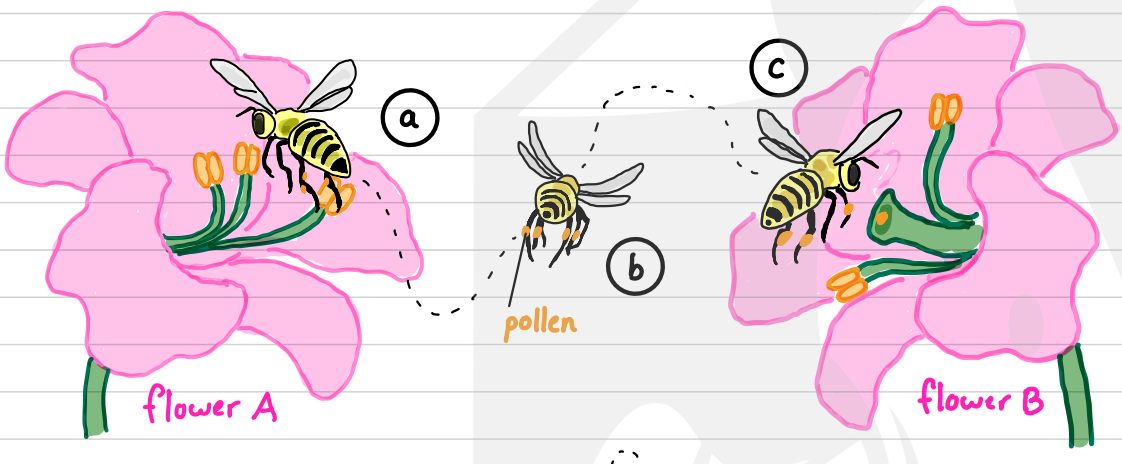
Sepal: protects flower during development



1 Pollination

Pollination: the process of bringing pollen from the anther of one flower to the stigma of another. Can be biotic or abiotic

Biotic Pollination

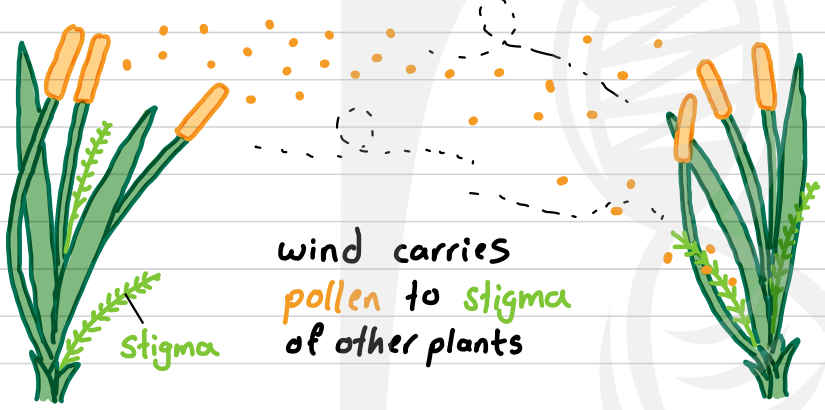


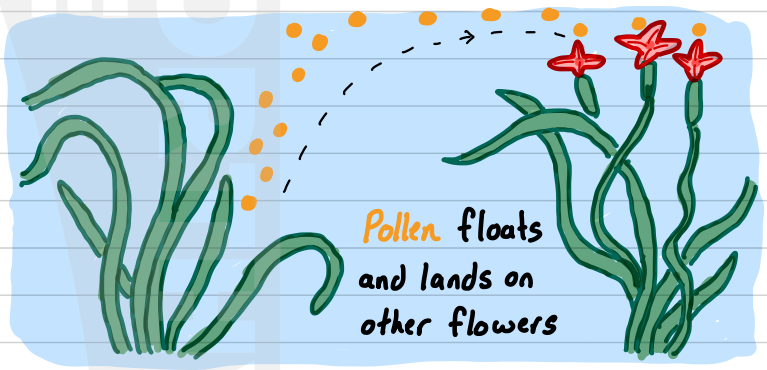
a) Pollinator (bees, wasps, hummingbirds, bats, etc.) are attracted to flower and visit them to feed (like on sugary nectar)

b) As pollinator feeds, pollen from anther sticks to their body. They leave to visit another

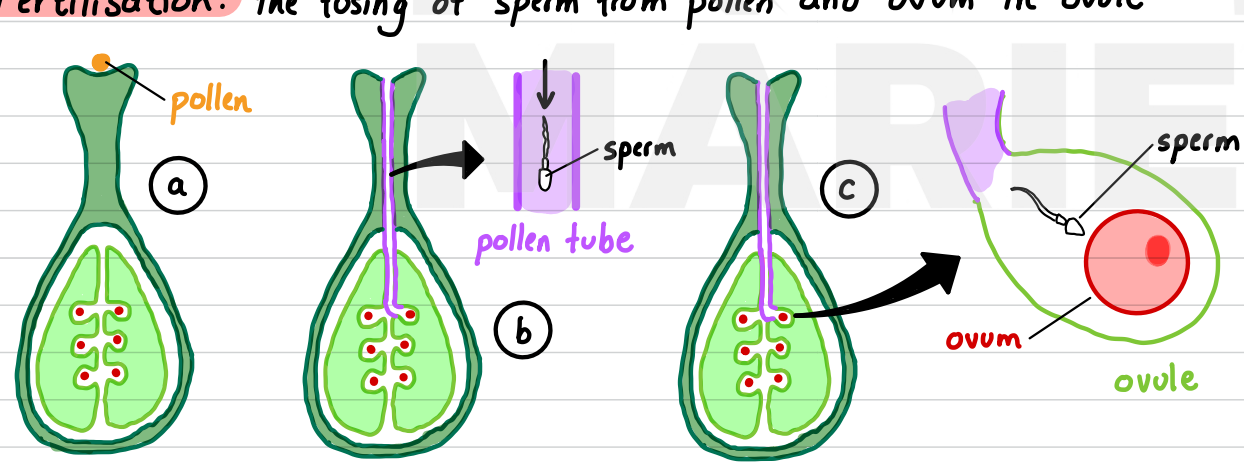
c) Pollinator visits second flower and pollen stuck to their bodies is transferred to stigma

Abiotic Pollination





2 Fertilisation: the fusing of sperm from pollen and ovum in ovule

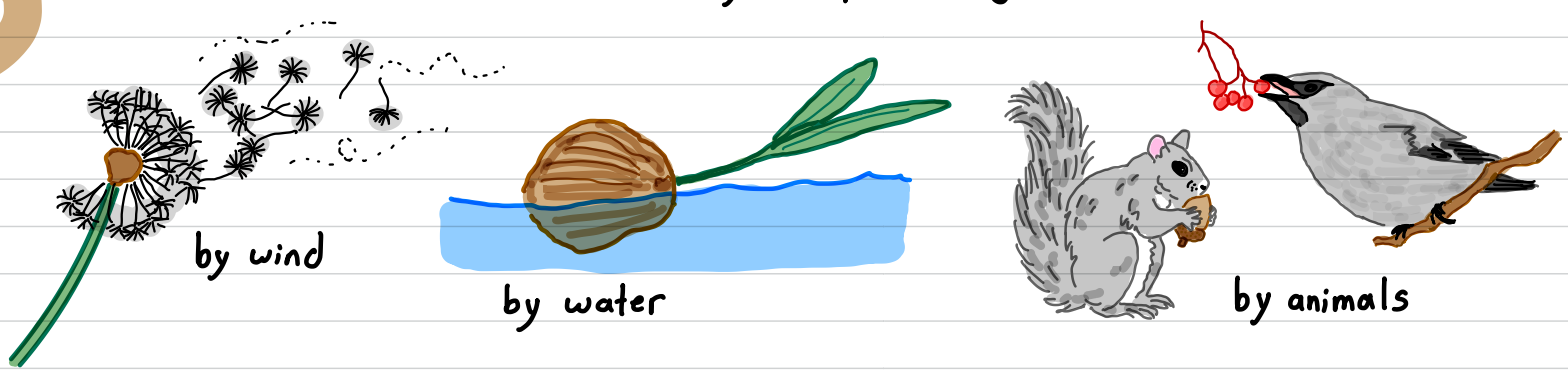


a) Pollen lands on stigma.
Contains: tube cell – forms pollen tube
generative cell - forms 2 sperm

b) Pollen tube forms and creates passageway for sperm to travel from stigma to ovary

c) Pollen tube penetrates ovule. Nuclei of sperm and ovum fuse. Extra sperm fertilizes extra cell which will divide into food source for embryo → seed

3 Seed dispersal: Seed is carried away from plant to grow elsewhere



a) Ovary develops into fruit with seeds inside

b) Animals eat fruit and move away

c) Animals defacate seeds

Assessment Tasks

(1) Research and provide an example of specific substances in <u>human cells</u> which move in/out via:
- a) simple diffusion
- b) facilitated diffusion
- c) primary active transport
- d) secondary active transport

(2) Complete the following table summarizing modes of transport in transpiration and translocation:

	Transpiration	Translocation
Simple diffusion		
Facilitated diffusion		
Osmosis		
Active transport		

(3) What abiotic factors would impact the rate of transpiration? Explain

(4) Saline soils have repercussions for water conservation in plants.

a) Explain why saline soils impact transpiration and water conservation.

b) Research and explain how a plant has adapted to live in this condition.

(5) Deserts have repercussions for water conservation in plants.

a) Explain why deserts impact transpiration and water conservation.

b) Research and explain how a plant has adapted to live in this condition.

(6) What abiotic factors would impact the rate of translocation? Explain

(7) Research and explain an example of a major crop dependent on animal pollination

(8) Provide advantages and disadvantages for biotic and abiotic pollination and seed dispersal

MARIER