

Support & Transport systems in plants

Scope

Topic	Breakdown of topic
Support and transport systems in plants	<p>Review plant tissues involved in support and transport</p> <p>Emphasis on the relationship between basic structure and function.</p> <p><u>Definition</u> of transpiration</p> <p><u>Relationship between water loss and leaf structure:</u></p> <ul style="list-style-type: none"> - Thickened cuticle - Size and shape of leaves - Number and position of stomata - Hairs on the leaf - Leaf arrangement <p><u>Factors affecting the rate of transpiration:</u></p> <ul style="list-style-type: none"> - Temperature - Light intensity - Wind - Humidity <p><u>Transport of water and mineral salts in plants:</u></p> <ul style="list-style-type: none"> - Uptake of water and minerals from the soil to the root hair - Lateral movement of water from the root hair to the xylem in the root <p><u>Transport of water from roots to the leaves:</u></p> <ul style="list-style-type: none"> - Transpiration pull - Capillarity - Root pressure <p><u>Translocation</u> of manufactured food from leaves to other parts of the plant</p>

Support & transport systems

Notes

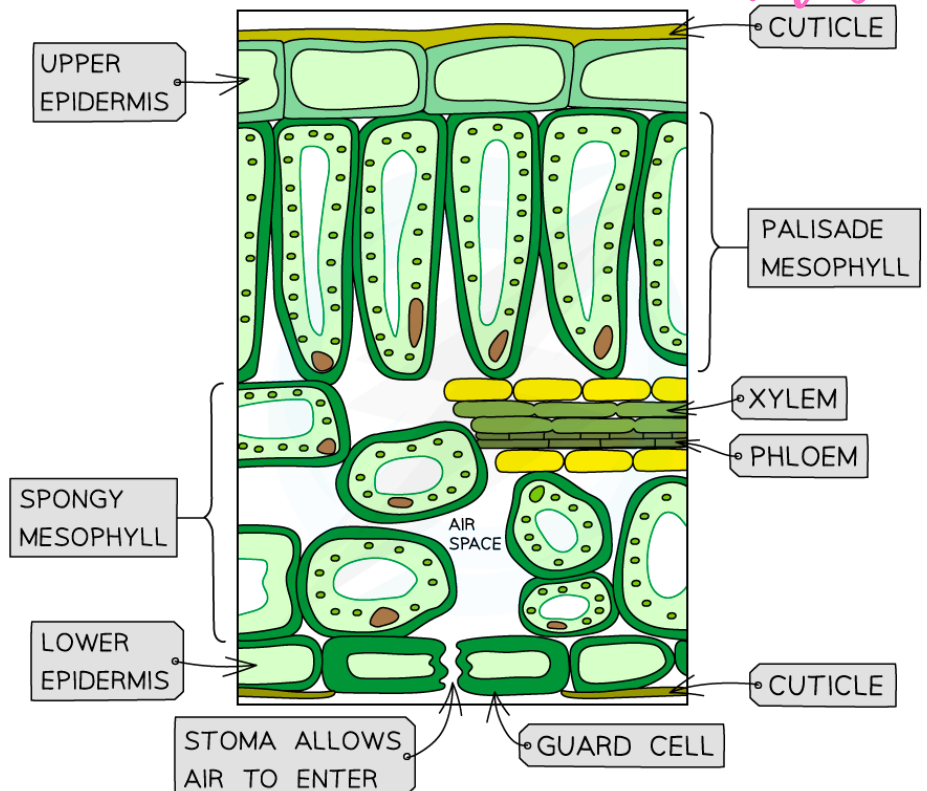
The leaf consists of three main sections:

- The epidermis
- The mesophyll
- The vascular bundles

Epidermis

The upper and lower surfaces of the leaf are covered by a thin transparent **epidermis**.

- The epidermis is thin and transparent so that the light can pass through for photosynthesis.
- Covered by a thin **waxy cuticle** to reduce water loss
- The lower epidermis has specialised cells called **stomata** (responsible for gaseous exchange).



Mesophyll

Mesophyll cells include **palisade** and **spongy mesophyll**.

The **palisade mesophyll** cells are thin-walled & elongated parenchyma cells. They contain large many of chloroplasts to absorb sunlight for photosynthesis.

The **spongy mesophyll** is round parenchyma that has many intercellular spaces and air chambers to allow gases to diffuse easily. They also have chloroplasts than the palisade.

Vascular bundle

The veins consist of **xylem** and **phloem**.

The **xylem** carries water from the roots up the stem and into the leaf where it is needed in the mesophyll tissues for photosynthesis,

The **phloem** carries the food that is made by photosynthesis down to the other parts of the plant.

Adaptations

Thin & transparent epidermis - allow sunlight to pass through & easy diffusion

Thin & waxy cuticle - allow sunlight to pass through & waxy to reduce water loss

Many stomata - for gaseous exchange

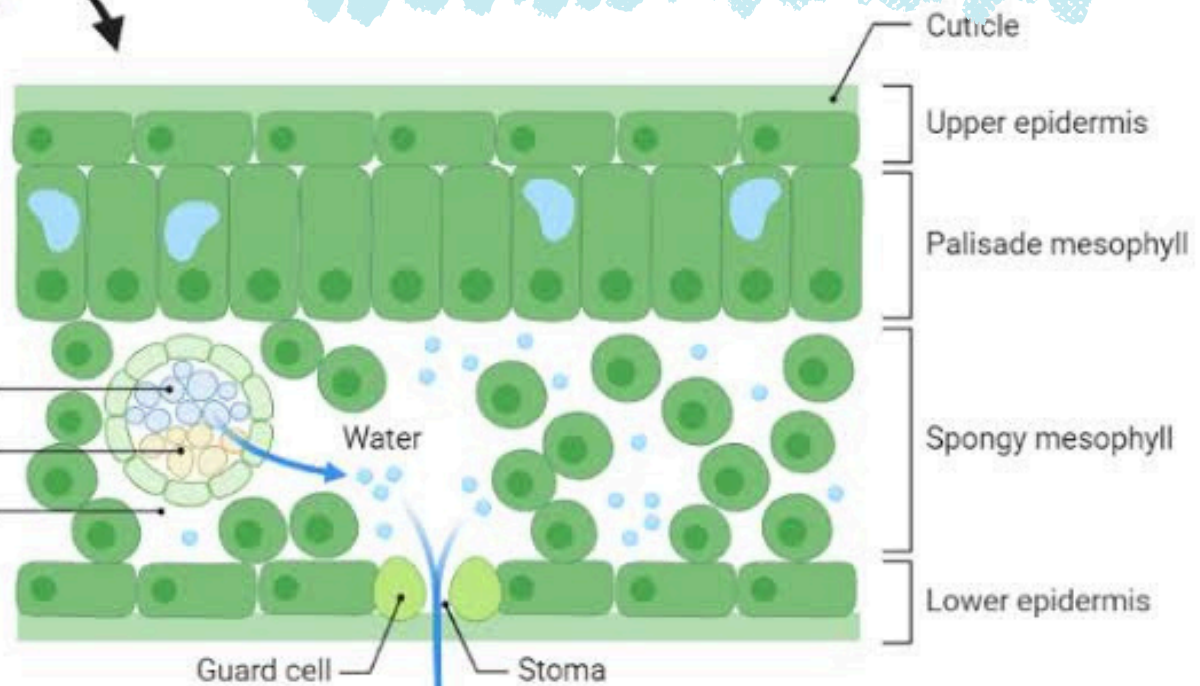
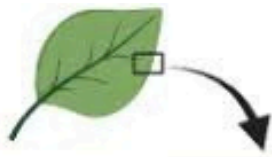
Palisade is elongated to increase surface area absorption of sunlight

Spongy mesophyll with air spaces - for gaseous exchange

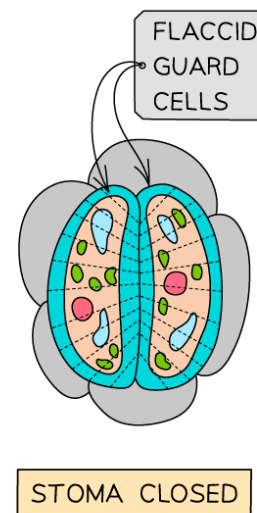
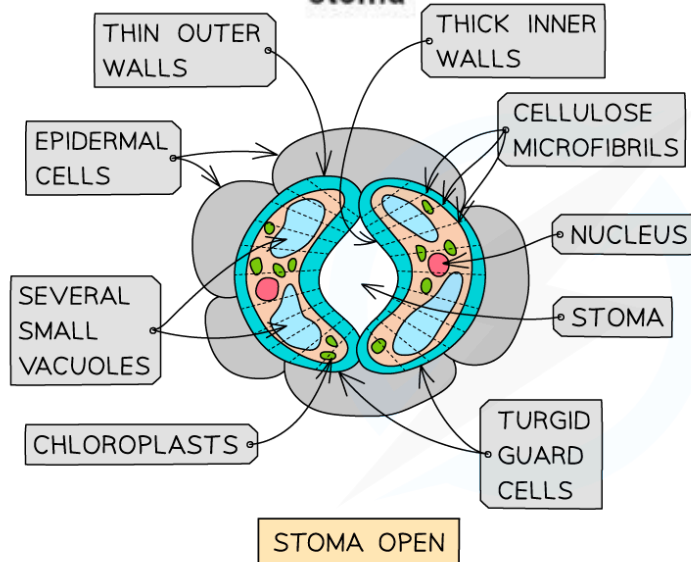
Vascular bundle - for transporting substances

Transpiration

Transpiration is the loss of water vapour from the aerial parts of the plant through the stomata of the leaf



**Transpiration of
water through the
stoma**



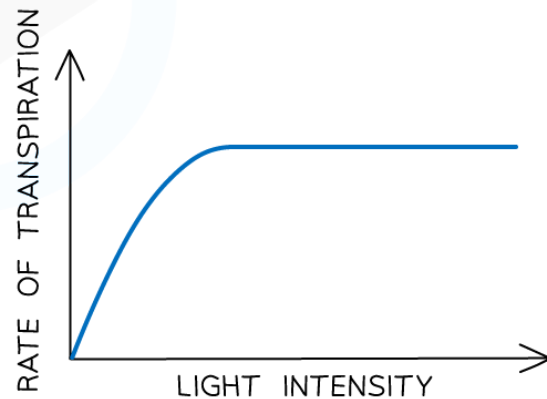
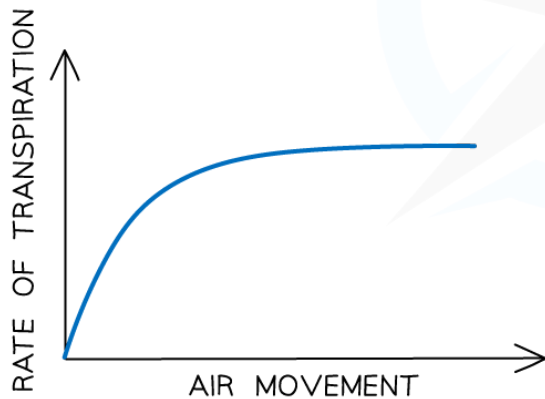
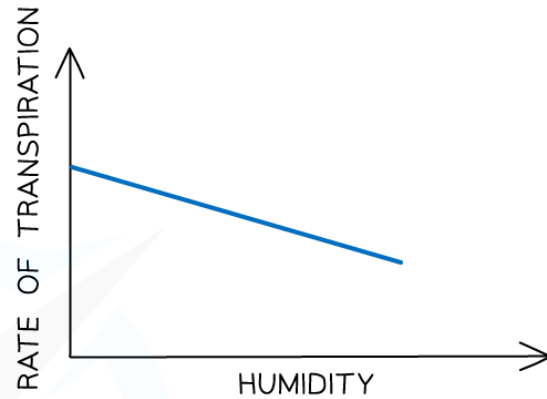
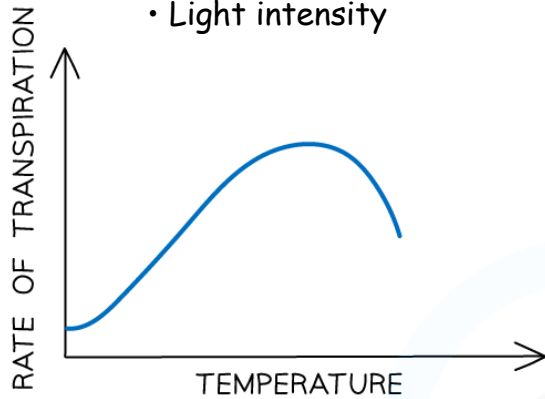
Adaptations to reduce water loss

- **Position of a stomata:** Ventral than dorsal - more stomata at the bottom
- **Sunken stomata:** Air is trapped outside of stomata decreasing the diffusion gradient
- **Thickened cuticle:** Prevents water loss; the thicker the cuticle the lesser transpiration
- **Small leaf surface:** Small surface area for evaporation
- **Leaf arrangement:** Lamina is not exposed to the sun to decrease evaporation

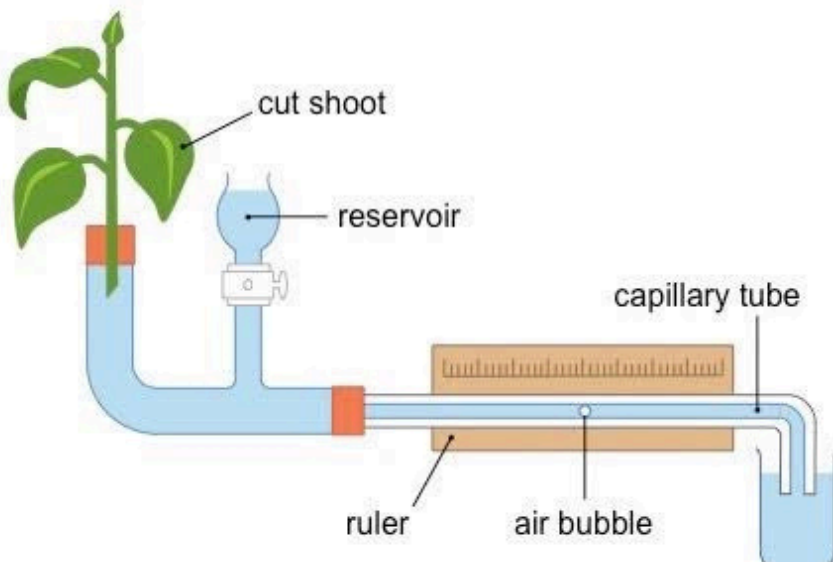
Transpiration

Transpiration is affected by four factors:

- Temperature
- Wind
- Humidity
- Light intensity



- **Temperature:** heat increases the kinetic energy of water molecules. When temperature rises water vapour diffuses out of the leaf faster.
- **Wind:** removes water vapour close to the surface of the leaf.
- **Humidity:** air that is humid is filled with water therefore decreasing diffusion between air and leaf spaces causing a decrease in the rate of transpiration.
- **Light intensity:** in brighter light the stomata opens more which allows more transpiration, transpiration occurs faster during the day than at night.



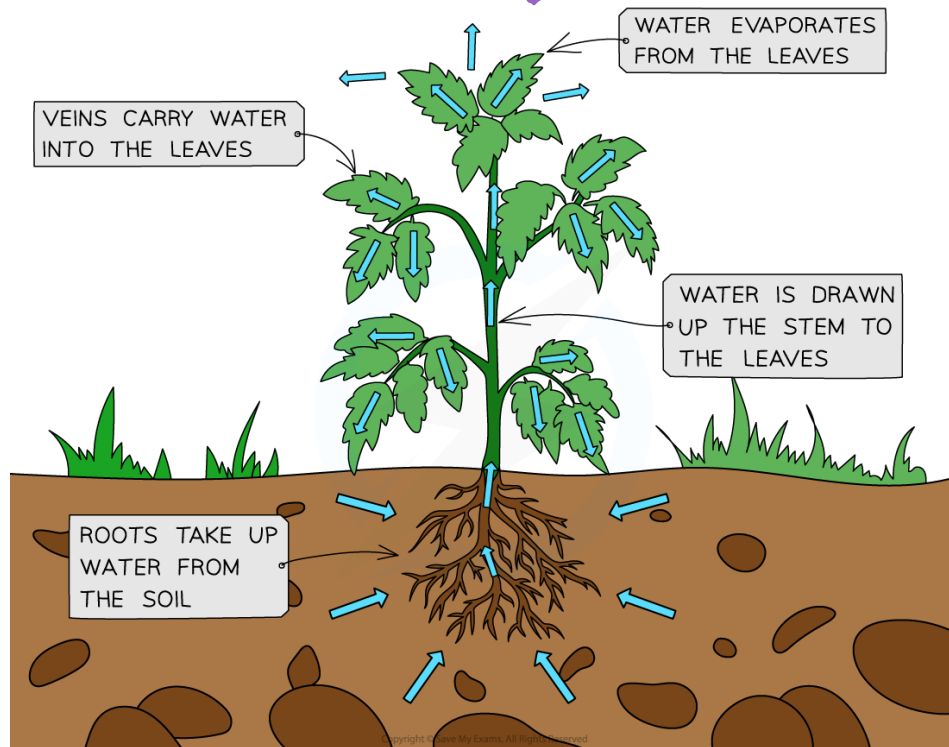
Apparatus:

A **potometer** is a device used to estimate *transpiration rates*

Experimental Method:

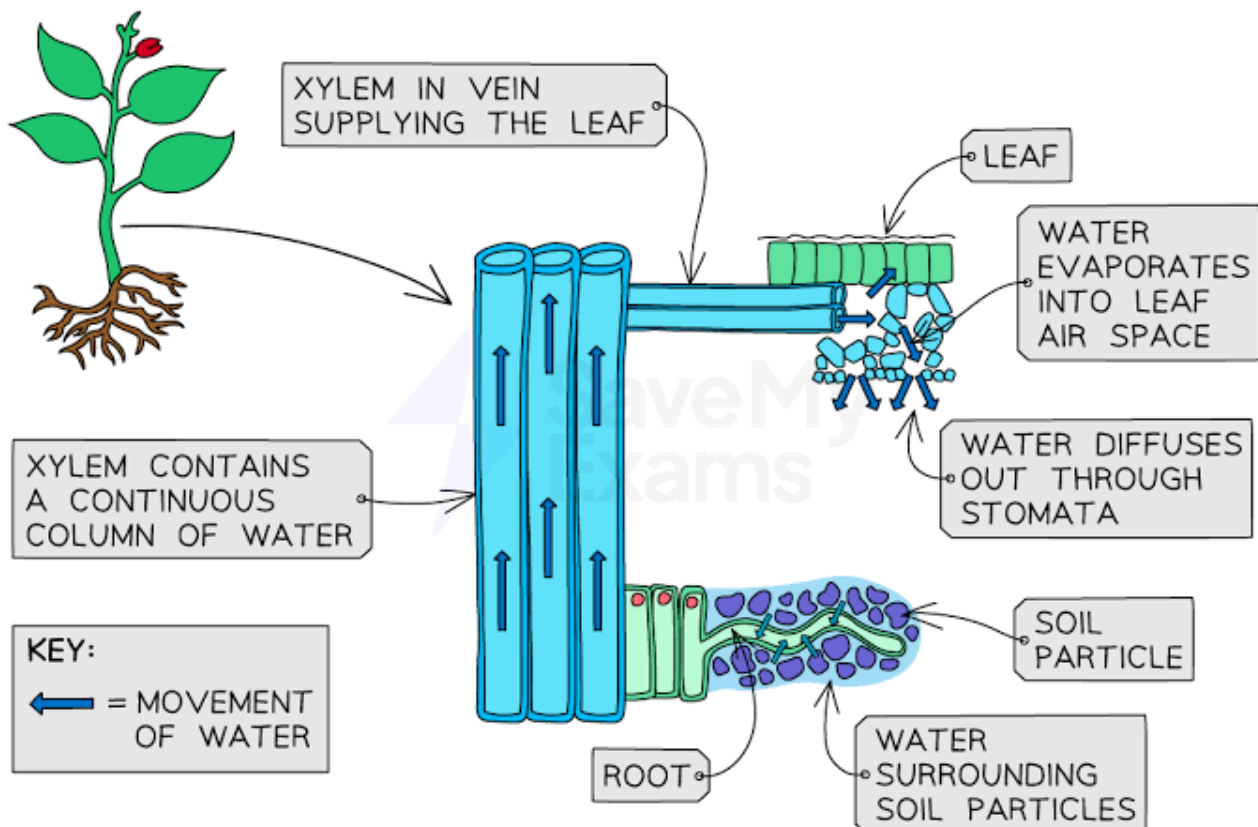
The distance moved by an air bubble can be recorded every minute and used to indicate the rate of water uptake by the plant

Transport



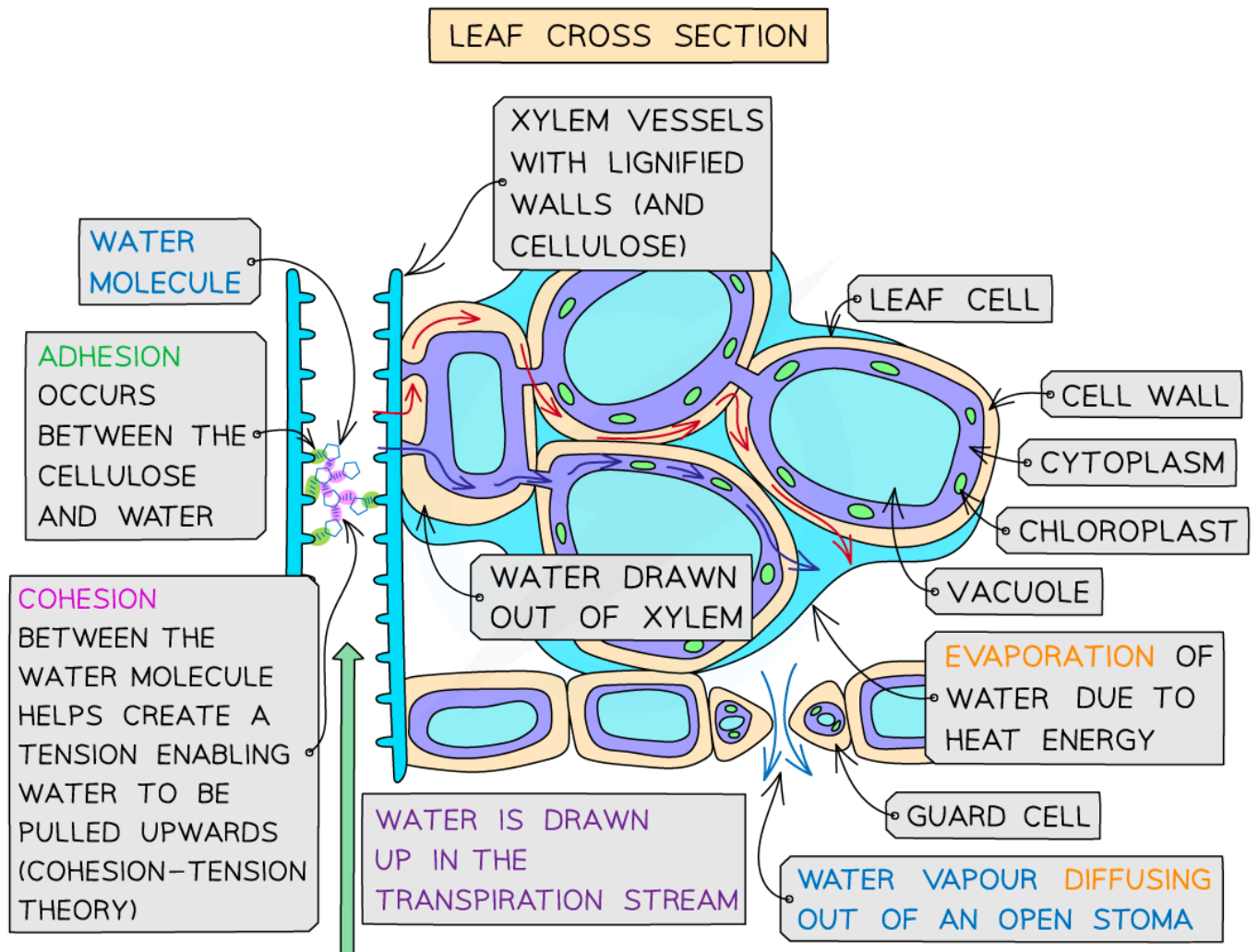
Xylem

- Moves materials via the process of transpiration
- Transports water and minerals from the roots to aerial parts of the plant.
- Xylem occupy the inner portion or centre of the vascular bundle and is composed of vessel elements and tracheids
- Vessel wall consists of fused cells that create a continuous tube for the unobstructed flow of water and materials.
- Vessels are composed of dead tissue at maturity, such that vessels are hollow with no cell contents



Transport

Minerals are actively transported into the xylem vessels. This lowers the water potential in the xylem and water flows by osmosis. **Root pressure** pushes some of the water upwards. Water evaporates from the surface of leaf by transpiration and water is lost. The water must be replaced as it moves out of the xylem into the leaf, creating a low hydrostatic **pressure** and **tension**. Water molecules are attracted to each other by forces of **cohesion** creating a continuous column of water so that water can be pulled upwards. Water molecules are also attracted to the walls of the xylem by forces of **adhesion** and causing **capillary action**.



Water is absorbed by **osmosis** into the root

Water then moves through parenchyma or cytoplasm or vacuole

The **casparian strip** blocks pathway & water moves through cell membrane

Forces that assist with upward movement of water:

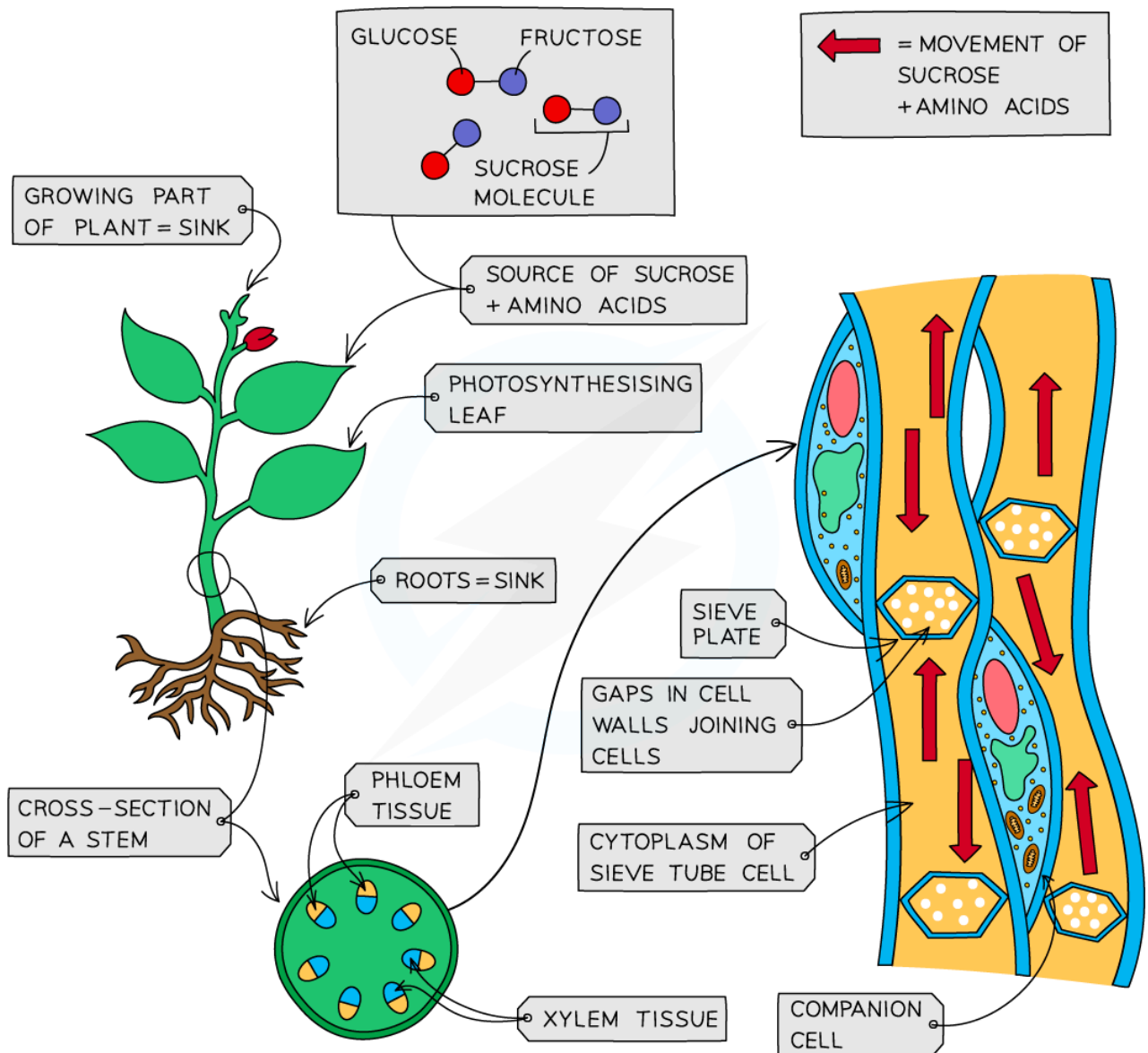
- Transpiration pull
- Capillarity
- Root pressure

Capillarity is the ability of water molecules to rise up a narrow tube through forces of cohesion & adhesion)

Translocation

Phloem

- Moves materials via the process of active **translocation**
- Transports food and nutrients to storage organs and growing parts of the plant
- Phloem occupy the outer portion of the vascular bundle and are composed of **sieve tube elements** and **companion cells**
- Vessel wall consists of cells that are connected at their transverse ends to form porous sieve plates (function as **cross walls**)
- Vessels are composed of **living tissue**, sieve tube elements **lack nuclei** and have few organelles



Translocation is the movement of organic compounds (e.g. sugars, amino acids) from sources to sinks

- The **source** - where the organic compounds are synthesised - this is the leaves
- The **sink** - where the compounds are delivered to for use or storage - this includes roots, fruits and seeds
- Organic compounds are transported from sources to sinks via a vascular tubes called the phloem
- Sugars are principally transported as **sucrose** (disaccharide), because it is soluble
- The nutrient-rich, viscous fluid of the phloem is called **plant sap**.

Support & transport systems

Terminology

Biological term	Description
Adhesion	Attraction and binding between surfaces
Capillarity	the ability of water molecules to rise up a narrow tube through forces of cohesion & adhesion
Cohesion	intermolecular attraction between like molecules, particularly water molecules, causing them to stick together
Humidity	The amount of water vapour in the air
Phloem	Tissue responsible for transporting organic molecules(food)
Potometer	A device used to measure transpiration rate
Root pressure	A force that pushed water upward by osmosis
Transpiration	loss of water vapour from the aerial parts of the plant through the stomata of the leaf
Transpiration pull	A force that pushes water upward from roots to leaves
Translocation	the movement of organic compounds (e.g. sugars, amino acids) from sources to sinks
Xylem	Tissue that transports water and minerals