9.1 Transport in the Xylem of Plants

Understandings, Applications and Skills

	Statement	Guidance
9.1.U1	Transpiration is the inevitable consequence of gas exchange in the leaf.	
9.1.U2	Plants transport water from the roots to the leaves to replace losses from transpiration.	
9.1.U3	The cohesive property of water and the structure of the xylem vessels allow transport under tension.	
9.1.U4	The adhesive property of water and evaporation generate tension forces in leaf cell walls.	
9.1.U5	Active uptake of mineral ions in the roots causes absorption of water by osmosis.	
9.1.A1	Adaptations of plants in deserts and in saline soils for water conservation.	
9.1.A2	Models of water transport in xylem using simple apparatus including blotting or filter paper, porous pots and capillary tubing.	
9.1.S1	Drawing the structure of primary xylem vessels in sections of stems based on microscope images.	
9.1.S2	Measurement of transpiration rates using potometers. (Practical 7)	
9.1.S3	Design of an experiment to test hypotheses about the effect of temperature or humidity on transpiration rates.	

9.1.U1 Transpiration is the inevitable consequence of gas exchange in the leaf

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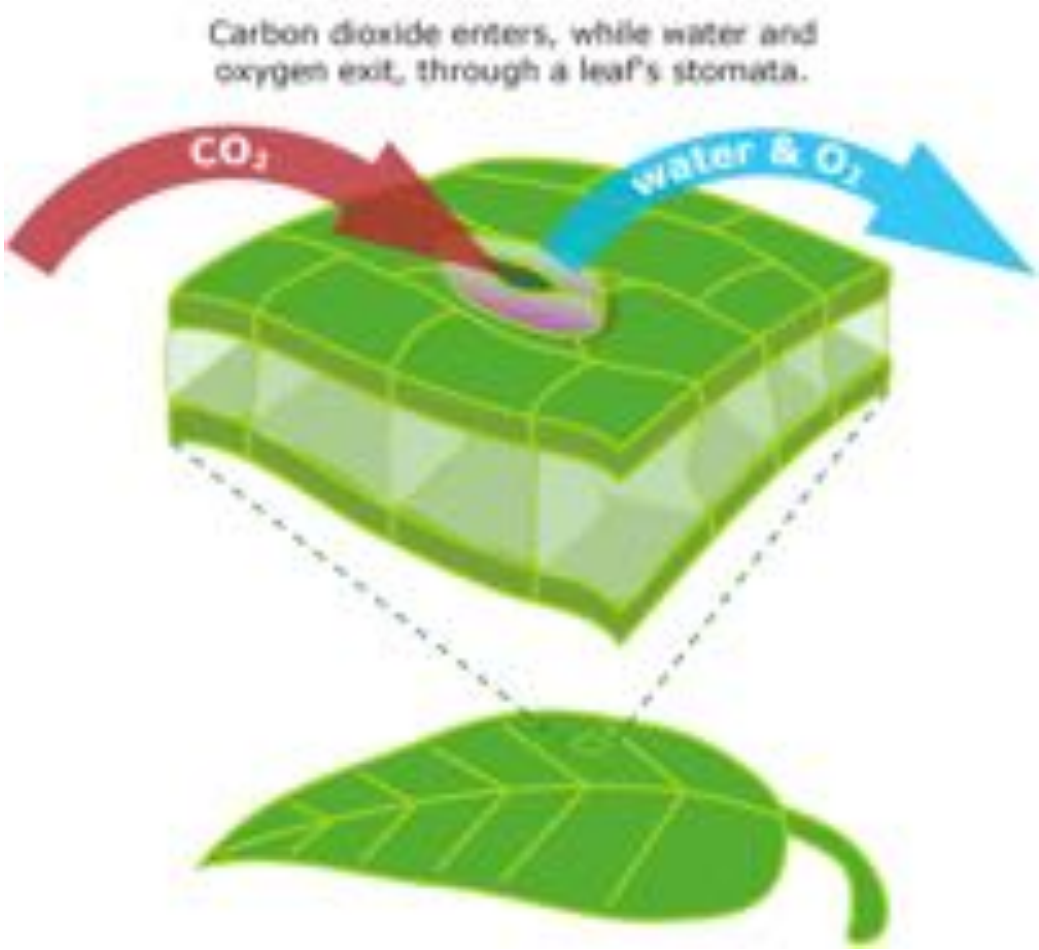
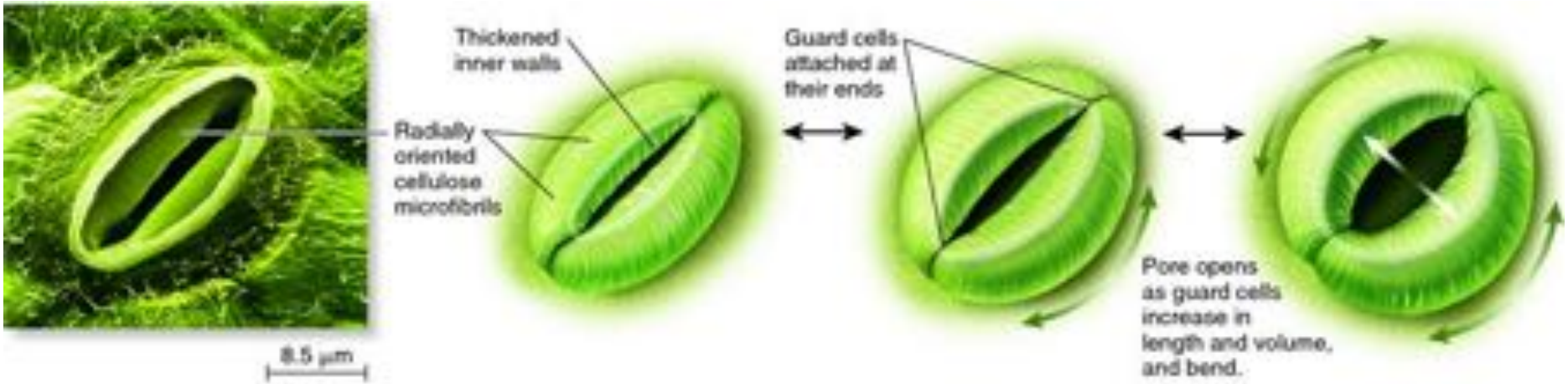
- Exchange of H2O and CO2 gas is essential to photsynthesis

- Transpiration is loss of water vapor from stems and leaves

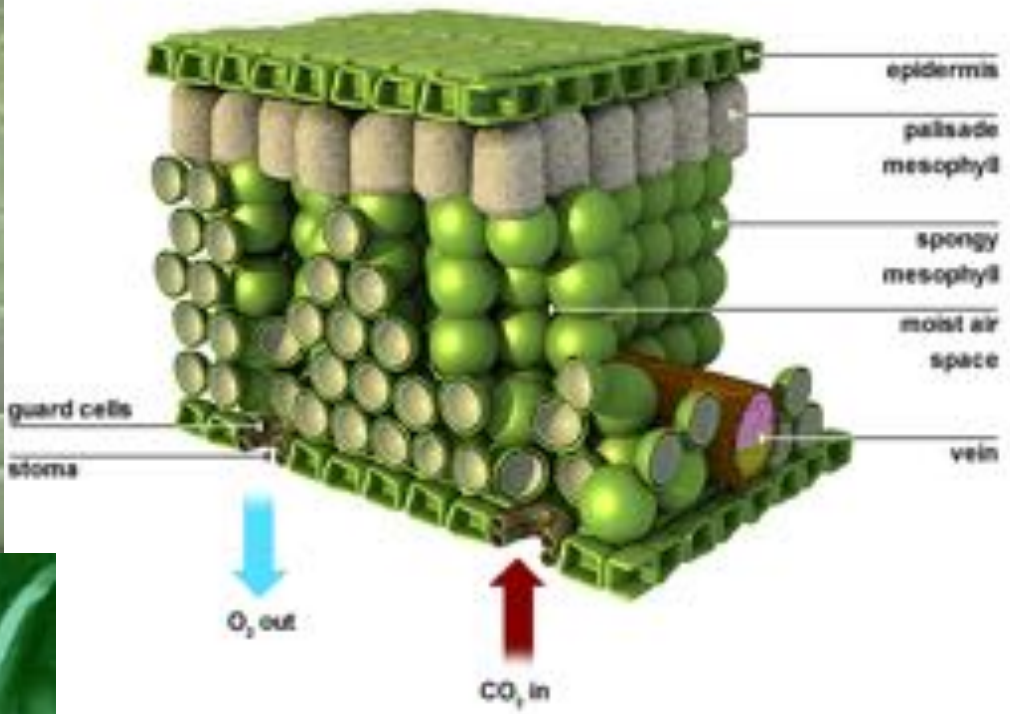


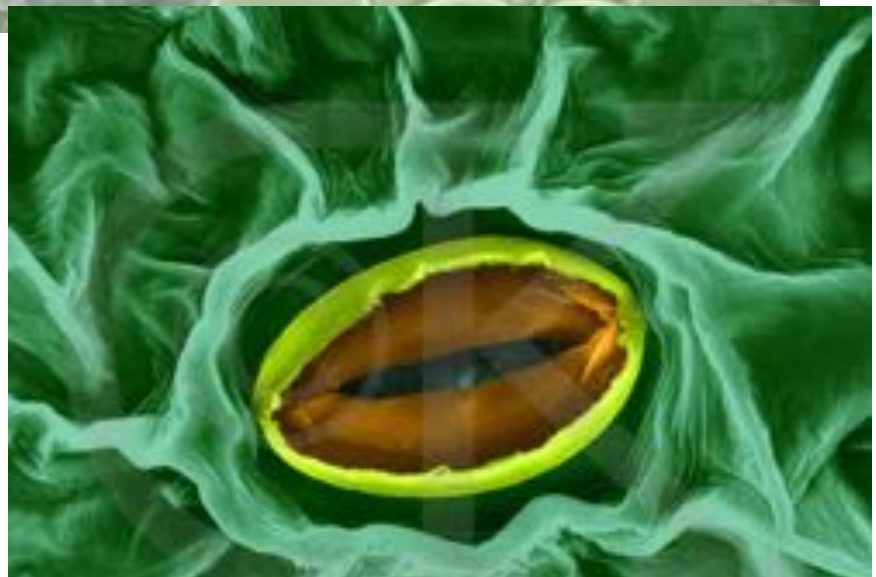
9.1.U1 Transpiration is the inevitable consequence of gas exchange in the leaf

- Stomata are pores in leaves
- 2 Guard cells surround each stomata and control the size of the opening
- Epidermis has waxy cuticle impermeable to water
- When water loss is severe guard cells are triggered to close



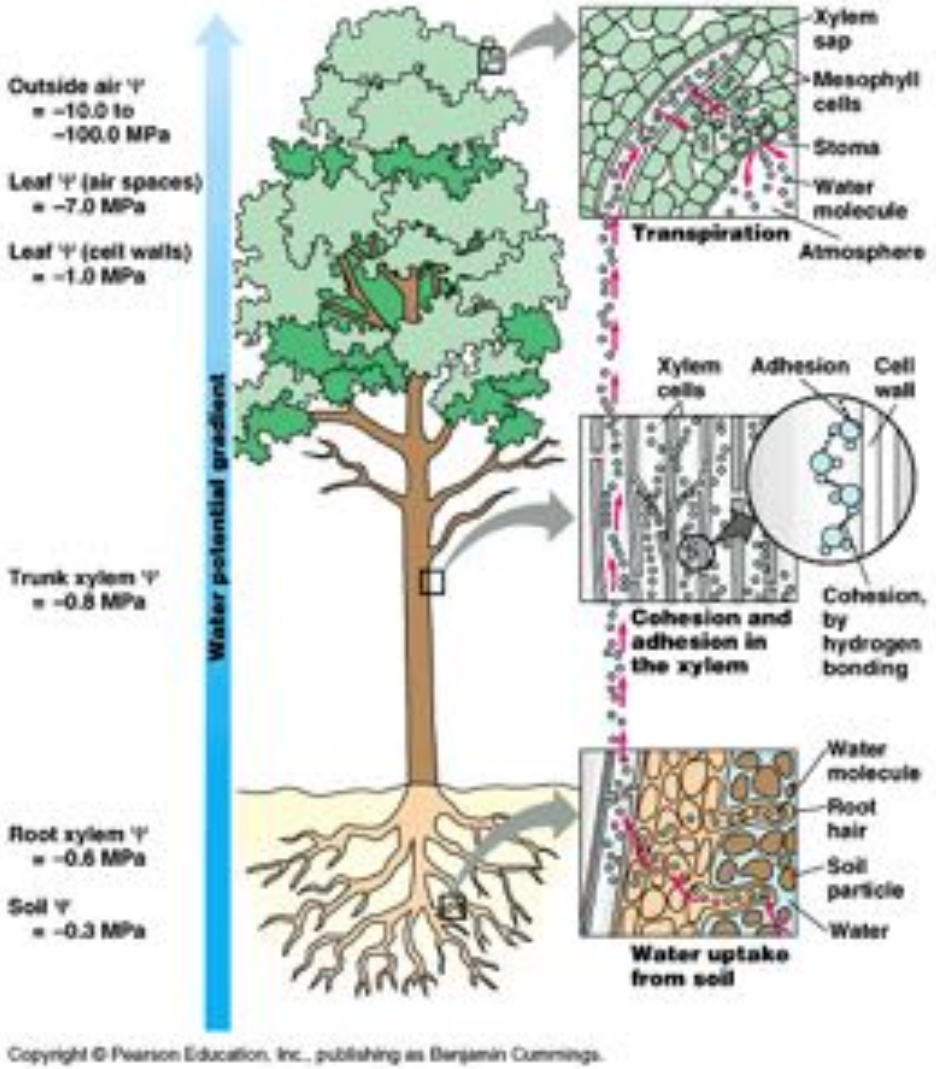
Leaf mesophyll cells and stomata





9.1.U2 Plants transport water from the roots to the leaves to replace losses from transpiration

- Water loss from leaf to air draws new water vapor from spongy mesophyll
- Water from mesophyll draws water up from the xylem by cohesion

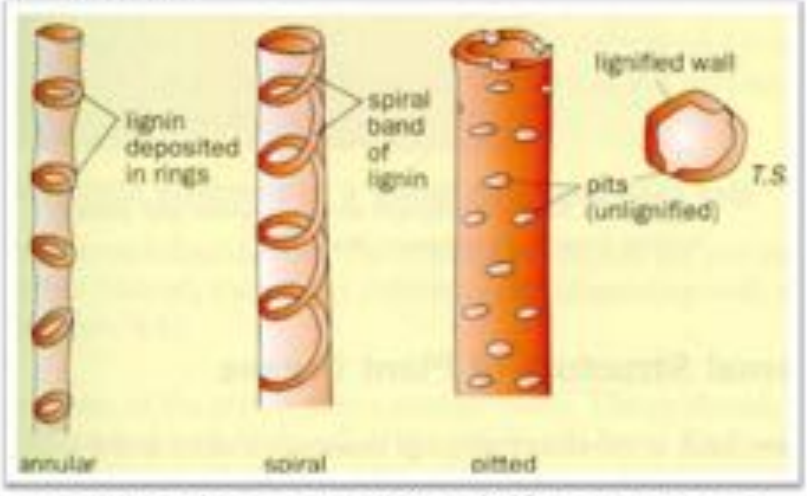


9.1.U3 The cohesive property of water and the structure of the xylem vessels allow transport under tension

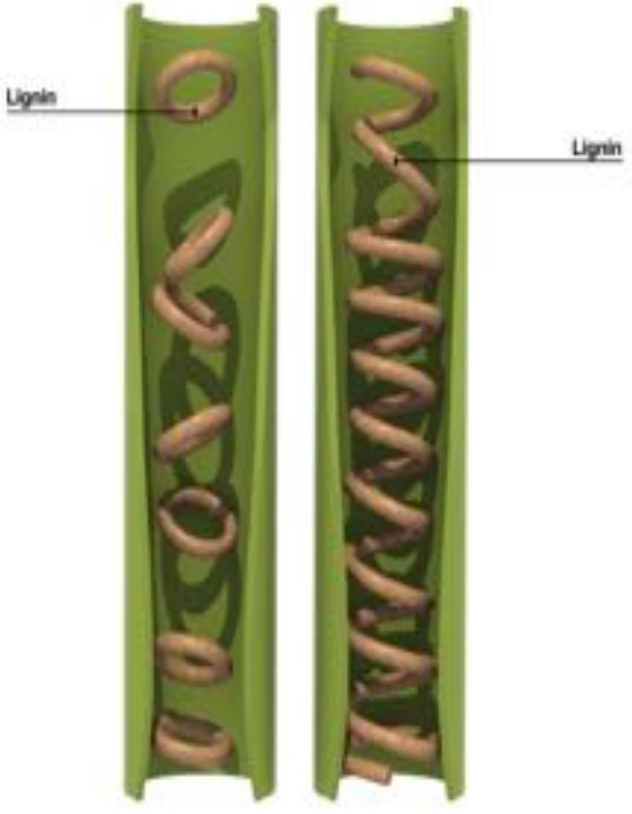
- Thin xylem tubes with thick cell walls and lignin rings aid in water transport

Lignin

- Hard and rigid substance
- Named after the latin word "Lignum", which means "Wood"



- Lignin maybe deposited in different ways, giving rise to annular, spiral or pitted xylem vessels

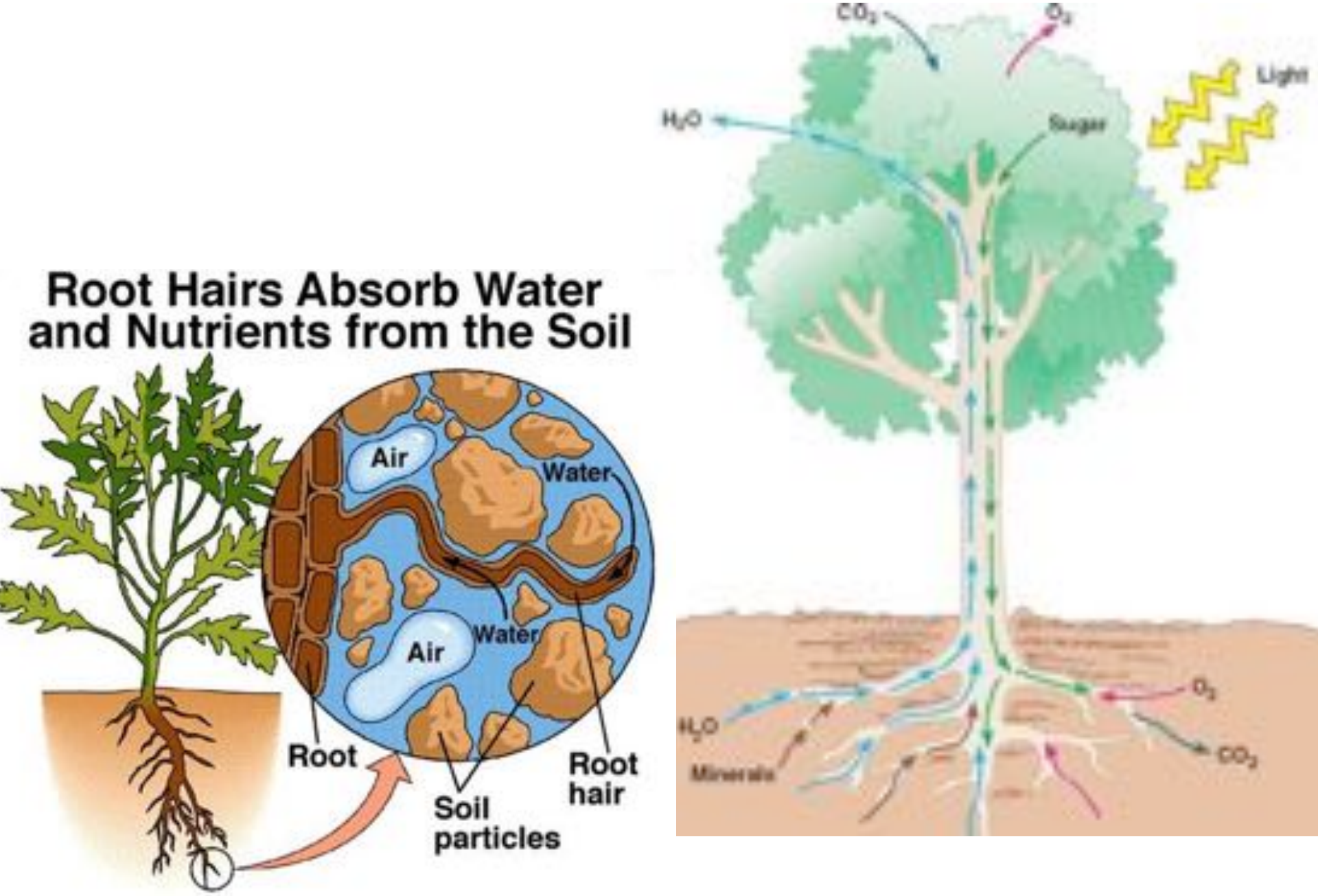


9.1.U4 Adhesive property of water and evaporation generate tension forces in leaf cells

- The loss of water from the top of xylem vessels due to **evaporation** lowers the pressure inside the vessel and pulls more water into the vessel due to **cohesion**
- **Adhesion** attracts water molecules to the walls of xylem and vice versa.
- Therefore as the water moving upwards (similarly to cohesion) it pulls inward on the walls of the xylem vessels generating **tension -** try sucking on a straw when the bottom end is closed.

9.1.U5 Active uptake of mineral ions in the roots causes absorption of water by osmosis

- For osmosis to occur there must be a higher concentration of solutes inside the cell than in the soil water surrounding the roots.
- A high concentration of solutes (loaded actively with ATP) in the root cells, means water will move passively (osmosis) down the concentration gradient and enter the root hair cells.


Root Hairs Absorb Water and Nutrients from the Soil
Air
Water
Air
Water
Root
Soil particles
Root hair
CO_2
O_2
Light
H_2O
Sugar
H_2O
Minerals
O_2
CO_2

9.1.U5 Active uptake of mineral ions in the roots causes absorption of water by osmosis

- Plants take up water and essential minerals via their roots and thus need a large surface area to optimize uptake

- Fungi can increase surface area dramatically

9.1.A1 Adaptations of plants in deserts and in saline soils for water conservation

- Waxy leaves: both upper and lower epidermis has thick waxy cuticle
- Needles: reduced leaf surface area
- Rolled leaves: reduces affects of wind on transpiration