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| At the end of this section you should be able to ....... |
| 3.3.1 Explain the Autotrophic nature of plants |
| 3.3.1 Describe the uptake and process of transport of the following through the plant:   * Water: to include reference to root hairs, root cortex, xylem, osmosis, diffusion, root pressure, transpiration, and stomata * Minerals: to include solubility in water, transport from the roots to all parts of the plant by the same route as water * Carbon dioxide: directly from respiring cells or through stomata * Photosynthetic products: production of carbohydrate and transport through phloem sieve tube cells |
| **3.3.2 Modified plant food storage**  Give one example of a root, stem and leaf modification as a food storage organ |
| **H.3.3.7 Cohesion-Tension Model of Xylem Transport**  Explain the work of Dixon and Joly : Cohesion-  The cohesion-tension model explains how water is transported in plants to extreme heights against the force of gravity. |

**Key Words**

**osmosis, diffusion, active transport, root pressure, cuticle, stomata, cohesion, adhesion, transpiration stream,**

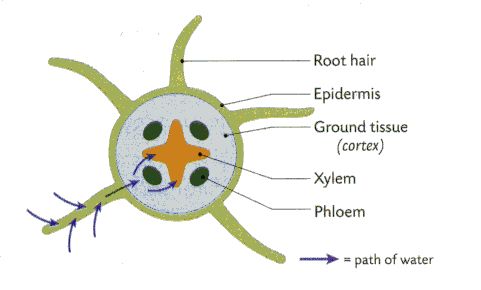
**Nutrition in the flowering plant - Summary**

**Autotrophs**: Plants are Autotrophs.They make their own food by a process called photosynthesis.

**Photosynthesis**

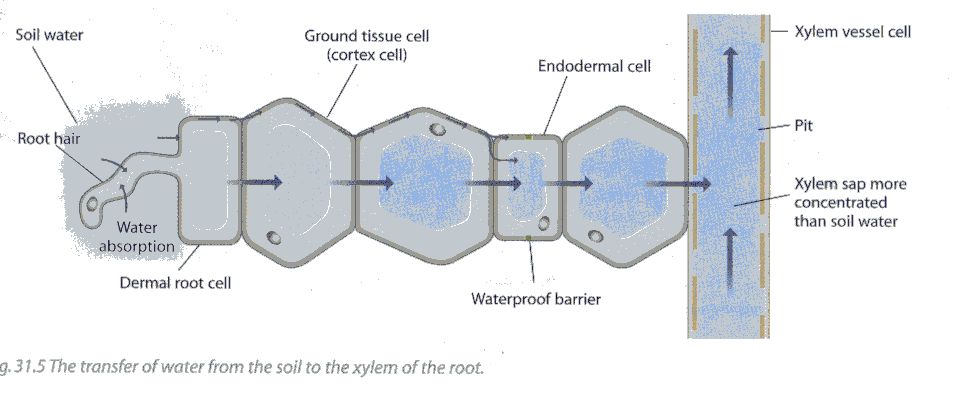
* Plants need light, chlorophyll, carbon dioxide and water to make food.
* Oxygen gas is released.

In order to carry out metabolism (e.g. photosynthesis, respiration), growth and reproduction, plants require **1. water, 2. carbon dioxide,** and **3. minerals.**

1. **Water**

* Plants absorb water through their roots
* Roots contain numerous root hairs.
* Root hairs are found in the zone of differentiation
* Root hairs have thin walls not covered by a cuticle.
* The cell wall and cell membrane of young roots are permeable to water
* The large number of root hairs increase the surface area available for absorption.
* Absorption of water into the root hairs takes place by **Osmosis**

**Osmosis is the diffusion of water from a region of higher water concentration to a region of lower water concentration across a selectively permeable membrane.**

* Soil water is very dilute i.e. has a high water concentration
* Root hair cells have a low water concentration.
* Therefore water moves from the soil into the root hairs by osmosis
* Water diffuses from cell to cell across the ground tissue until it reaches the xylem.
* Xylem vessels now form the route for the transport of water to all parts of the plant.
* Xylem vessels form a continuous hollow pipeline from roots to leaves.

**Movement of water in the xylem**

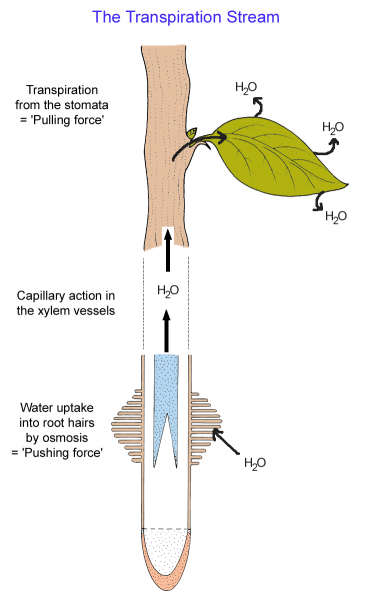
The upward movement of water in the xylem is helped by a combination of **Root pressure** and **Transpiration.**

* **Root Pressure**

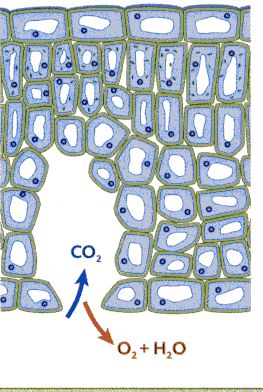
The transport of water up through the xylem is helped by **root pressure. This pressure is created** by water entering the root cells by osmosis which pushes the water up the xylem.

However this pressure while strong enough to push water as high as 20 m would not be strong enough to push water to the top of the tallest trees which can be over 100m tall.

* **Transpiration**

**Transpiration is the evaporation of water from the surface of a plant.** Most transpiration takes place through openings on the underside of the leaf - stomata

* When water evaporates from the cells in the leaf (transpiration), the cells become less turgid and more concentrated.
* This creates an osmotic gradient (change in concentration)
* This osmotic gradient causes the water to move from the xylem cells out to these cells in the leaf.
* This in turn causes water from the soil to flow into the root and enter the xylem at the centre of the root.
* Water lost from the top is replaced by water in the soil and this creates a stream of water to move upwards.
* This is known as the **Transpiration stream**

The loss of water from the leaves is controlled by **cuticle** and by **stomata.**

cuticle

**Cuticle:**

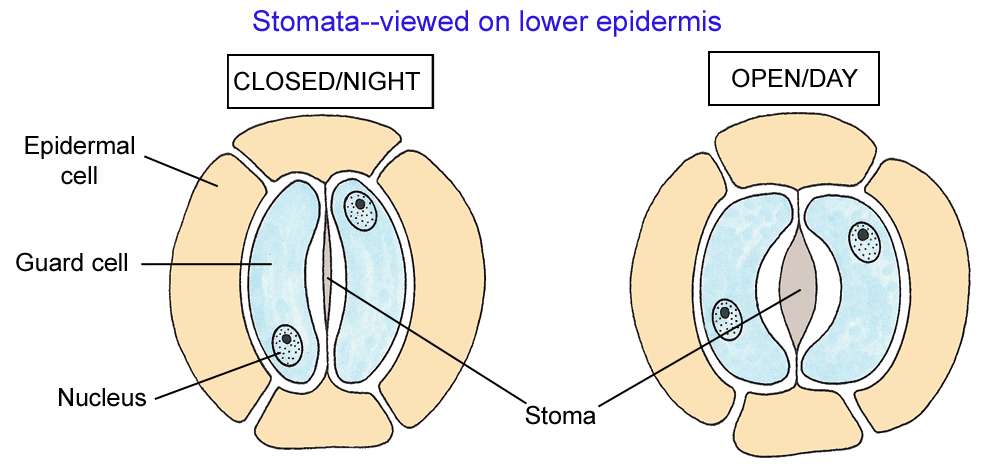
* A waxy covering on the dermal layer of leaves which reduces water loss (transpiration)

**Stomata**

* Openings on undersurface (lower dermal) of leaves
* Controlled by guard cells
* Normally closed at night - no photosynthesis
* Open by day – to allow exchange of gases

stomata

If water is in short supply the stomata can remain shut to conserve water.



**SOD:** Stomata Open Day

**2. Carbon Dioxide**

There are two sources of carbon dioxide for photosynthesis

* Produced in the leaf cells by respiration.
* From the atmosphere through stomata.
* Carbon dioxide enters through the stomata
* It diffuses through the air spaces in the ground layer

**3. Minerals**

* Minerals required by the plant exist in the soil dissolved in water**.**
* They are transported from the roots to all parts of the plant by the same **route** as water.
* Only water enters by osmosis
* Minerals enter the root hairs by **active transport** i.e. energy is required to pump the minerals in.

**Photosynthetic products:**

The products of photosynthesis are **oxygen gas and glucose**

**Oxygen gas** – released through the stomata

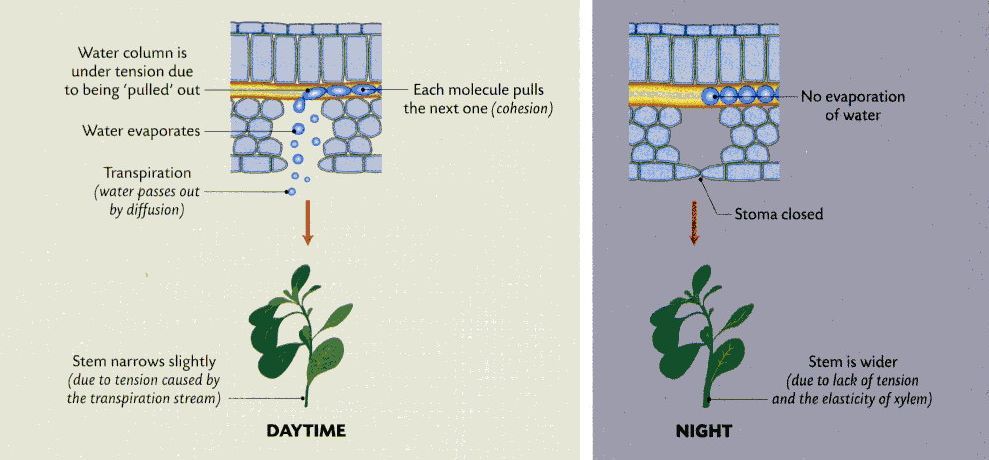
**Glucose** can be either**: 1.** used as energy **2.** converted to starch and stored in the leaves or **3.** converted to sucrose and transported through phloem sieve tube cells to all parts of the plant for storage as starch or used in respiration

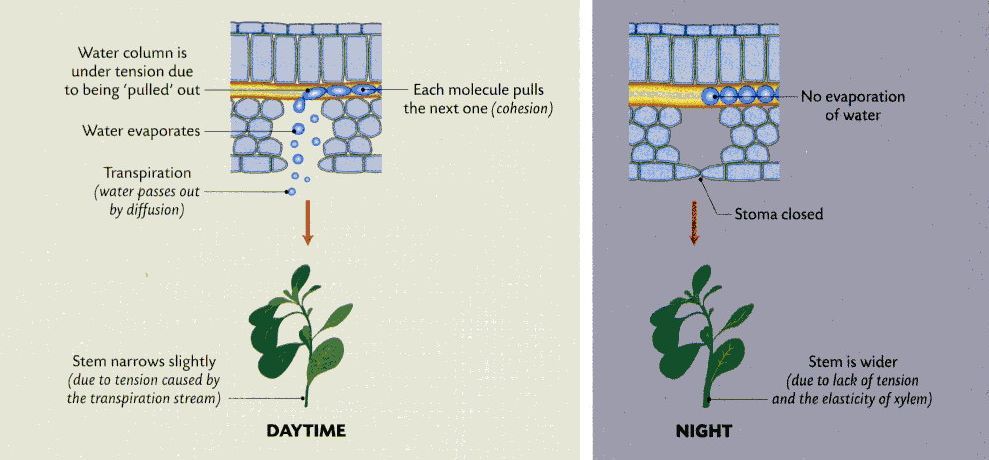
**H.3.3.7 Cohesion-tension model**

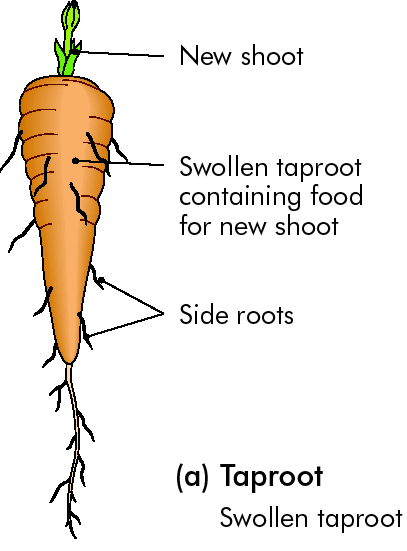
* The cohesion-tension model explains how water is transported in plants to extreme heights against the force of gravity.
* Theory first put forward by two Irish scientists **Dixon and Joly** working in TCD in 1895.

**Cohesion:** Is the attractive forces between the water molecules

**Adhesion**: Is the ability of different molecules to stick together

**How the cohesion-tension model works**

* Water evaporates from the xylem into the air spaces of the leaves and out through stomata (Transpiration)
* As transpiration pulls each water molecule out of the xylem, the next water molecule is pulled with it due to high **cohesion.**
* Water molecules also **adhere (stick)** to the walls of the xylem vessels.
* Provided there is a continuous column of water in the xylem tube, this pull is transmitted through the water right down the stem to the root.
* When water molecules are pulled in this way the entire column of water in the xylem is stretched and the water is said to be under tension.
* Transpiration causes this tension.
* The cohesive forces can hold water in a column without breaking when this tension is applied.
* This tension can pull a column of water in xylem tubes of very small diameter up to great heights
* During the day transpiration occurs and the stomata are open.
* The tension causes xylem to become narrower and so stems are slightly narrower by day.
* To prevent the xylem vessels collapsing inwards the xylem walls are strengthened with **lignin.**
* At night when transpiration stops the xylem become slightly wider.

**3.3.2 Modified plant storage organs Summary**

**(a) Root modification**

In some plants e.g. dicots, the first root grows straight down to form the main root of the plant.

This root may become fleshy and modified to store food.

Example: carrot

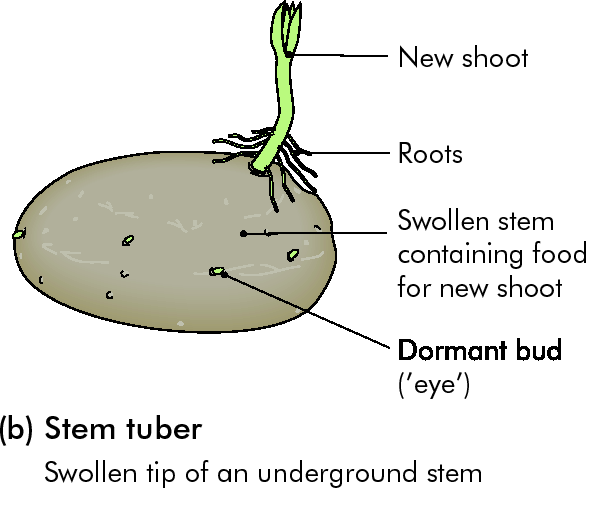
Sugar is the food reserve.

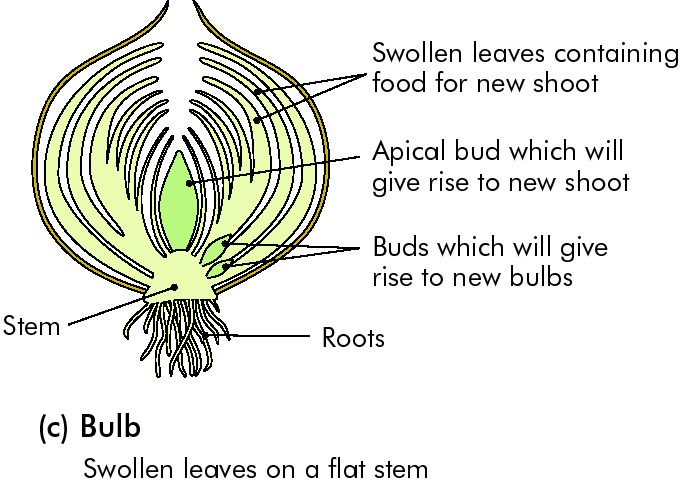
**(b) Stem modification**

A tuber is a modified stem that functions in the storage of food e.g. potatoes

A Potato tuber is easily identified as a stem as it contains leaves and buds**.**

Starch is the food reserve





**( c ) Modified leaves**

Leaves can be modified for food storage e.g. onion bulbs

Sugar is the reserve food.