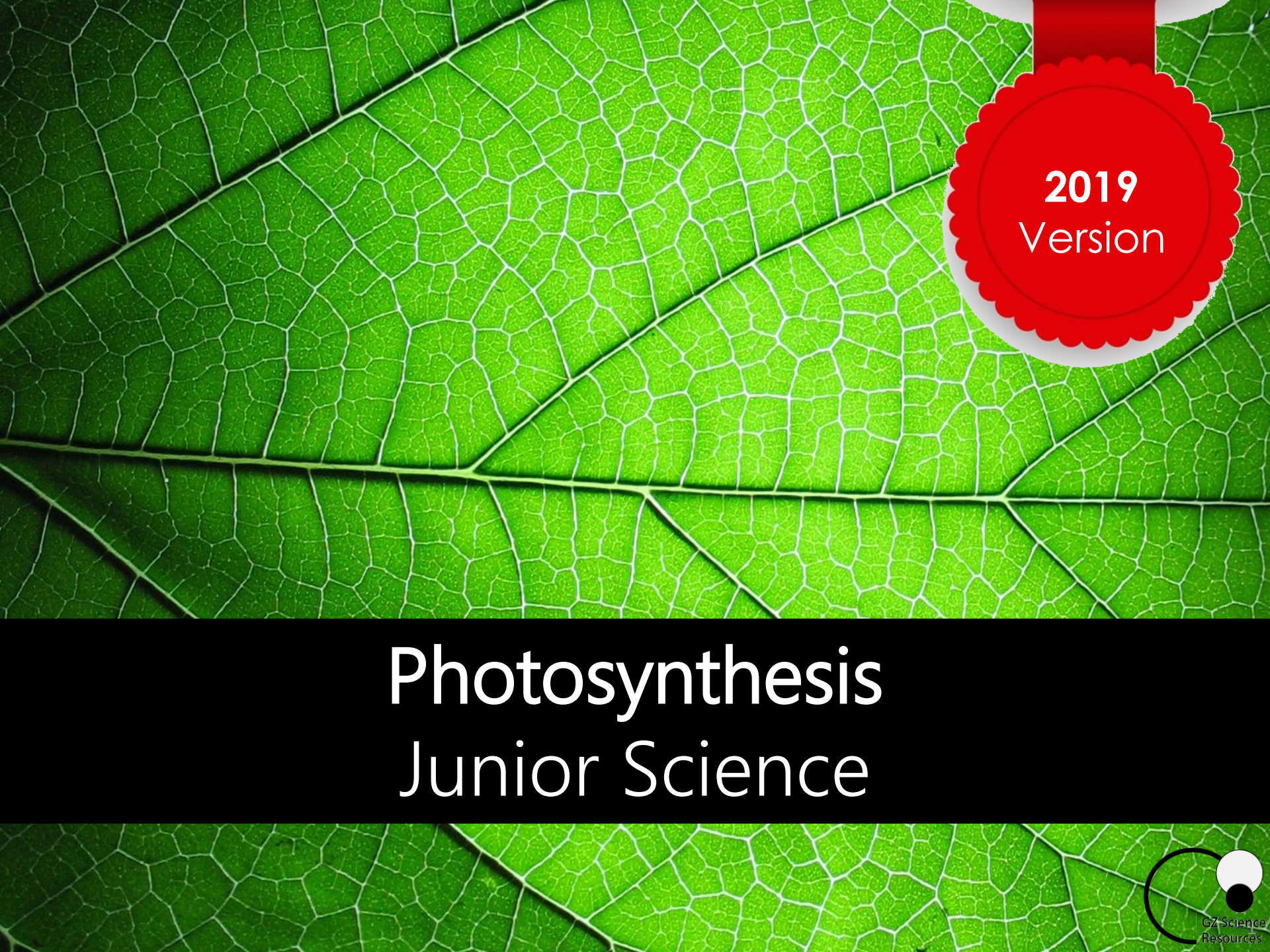


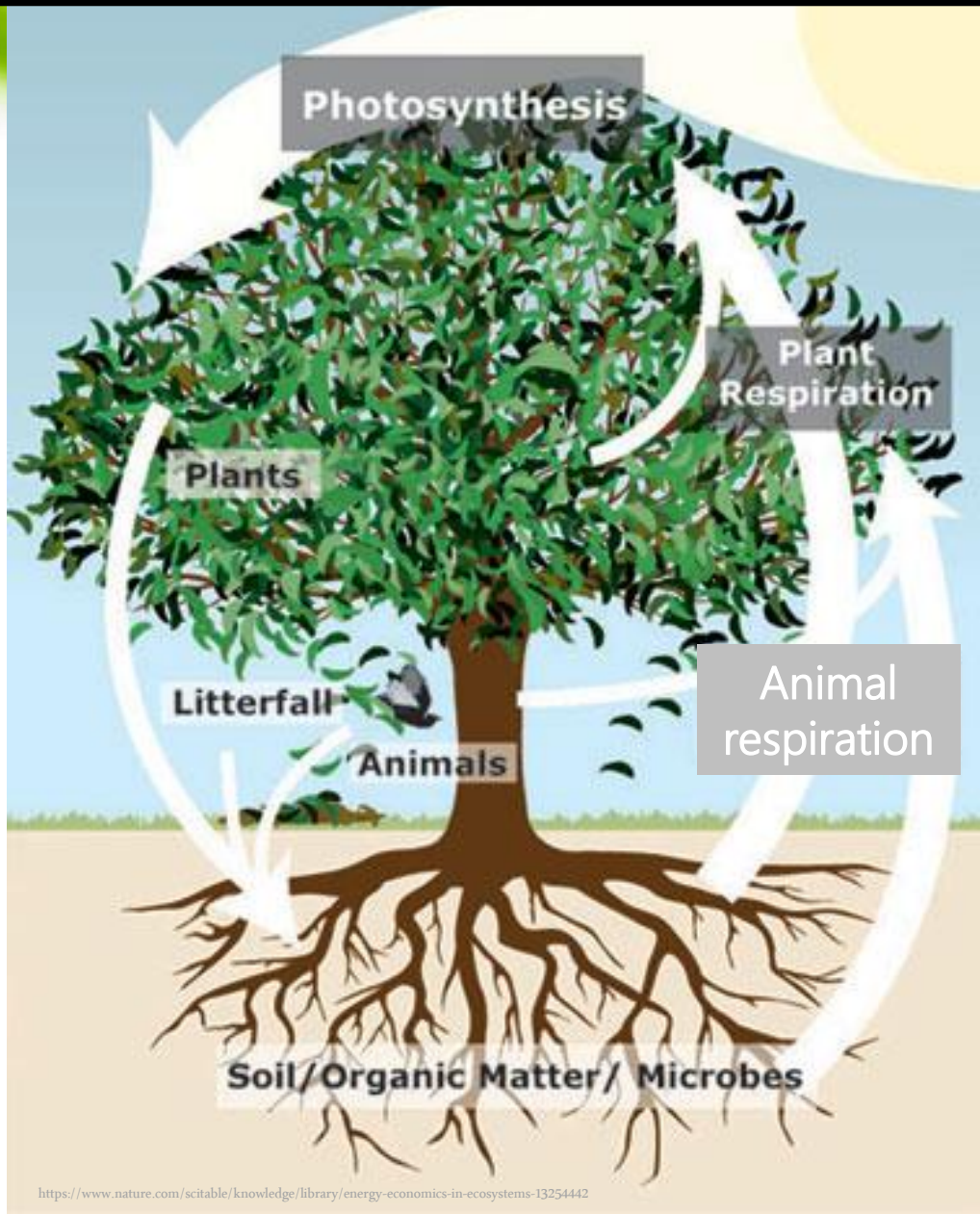
Photosynthesis
Junior Science

GZ Science Resources

Plants fill the role of Producers in a community

Plants are special because they have leaves and are able to produce their own food by the process of **photosynthesis** from sunlight using raw materials that they get from the air and soil.
Plants can be thought of as 'food factories' which provide most living organisms on Earth with a source of energy and food.
They produce the energy that is at the start of any food chain and therefore the group of plants are known as **Producers**.

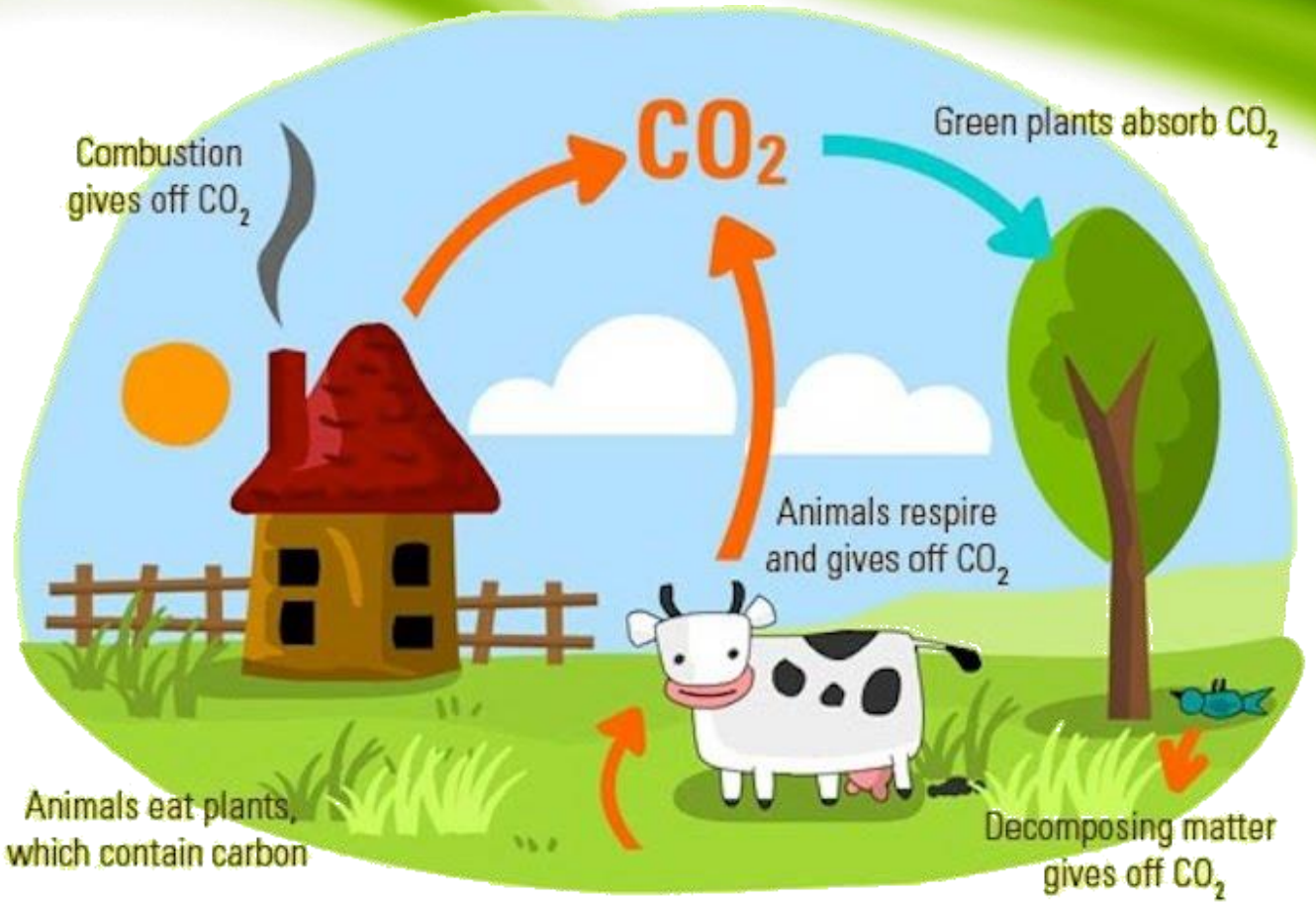
Community – a group of different species living together and interacting



extra info

Plants absorb carbon dioxide

Plants absorb **carbon dioxide** (CO_2) during the process of photosynthesis. They also release oxygen. Without plants the oxygen levels on Earth would soon become too low for most life and the build up of CO_2 would cause rapid heating of the Earth and also be toxic for most life.



Combustion – burning fuel in oxygen to release carbon dioxide
Respire – break down food in living cells to release energy and carbon dioxide

The structure and functions of the plant

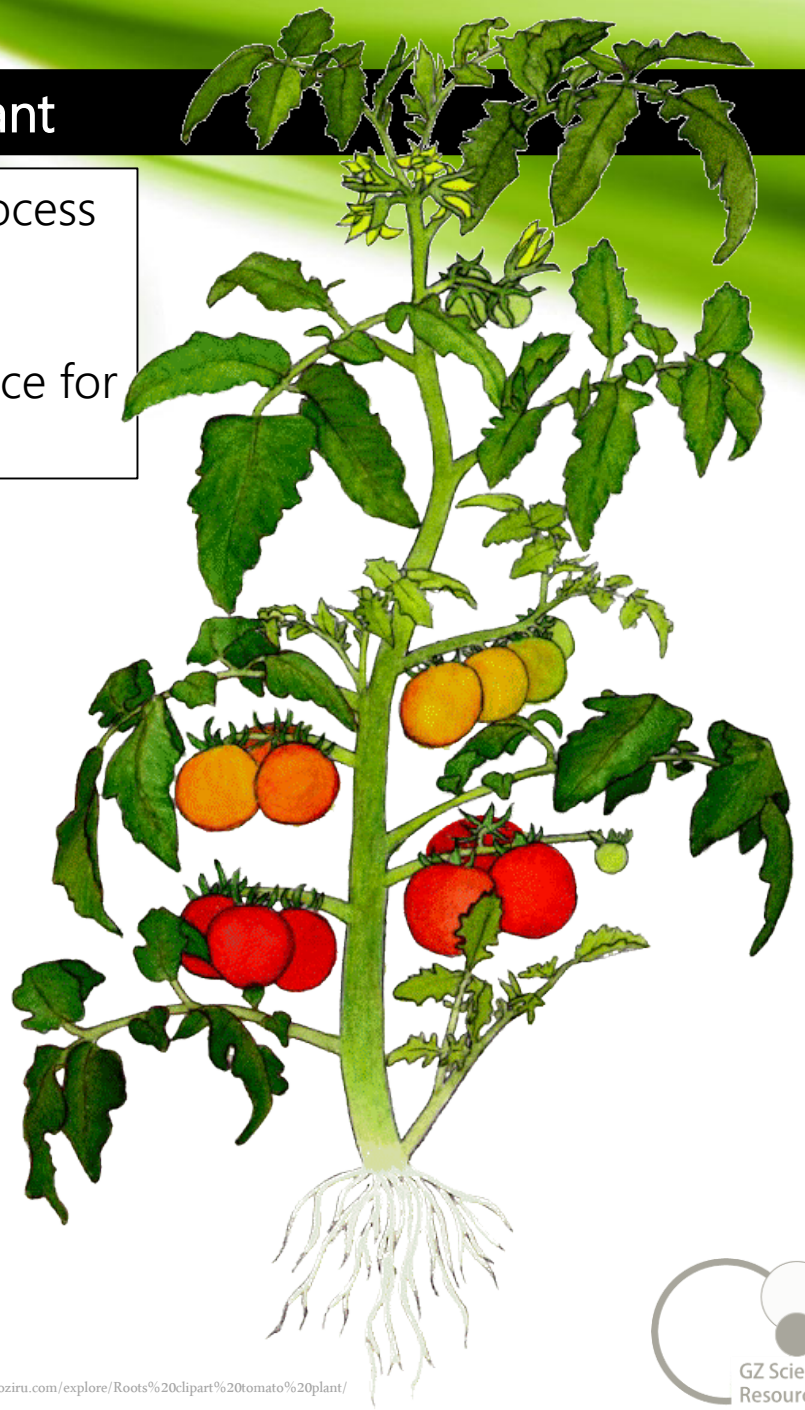
Many parts of the plant are involved with the process of photosynthesis, either by helping collect the substances needed (roots, stem, leaves), storing products formed (roots, stem) or providing a place for the process to take place (leaf cells).

The Shoot System

Above ground (usually)
Lifts the plant above the soil
Main functions include:
Leaves - photosynthesis
Flowers - reproduction
Fruit – seed dispersal
Stem - food and **water transport**

The Root System

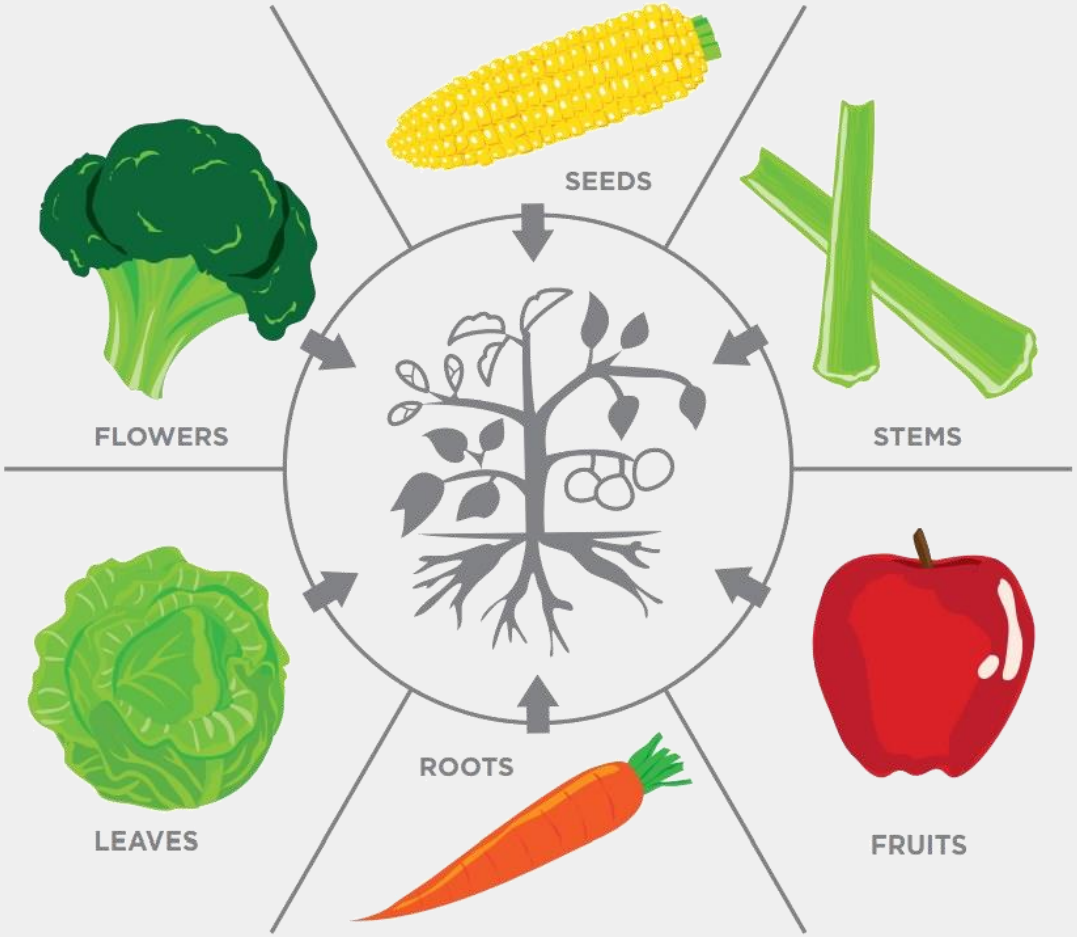
Underground (usually)
Anchor the plant in the soil
Main functions include:
Absorb water and nutrients
Transport water and nutrients
Food Storage



http://moziru.com/explore/Roots%20clipart%20tomato%20plant/

Background Knowledge

Parts of a plant we eat



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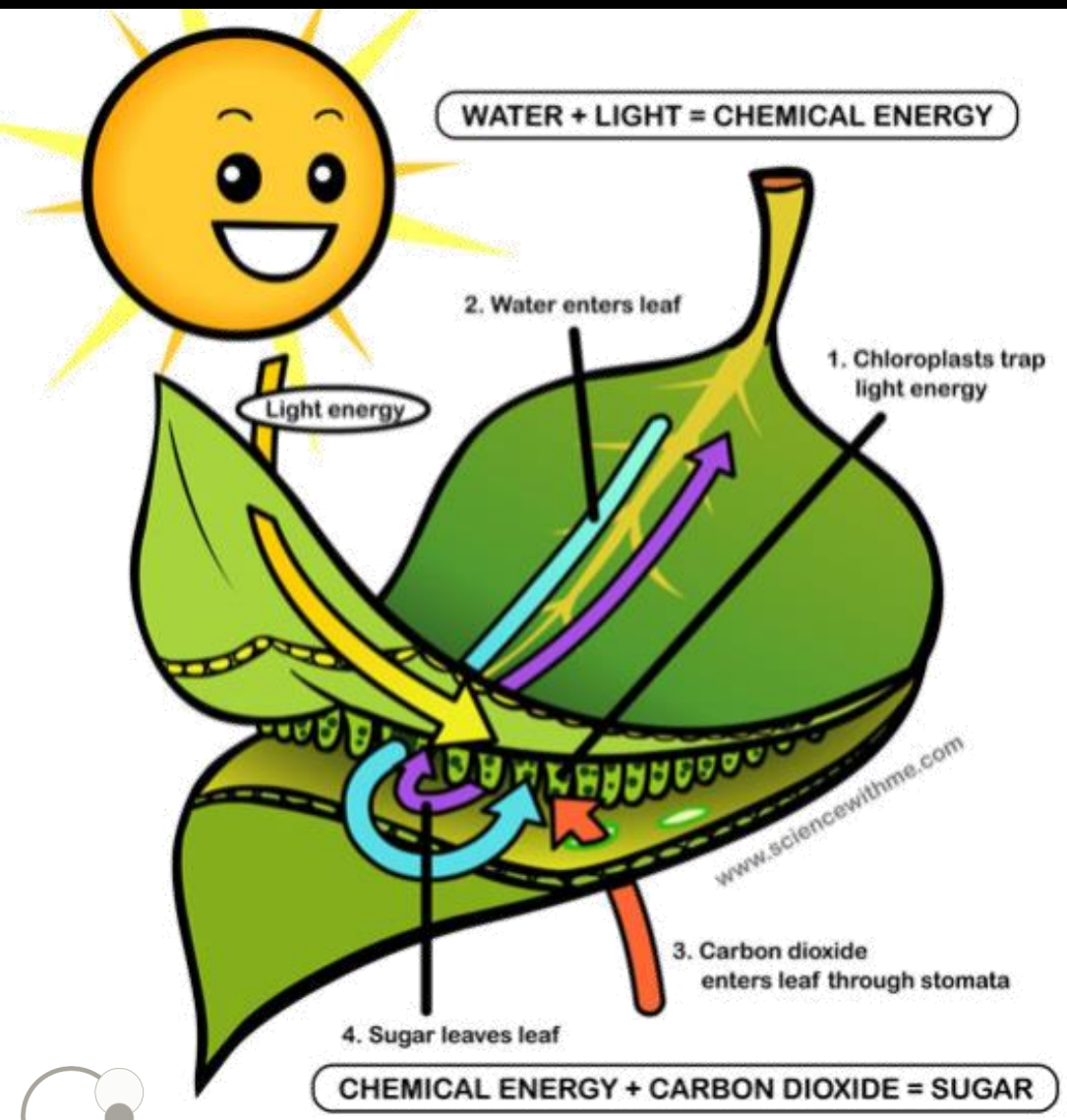
We use many types of plants for food. The fruit and vegetables that we eat, and grow for eating, come from various parts of the plant. We often breed types of plant for food by **exaggerating** a part of a plant, such as flowers of the plant to grow broccoli, to make better use of them.

https://www.scienceworld.ca/resources/units/plants-we-eat

Photosynthesis transfers energy from sunlight into energy in chemicals such as glucose and starch.



Light enters the leaf and is trapped by a green substance called chlorophyll contained within structures called the chloroplasts in the cells.

Water is transported via water tube cells to the leaf cell and the **carbon dioxide** enters through the stomata and diffuses (spreads) to the leaf cells.

These substances react chemically within the chloroplasts, powered by the light then **glucose** (a sugar) is produced along with **oxygen** which diffuses out. The sugar leaves the leaf via sugar/food tube cells.

Reactants and products of photosynthesis

The photosynthesis reaction can be written as a chemical equation with the reactants needed on the left and the products produced on the right

light

Carbon dioxide + Water → Glucose + Oxygen

Word equation

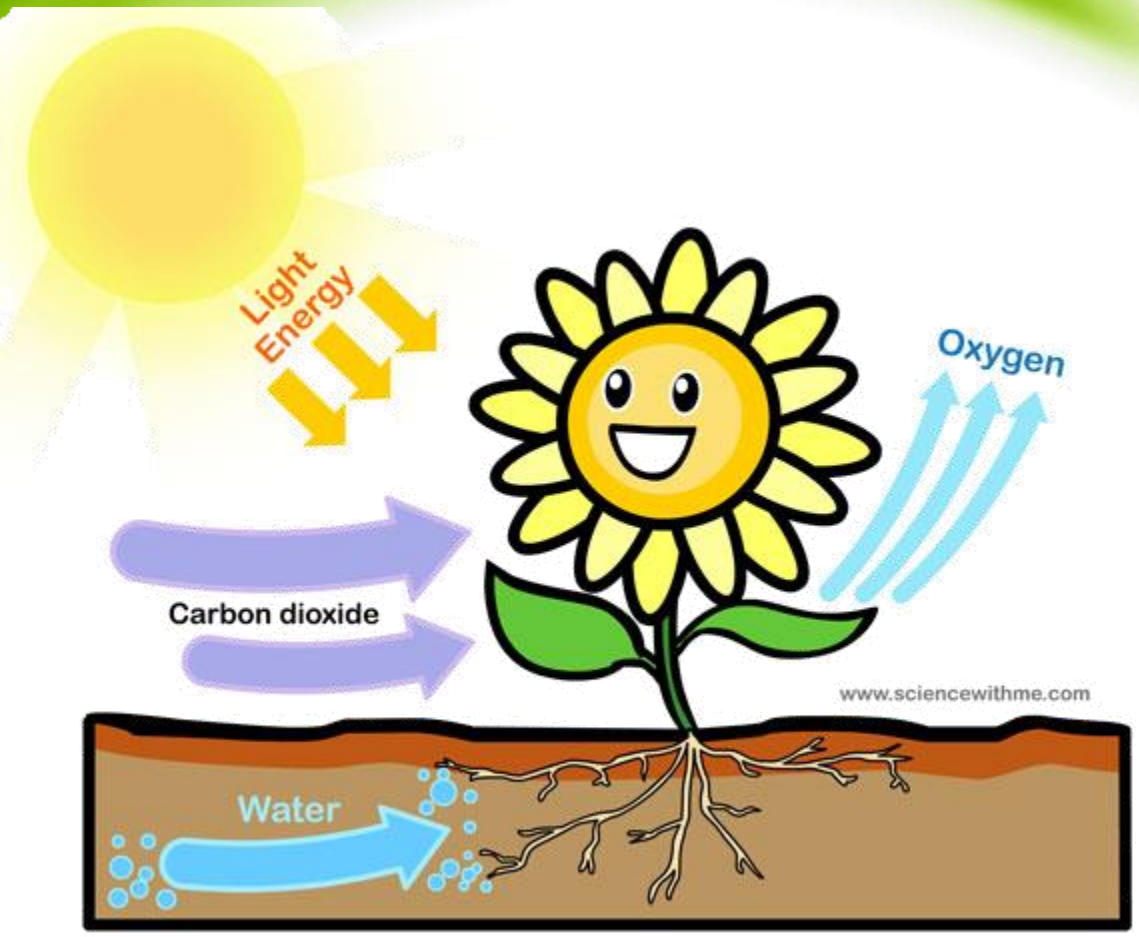
light

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Balanced Formula equation

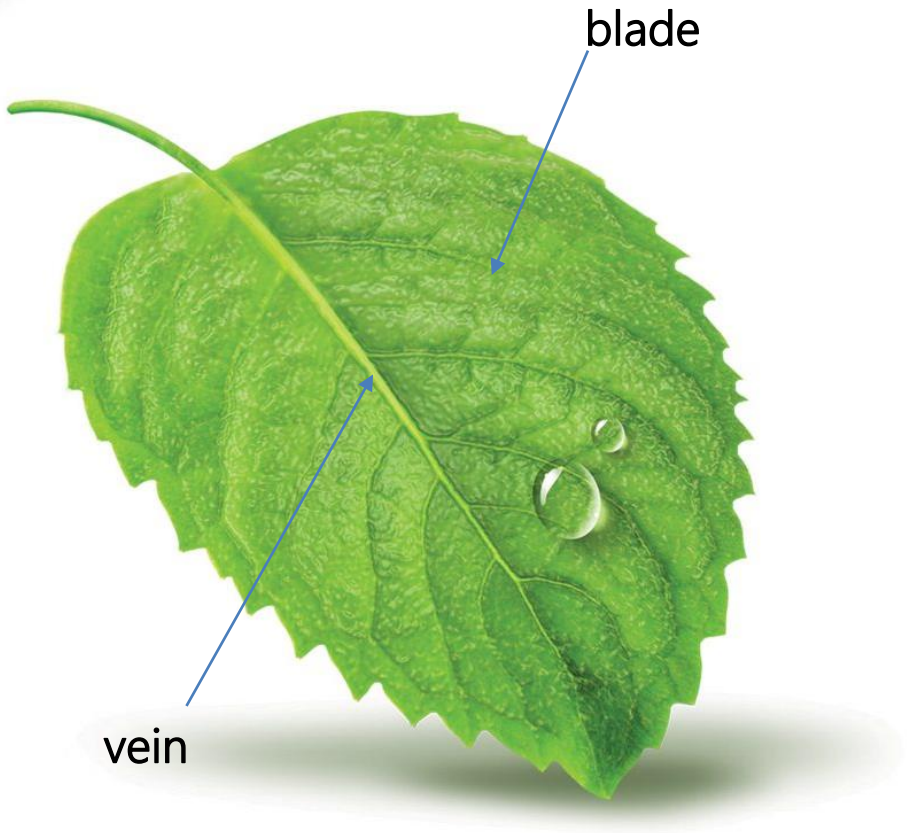
extra info

The significance of photosynthesis in making food



Most living organisms depend on plants to survive. Plants convert (change) energy from sunlight into food stored as carbohydrates through **photosynthesis**. Because animals cannot make their own food they must eat plants (producers) to gain nutrition. Plants produce oxygen, which is released during photosynthesis, which all organisms need for **respiration**.

The leaf is the location of most photosynthesis



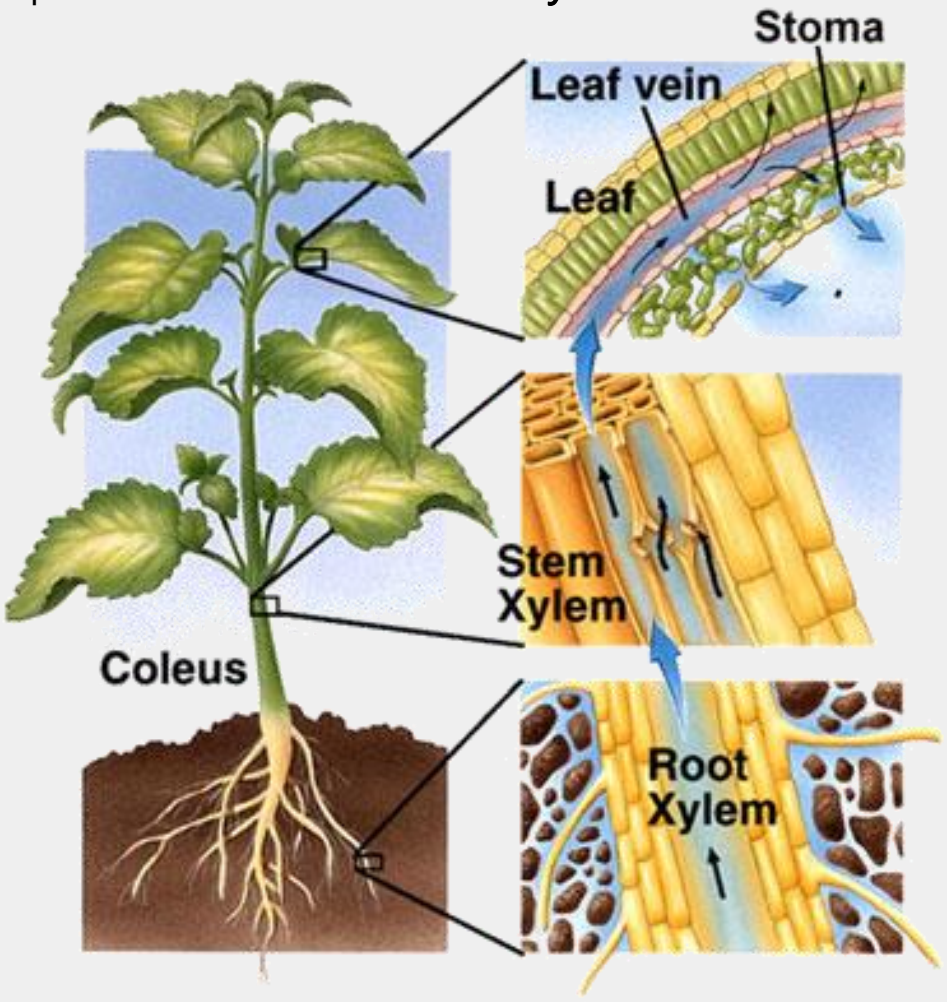
The flat surface of the leaf called the **blade** helps capture maximum sunlight for **photosynthesis**.
The leaf is attached by a stem-like petiole to the plant which branch out into veins. Inside these are cells forming a tube to **transport** water to the leaf cells, which they require for photosynthesis and to keep the leaf cells upright. The veins also contain cells forming a tube which are able to transport the sugars and starch which sugar is changed into, produced during photosynthesis, and send it away to other parts of the plant for use and storage.

Background Knowledge

Water movement through a plant

extra info

Water is required for photosynthesis and it move through the plant in **one direction only**.



Step three: water moves out of the plant by <u>transpiration</u> through the <u>stomata</u> on the underside of the leaf

Step two: water moves up through the <u>xylem</u> by molecules "sticking" together and being pulled upwards

Step one: Water uptake by the process of <u>osmosis</u> into the root hairs

Background Knowledge

Water movement - Plants take up water through root hairs

extra info

STEP ONE: Water moves into the plant through root hairs. Water being pulled up the plants water tubes (xylem) due to transpiration decreases the pressure inside the root hair cells and this reduced pressure pulls water in.

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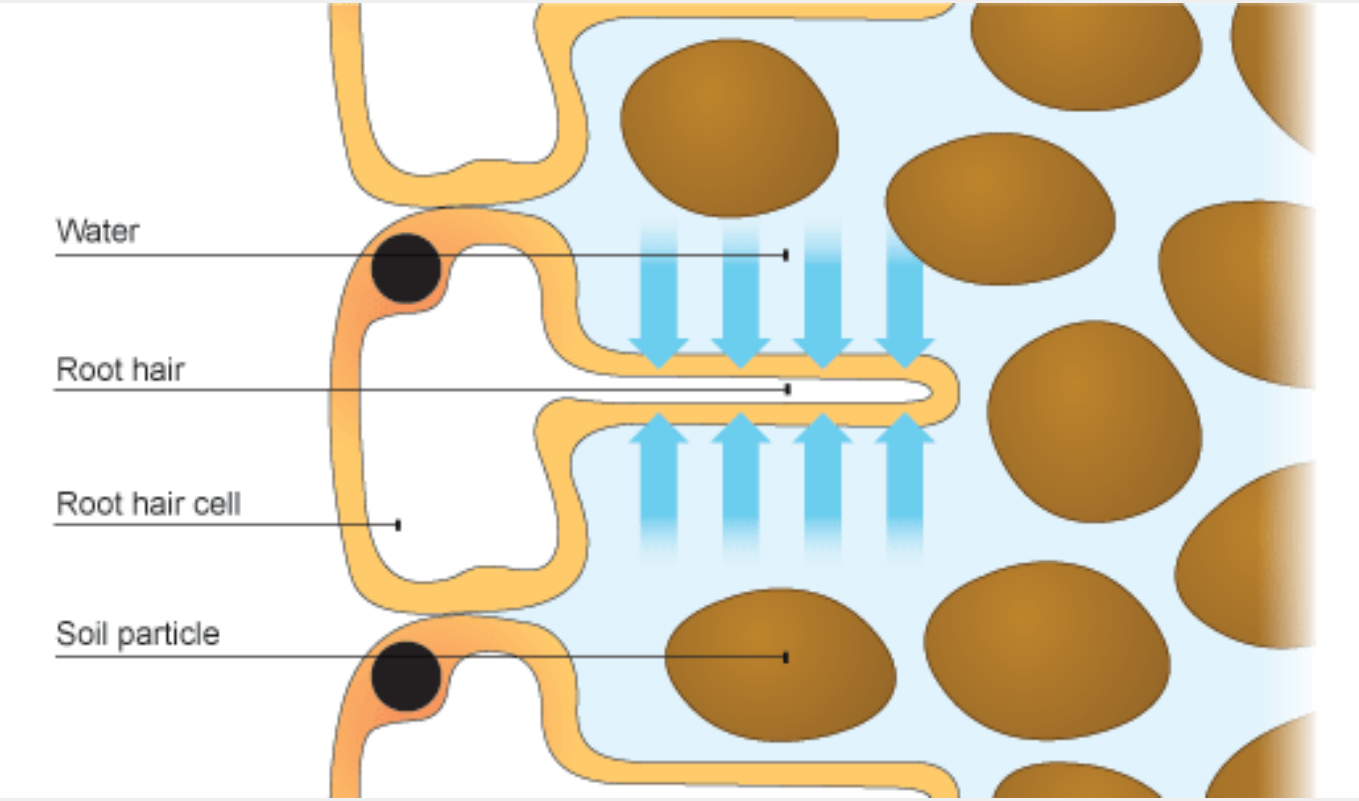
Transpiration – water loss through the leaf stomata (holes in the leaf) due to evaporation



Background Knowledge

Osmosis is the diffusion of water molecules through a partially permeable membrane

Water moves into the root hairs by **osmosis.** **Partly permeable** means some particles can move through like water.

extra info

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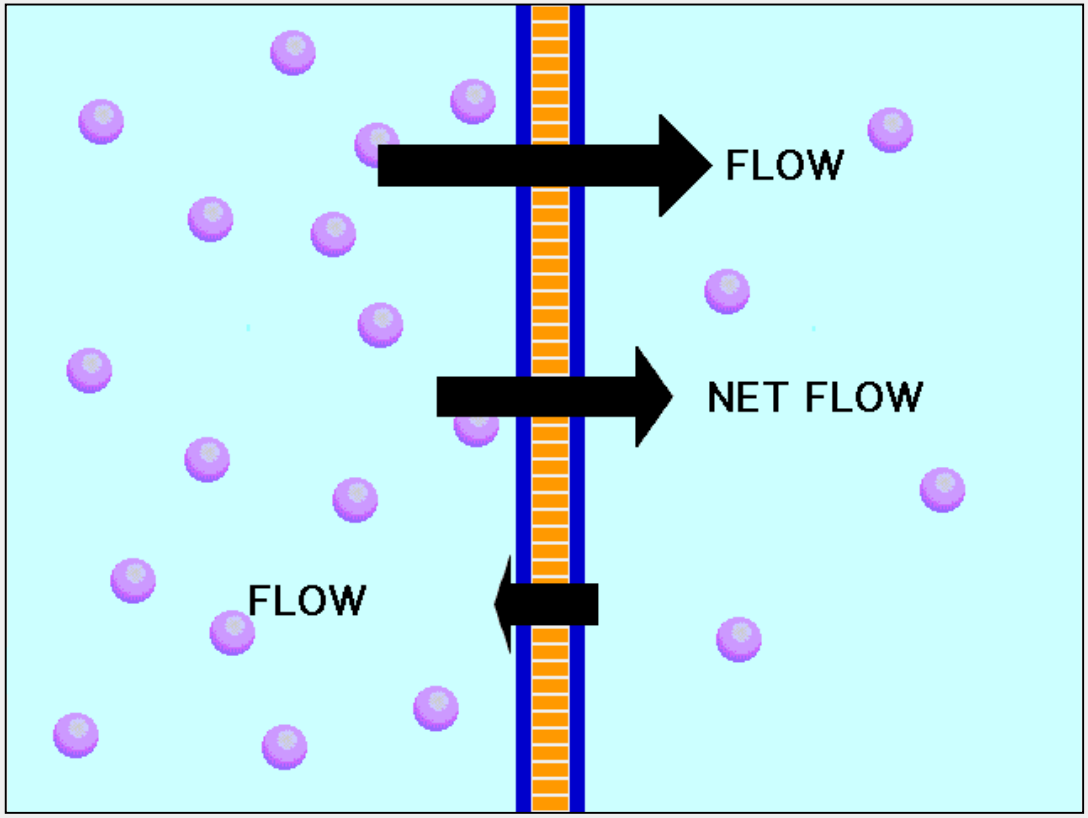
Diffusion means that the net movement of particles (molecules) is from an area of high concentration to low concentration. Oxygen, Carbon Dioxide and water move across the cell membrane by diffusion.



Background Knowledge

The xylem transports water and the phloem transports the products of photosynthesis

extra info

STEP TWO: Water is pulled up the xylem as each water particle sticks to each other. The xylem is probably the longest part of the pathway that water takes on its way to the leaves of a plant. Transpiration of water in the leaf pulls the water up.

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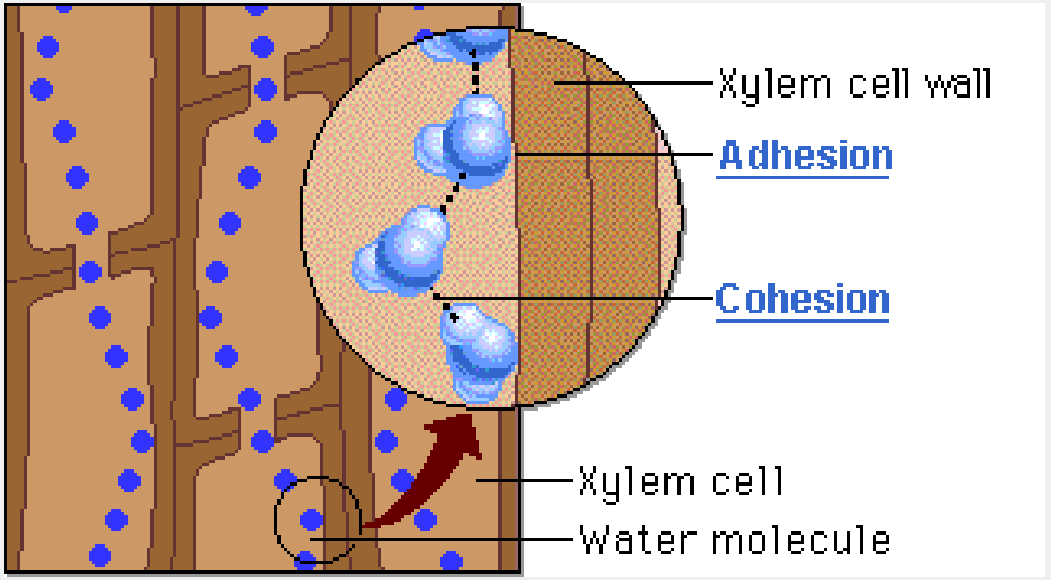
Xylem cells have cell walls containing cellulose and lignin making them extremely strong. Xylem cells contain no membranes and are considered dead. These cells overlap to create a series of pathways that water can take as it heads to the leaves.

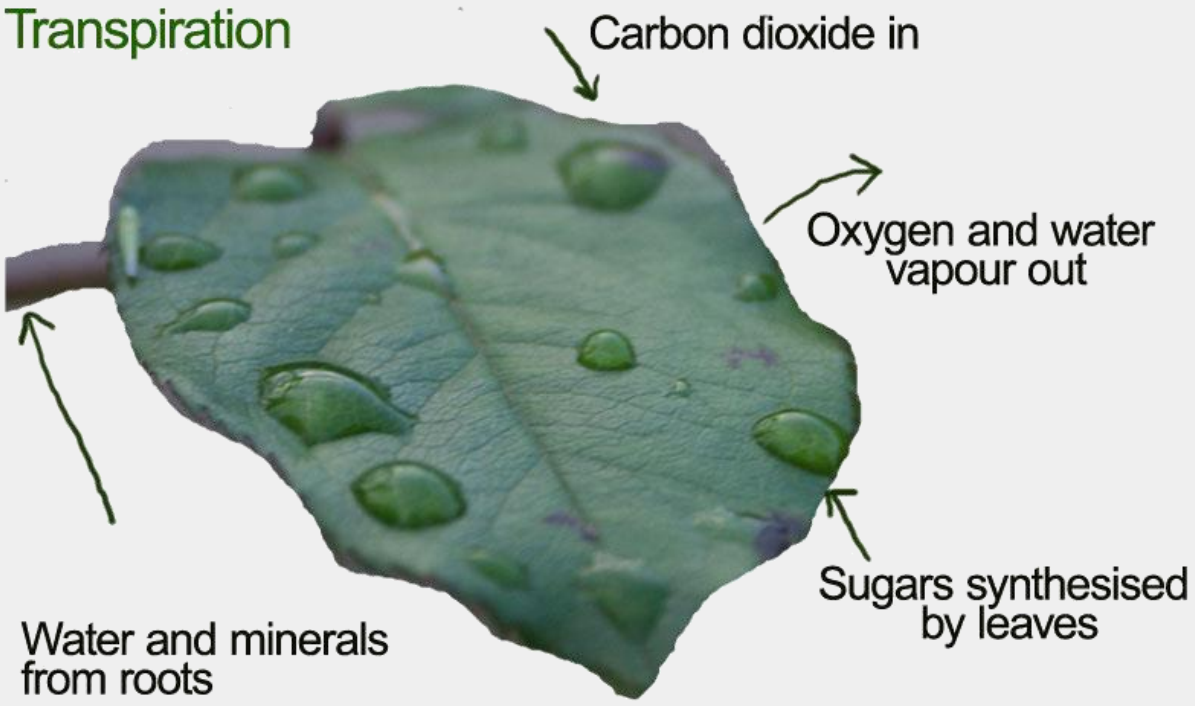


Background Knowledge

The process of transpiration

extra info

STEP THREE: Transpiration is the process where plants lose water from their leaves.
Water enters a plant through root hairs. When stomata, on the underside of leaves, are open during photosynthesis to allow CO_2 to diffuse in and O_2 to diffuse out, water vapour evaporates and diffuses out.



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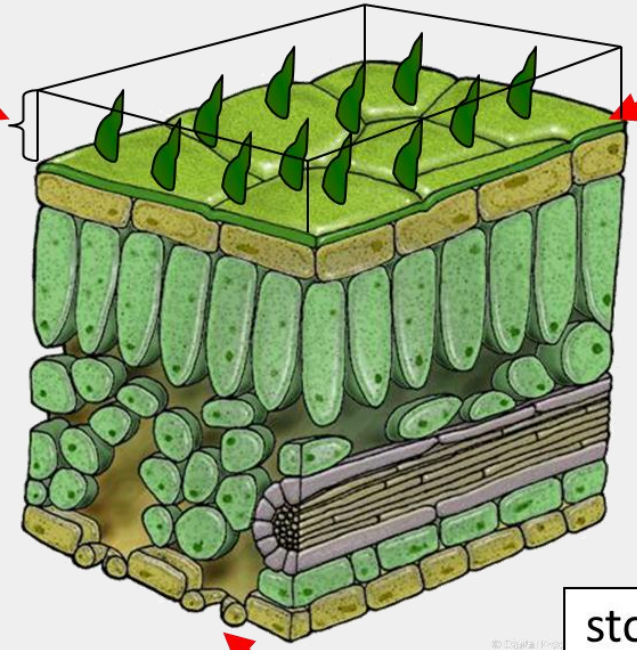
Background Knowledge

Plant features that control transpiration

extra info

The structure of a plant influences the rate of transpiration. These features can reduce the rate of water loss from the plant.



boundary

A layer of non-moving air around the leaf surface that decreases water loss. Hair can increase boundary size.

cuticle

A waxy waterproof layer on plant epidermis to prevent water loss.

stomata

Pores in the plant that can be closed to stop plant transpiration

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Background Knowledge

Aquatic environment adaptations

extra info

boundary

>Unimportant to increase boundary as mostly surrounded by water and reducing transpiration not an issue

> Many have large leaves to maximise light collection because they do not have to reduce their surface area exposed for transpiration

stomata

>many do not have stomata as they use energy to open and close

>if they have stomata they are on the upper part of the leaf in contact with the air (especially in floating plants)

cuticle

> Thin cuticle or none at all because water retention not necessary.

> Some have thin cuticle to prevent algae growth and allow water to roll off

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Background Knowledge

Temperate environment adaptations

extra info

boundary

> Larger leaves are often found on plants in the undergrowth (also because of low light levels to collect more light) and smaller leaves on plants exposed to wind – the less surface area the less boundary to protect.

> Some plants will lose there leaves (and reduce boundary) during winter when water is limited.

stomata

>stomata have active guard cells that are triggered to close by high CO_2 in the plant and low water levels in the plant or soil.

>closing and opening of the stomata uses active transport (ATP) so comes at a cost.

cuticle

> A cuticle of wax around the plant is present to prevent water loss through the epidermis layer of the leaves and stem. The wax is water repellent but transparent so still allows light to reach the chloroplasts.

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Background Knowledge

Desert environment adaptations

extra info

boundary

> Many plants have fine hairs on their epidermis to reduce air movement and increase the size of their boundaries – moist air is also trapped in the hairs

> Leaves can roll up tightly and reduce surface area available for transpiration

> Have very small leaves, reduced them to spines or lost them completely

stomata

> Often their stomata are sunken in pits (crypts) or in channels

> Some plants can open their stomata at night (C4 plants) to get CO_2 for photosynthesis – a special dark process that doesn't directly need light. Transpiration is much reduced in this cooler dark environment.

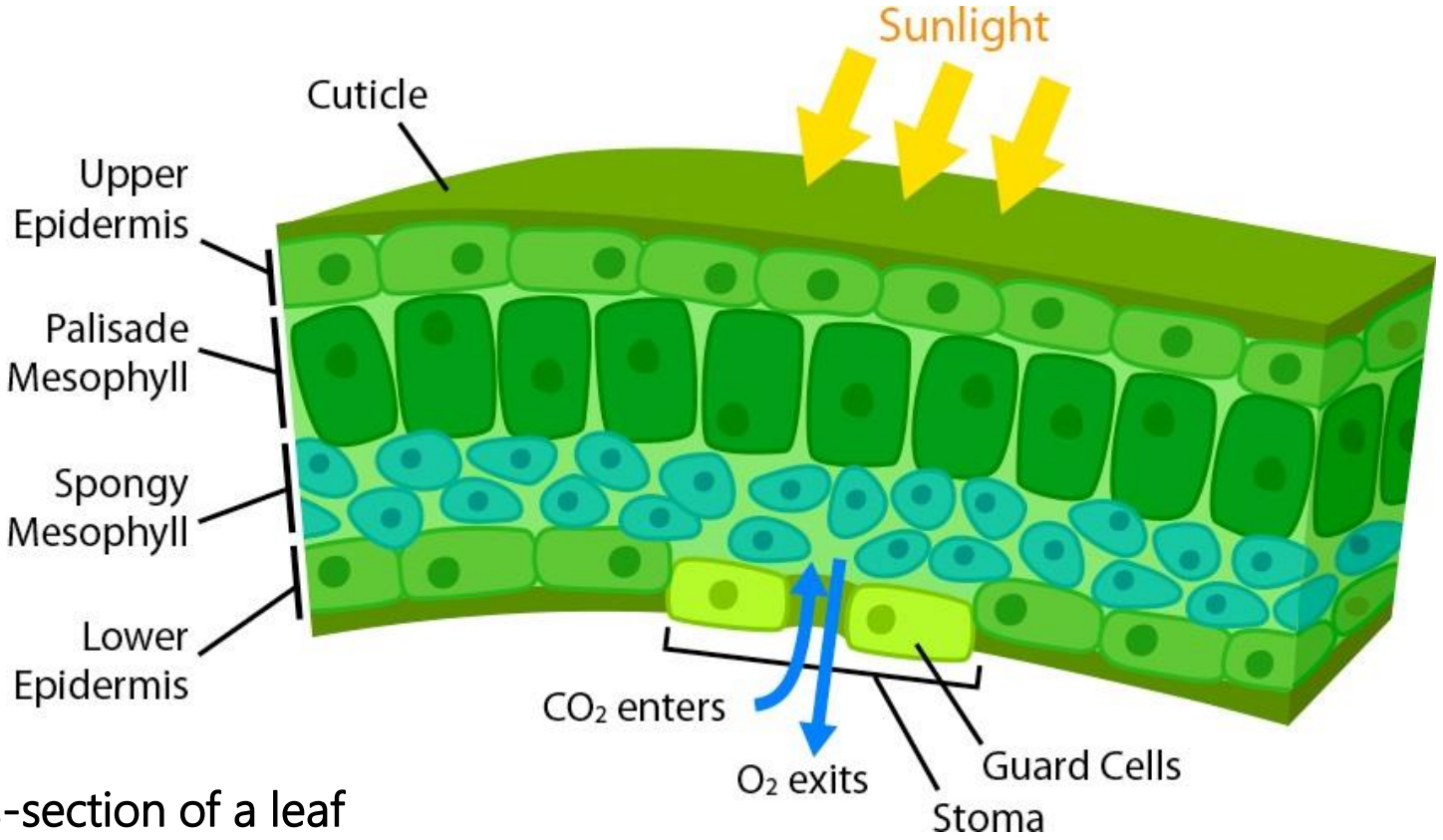
cuticle

> Often very thick, leathery and tough – covering the entire leaf and plant.

> the thick cuticle is shiny and reflects light lowering the temperature

Photosynthesis happens in the chloroplasts/ chlorophyll in the leaf cells

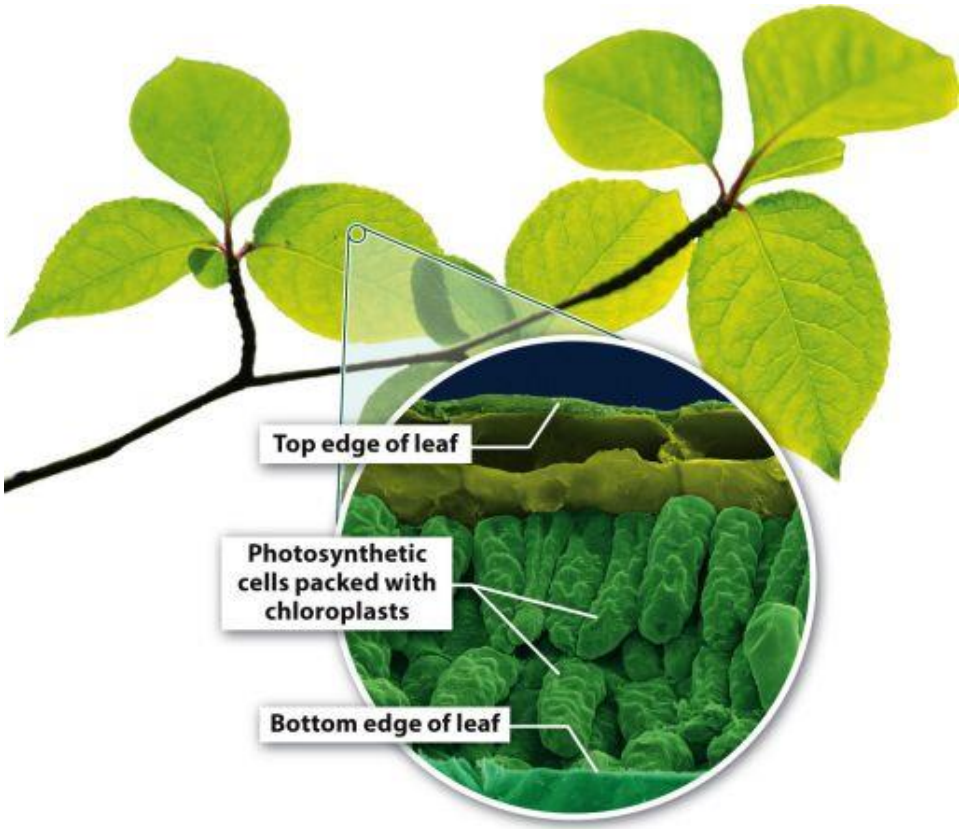
The cells at the top of the leaf are filled with **chlorophyll,** which gives leaves the green colour. The chlorophyll allows the leaf to absorb light energy which is required for photosynthesis. The **spaces between cells** in the spongy mesophyll allow carbon dioxide to diffuse around through the cells.

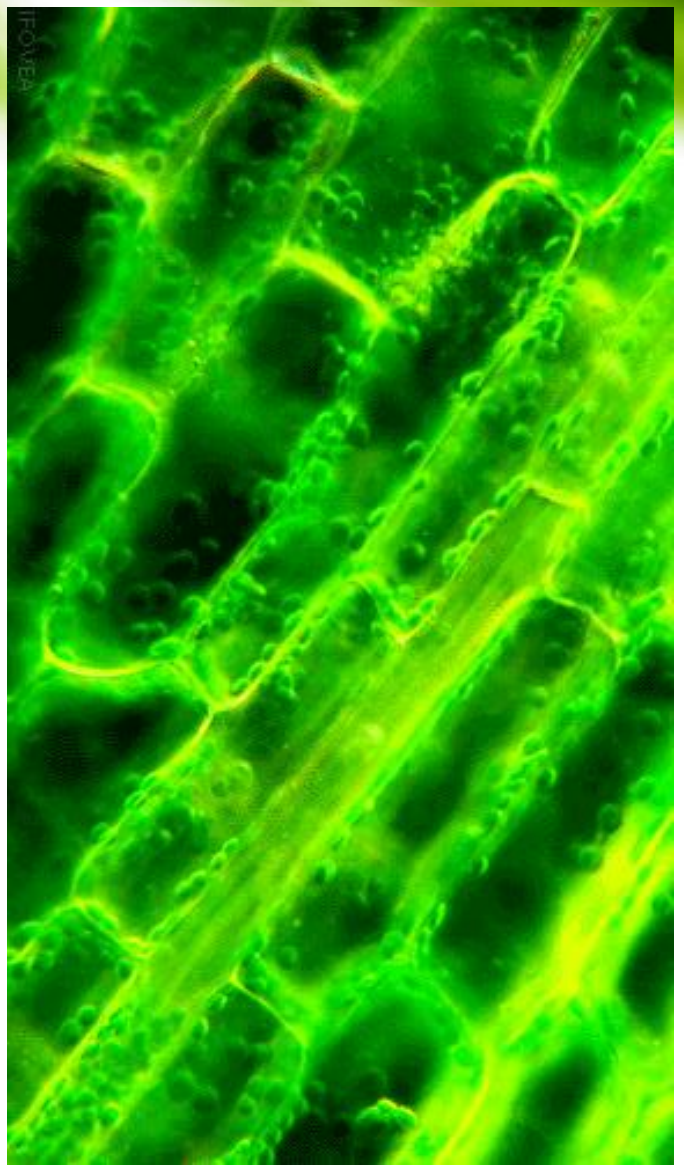


Cross-section of a leaf

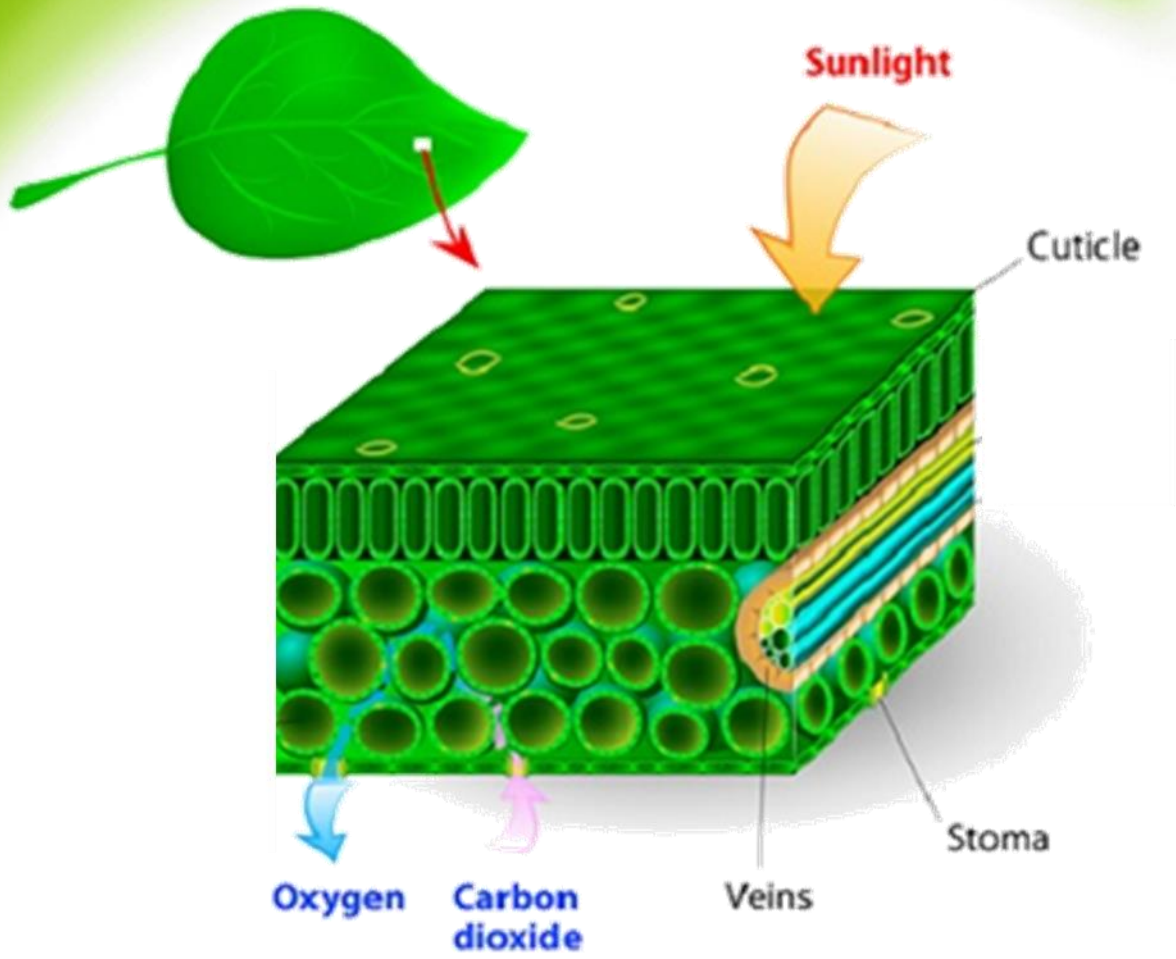
Photosynthesis happens in the chloroplasts/ chlorophyll in the leaf cells

The chloroplasts circulate around the cells, especially the palisade cells that are close to the top of the leaf. This allows maximum amounts of light to be distributed to the chloroplasts for photosynthesis to take place.





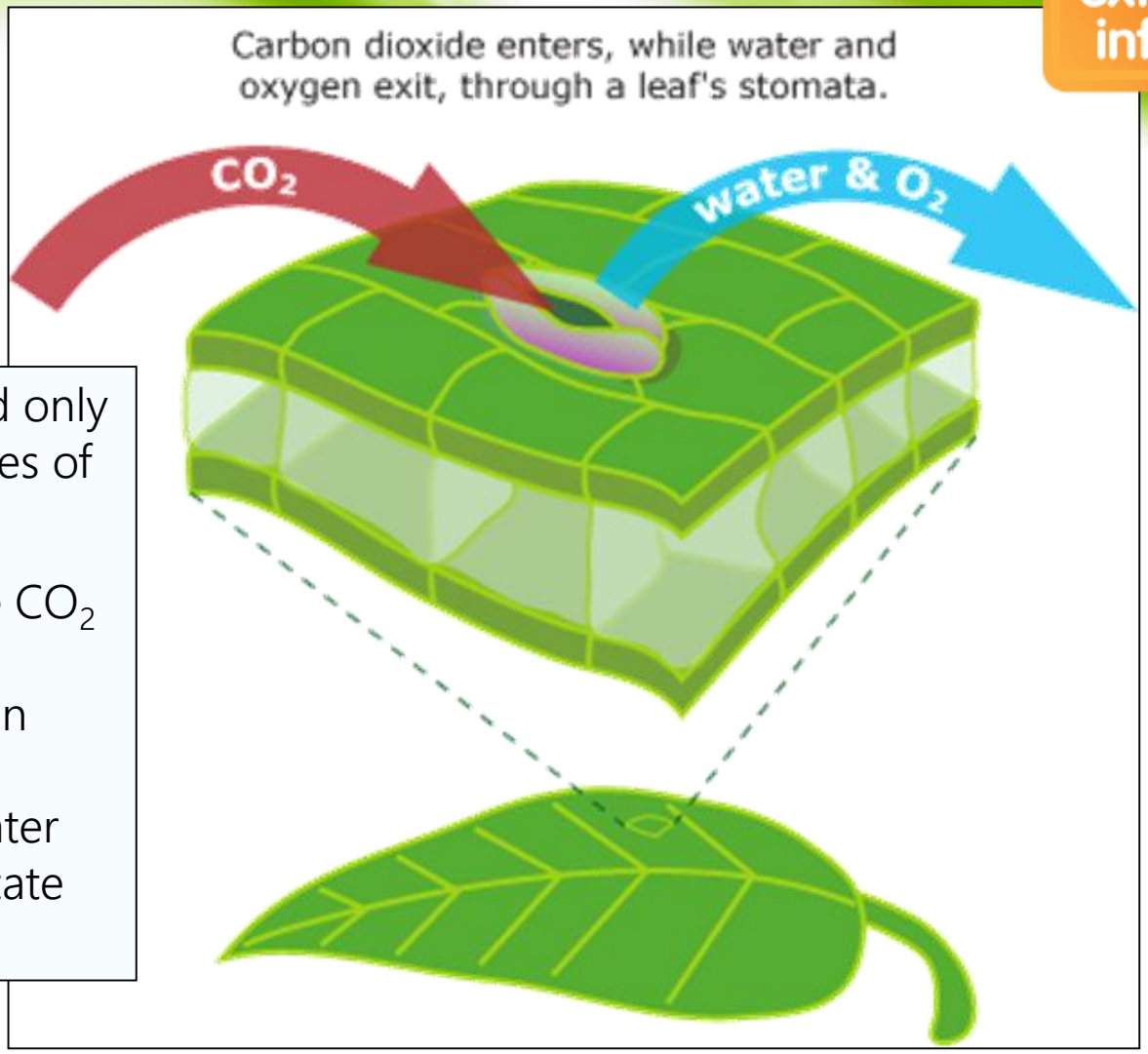
The adaptations of leaves for photosynthesis



A waxy **cuticle** on the outside of the leaf provides a waterproof covering while remaining **transparent** to allow light into the leaf cells for photosynthesis.
Openings (usually on the underside of the leaf) called **stomata** allow carbon dioxide to enter and diffuse into cells as well as allowing oxygen to move in and out.
Two guard cells on either side of the stomata open and close the openings.

The role that stomata have in the process of photosynthesis

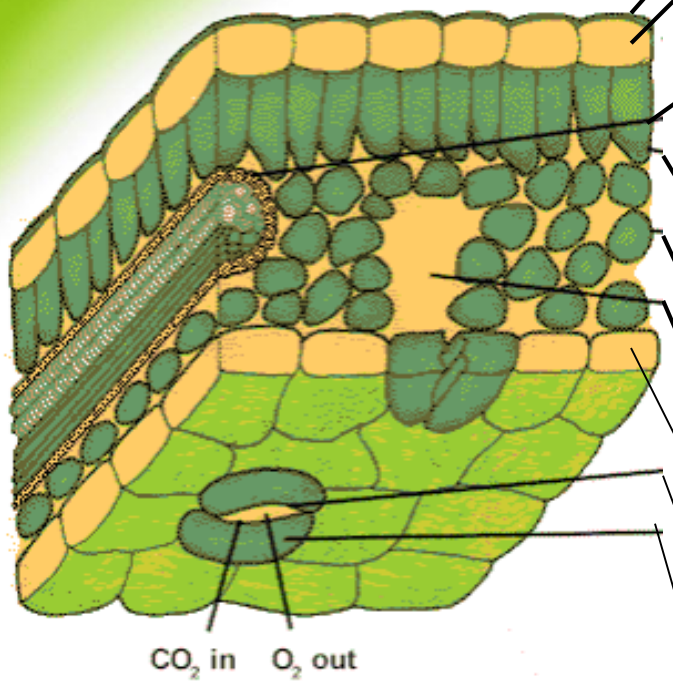
extra info



Stomata are normally found only on the under or shaded sides of leaves.

Their function is to capture CO_2 from the atmosphere by exchanging water for carbon dioxide. The exchange is accomplished by having water directly open to air to facilitate the capture.

The leaf structure and types of cell inside a leaf



Cuticle: Waxy layer water proofing upper leaves.
Upper epidermis: Upper layer of cells. No chloroplasts. Protection.
Vascular Bundle: Bundle of many vessels (xylem and phloem) for transport. Xylem: Living vascular system carrying water & minerals throughout plant.
Phloem: Living vascular system carrying dissolved sugars and organic compounds throughout plant.
Palisade Mesophyll: Tightly packed upper layer of cells containing chloroplast.
Spongy Mesophyll: Lower layer of cells.
Air space: Area for gases to disperse

Lower Epidermis: Lower external layer of cells in leaf.

Stomata: Opening between guard cells for gas & water exchange.
Guard Cells: 2 cells surrounding stomata that control rate of gas & water exchange.

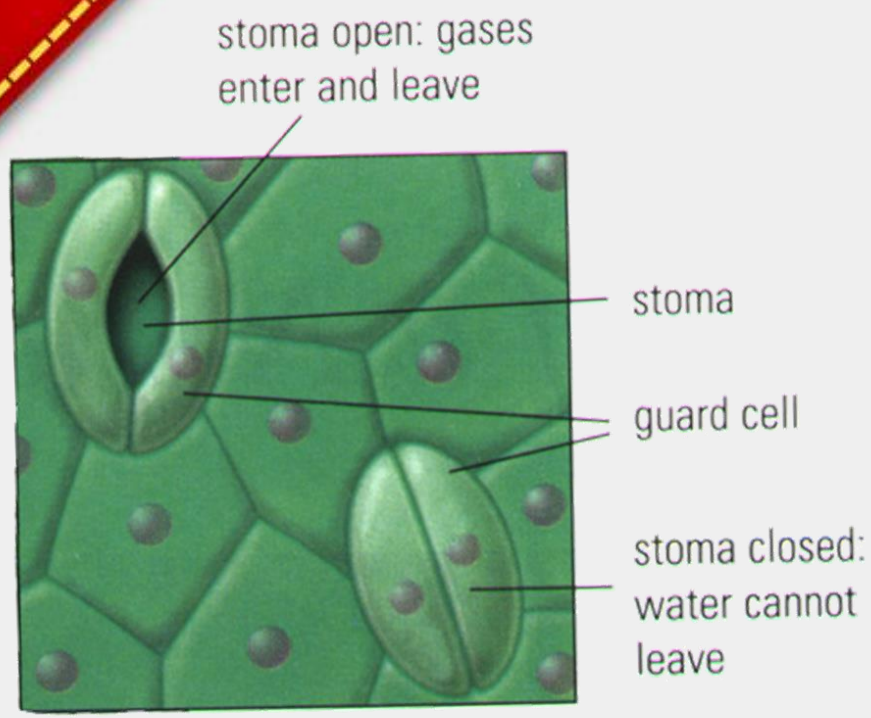
extra info

Background Knowledge

The role that stomata have in the process of photosynthesis

extra info

GZ Science Resources



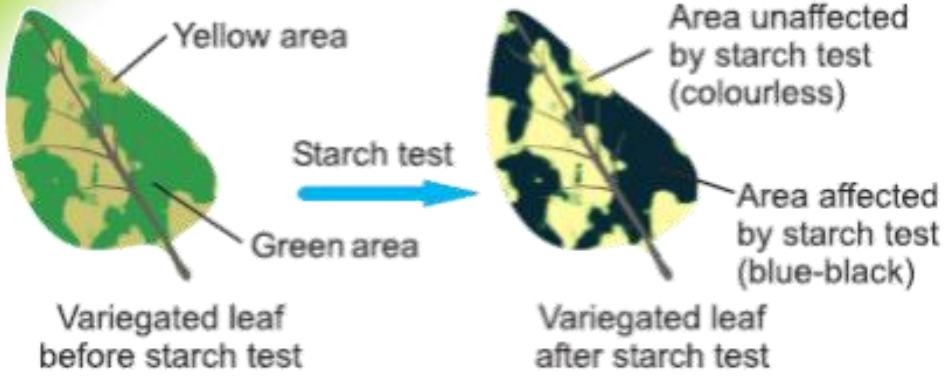
Leaves are the main site of photosynthesis. They make food from carbon dioxide and water in the presence of light. As stomata open in the presence of light, carbon dioxide will diffuse into the leaf and at the same time, water vapour will exit the leaf through the stomata to the surrounding atmosphere through the process of transpiration.

Plants will lose water vapour while taking up carbon dioxide through their stomata. If this water loss is uncontrolled, plants can deplete their water reserve.

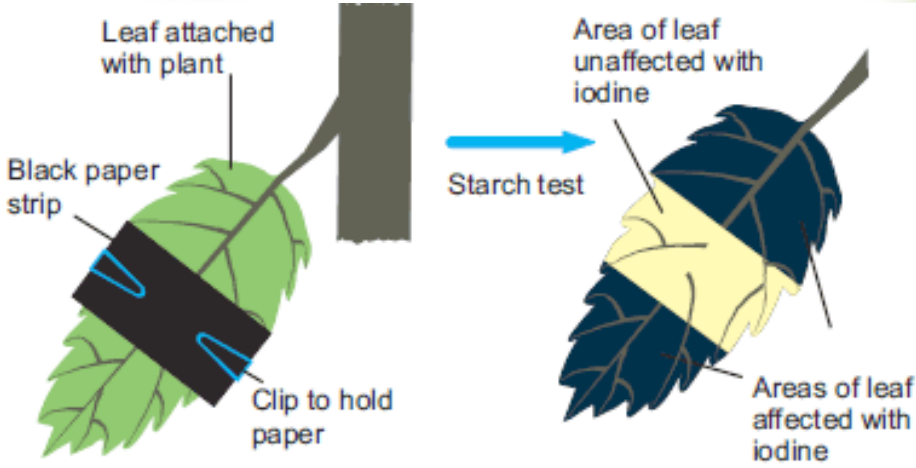
Stomata **prevent water loss** from the stoma by closing once the leaf has sufficient carbon dioxide.

Investigations into photosynthesis requirements

We can Investigate that photosynthesis happens in the chloroplasts/chlorophyll in the leaf cells and use the starch test as evidence When a plant undergoes photosynthesis it produces glucose which is converted into starch for storage. If we want to **investigate** what **factors** are required for **photosynthesis** we use the starch test to enable us to reach a conclusion. Factors include chlorophyll, water, carbon dioxide and light present.



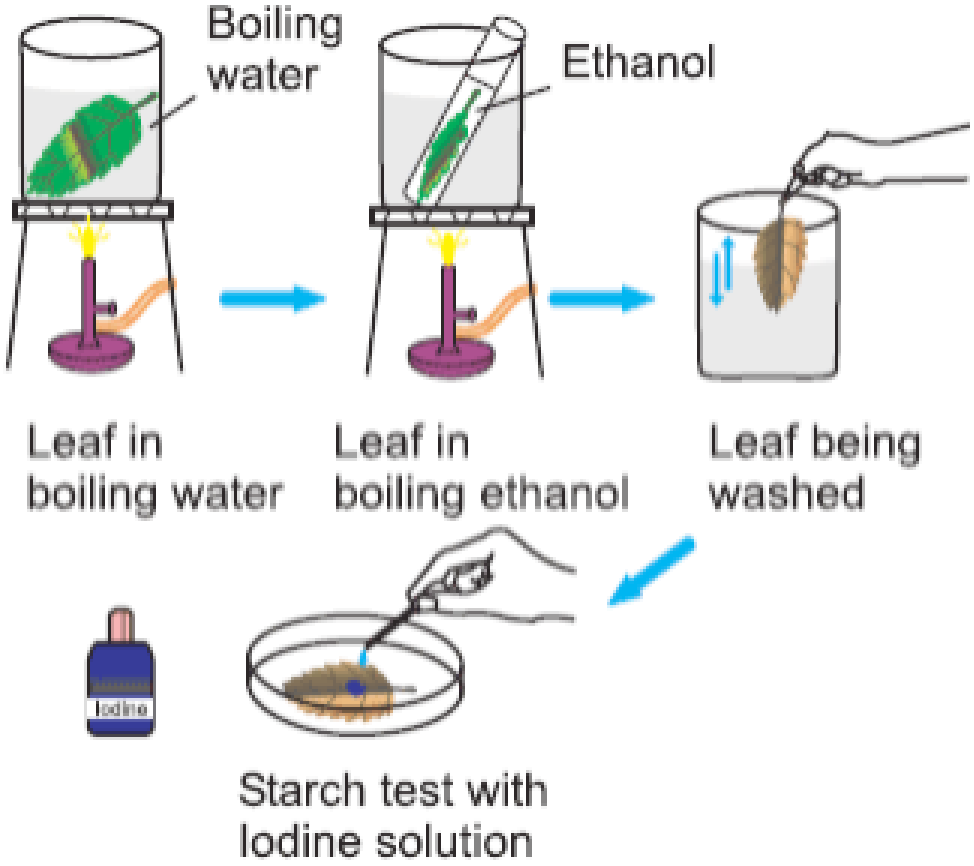
Investigating if Chlorophyll is required for photosynthesis:
Select a leaf that is variegated leaf. The green parts contain chlorophyll and the white parts do not. To show chlorophyll is required for photosynthesis only the previous green areas will turn black.



Investigating if light is required for photosynthesis:
Place a piece of black paper over a leaf and leave for a few days still on the plant. To show light is required for photosynthesis only the uncovered areas will turn black.

Starch test

A positive test for starch is the **leaf turning blue-black** when iodine is added. The starch is the storage product of the plant when it produces photosynthesis. A positive test means photosynthesis has occurred.



Step 1. The leaf is boiled in water to soften it.
Step 2. The leaf is then placed into a boiling tube of ethanol which is placed in a beaker of water and heated gently. This will remove the green chlorophyll.
Step 3. The leaf is washed in water to remove all of the ethanol.
Step 4. Iodine added to the leaf. It will turn blue-black in the presence of starch. The starch indicates photosynthesis and the production of glucose has occurred.