Plants

Plants and mineral ions

Plants need minerals for healthy growth. They are absorbed through the roots by active transport as mineral ions dissolved in the soil water.

Magnesium and nitrate

Magnesium ions and nitrate ions are needed by plants. A plant will not grow well if it cannot get enough of these ions, and it will show symptoms of mineral deficiency.

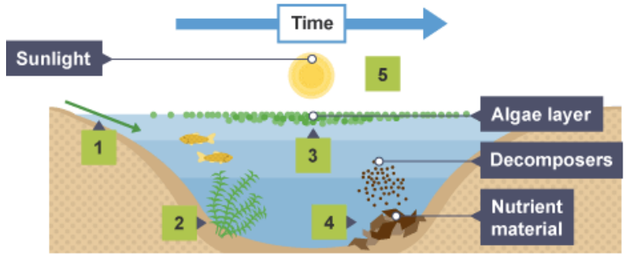
Mineral ion	Needed for	Effects of deficiency
Magnesium	Making chlorophyll	Leaves turn yellow
Nitrate	Making amino acids	Stunted growth

Nitrogen fertilisers

Fertilisers are used to replace minerals used by plants.

Nitrogen fertilisers - such as ammonium nitrate and ammonium phosphate - provide plants with water-soluble sources of nitrogen that they can absorb through their roots. They allow farmers to increase the yield and quality of their crops.

However, overuse can cause problems. Eutrophication happens when excess nitrate (or phosphate) enters rivers or lakes from fields. This can lead to the death of fish and other aquatic animals.



1. Nutrient load up: excessive nutrients from fertilisers are flushed from the land into rivers or lakes by rainwater.
2. Plants flourish: these pollutants cause aquatic plant growth of algae, duckweed and other plants.
3. Algae blooms, oxygen is depleted: algae blooms prevent sunlight reaching other plants. The plants die and oxygen in the water is depleted.
4. Decomposition further depletes oxygen: dead plants are broken down by bacteria decomposers, using up even more oxygen in the water.
5. Death of the ecosystem: oxygen levels reach a point where no life is possible. Fish and other organisms die.

Photosynthesis

Photosynthesis is the process by which plants make carbohydrates from raw materials, using energy from light. During photosynthesis:

- light energy is absorbed by chlorophyll - a green substance found in chloroplasts in green plant cells and algae
- absorbed light energy is used to convert carbon dioxide (from the air) and water (from the soil) into a sugar called glucose
- oxygen is released as a by-product

The following equations summarise what happens in photosynthesis:

carbon dioxide + water —> glucose + oxygen

$6CO2 + 6H2O \longrightarrow C6H12O6 + 6O2$

Some glucose is used for respiration, while some is converted into insoluble starch for storage. The stored starch can later be turned back into glucose and used in respiration.

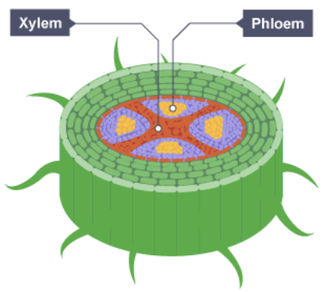
Leaf Structure

The structure of a leaf has adaptations so that it can carry out photosynthesis effectively.

A leaf needs:

- a way to transport water to the leaf, and glucose to other parts of the plant
- a way to exchange carbon dioxide and oxygen
- the ability to absorb light energy efficiently

Transport



Gas exchange

Gas exchange happens in the spongy mesophyll tissue of the leaf. Spongy mesophyll cells are covered by a thin layer of water and loosely packed.

When the plant is photosynthesising during the day, these features allow carbon dioxide to diffuse into the spongy mesophyll cells, and oxygen to diffuse out of it.

To get to the spongy mesophyll cells inside the leaf, gases diffuse through small pores called stomata. They also open or close to control the loss of water from leaf by the process of transpiration.

Factors affecting photosynthesis

Three factors can limit the rate of photosynthesis: light intensity, carbon dioxide concentration and temperature.

Light intensity

Without enough light, a plant cannot photosynthesise very quickly - even if there is plenty of water and carbon dioxide. Increasing the light intensity will boost the rate of photosynthesis.

Carbon dioxide concentration

Even if there is plenty of light, a plant cannot photosynthesise if there is insufficient carbon dioxide.

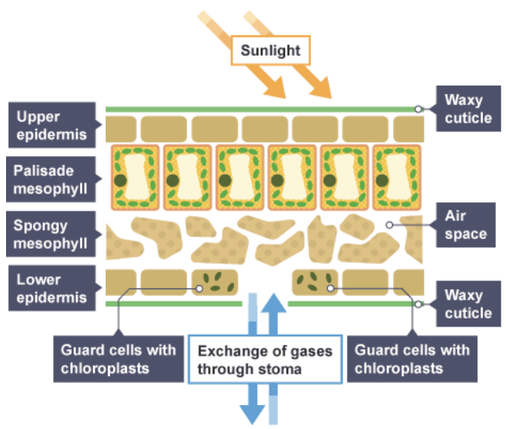
Temperature

If it gets too cold, the rate of photosynthesis will decrease. Plants cannot photosynthesise if it gets too hot.

Leaf Structure

Absorbing light energy

Light absorption happens in the palisade mesophyll tissue of the leaf. Palisade cells are column shaped and packed with many chloroplasts. They are arranged closely together so that a lot of light energy can be absorbed.



Features of leaves and their functions

Feature	Function
Large surface area	Maximise light absorption
Thin	Short distance for carbon dioxide to diffuse into leaf cells
Thin waxy cuticle	This protects the leaves without blocking out light
Thin transparent epidermis	Allows light to reach the palisade cells

Investigating photosynthesis – starch and chlorophyll

Photosynthesis can be investigated to show the production of starch and the importance of chlorophyll.

Starch testing

1. Iodine solution is used to test leaves for the presence of starch. You need to:
heat a plant leaf in boiling water for 30 seconds (this stops its chemical reactions)
2. heat it in boiling ethanol for a few minutes (this removes most of its colour)
3. wash with water and spread onto a white tile
4. add iodine solution from a dropping pipette
5. After a few minutes, the parts of the leaf that contain starch turn blue-black.

Note that ethanol is heated using a hot water bath. Ethanol boils at 78°C, so a tube of it boils when placed in a beaker of hot water. This is safer than using a Bunsen burner because ethanol is flammable.

Variegated leaves have green parts (where the cells contain chlorophyll) and white parts (where there is no chlorophyll). Only the parts that were green become blue-black with iodine solution, showing the importance of chlorophyll in photosynthesis.

A plant can be 'de-starched' by leaving it in the dark for a few hours. Parts of its leaves are covered with dark paper, and the plant is left in the light for a few hours. Only the uncovered parts become blue-black with iodine solution, showing the importance of light in photosynthesis.