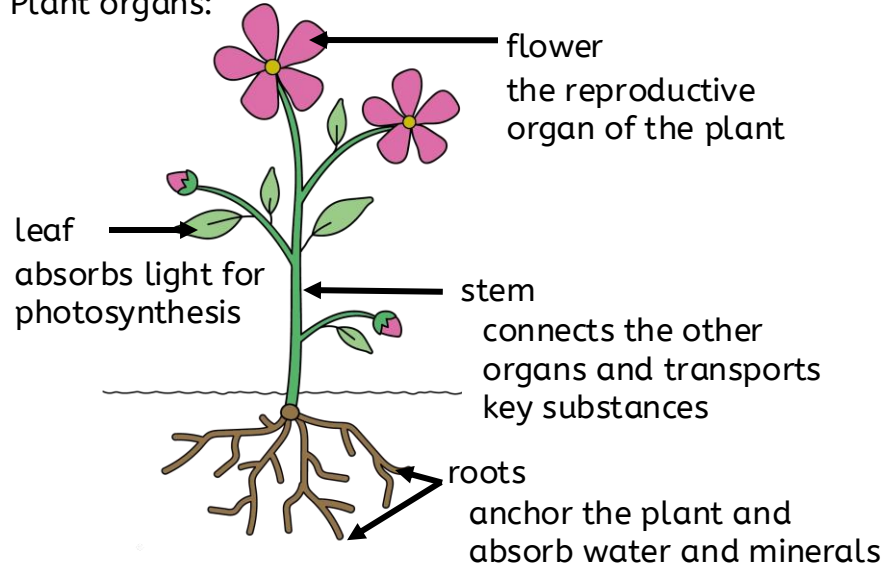


Plants and Their Processes

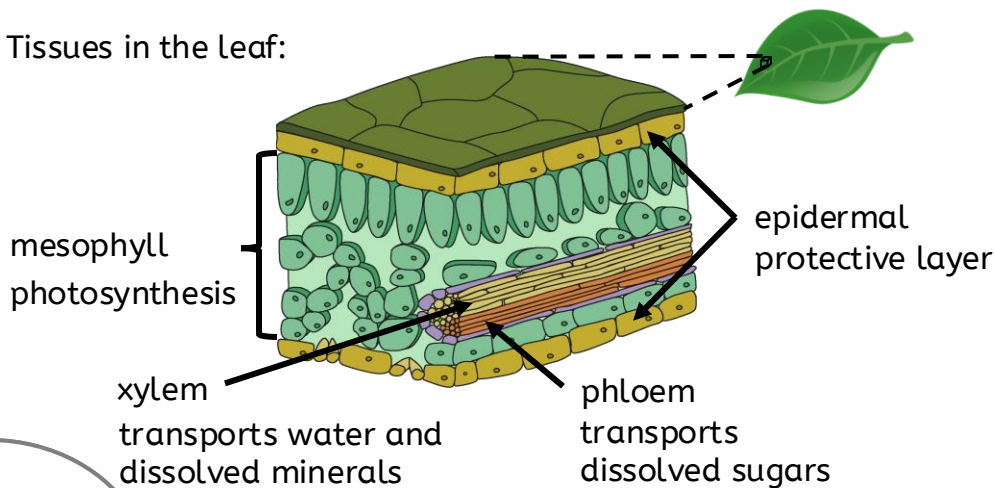


Plants as Organisms

Plant organs:

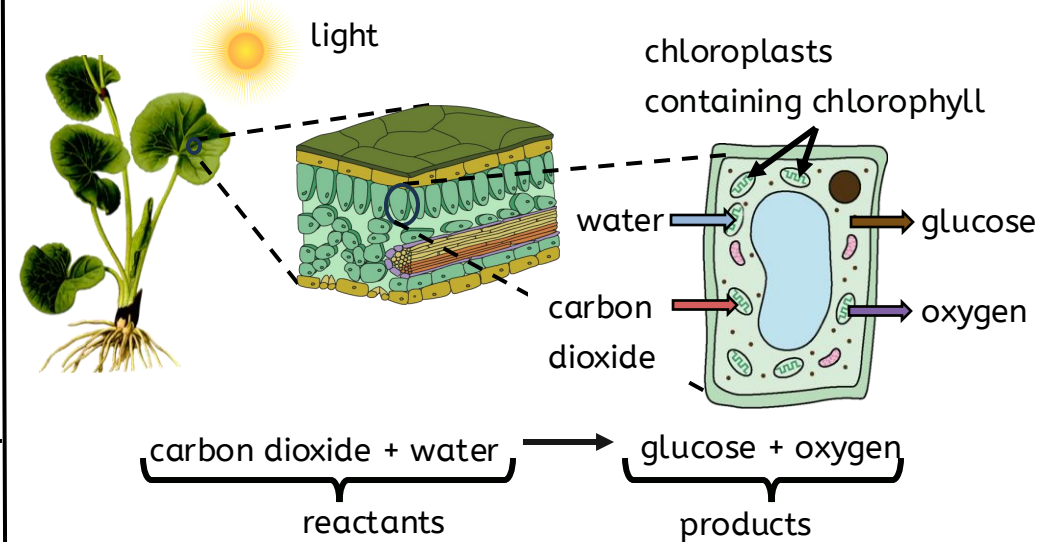


Tissues in the leaf:



Photosynthesis

Photosynthesis is a series of chemical reactions in which plants use carbon dioxide and water to make glucose and oxygen, driven by energy from light. Photosynthesis occurs in the chloroplasts and is absorbed by the green pigment called chlorophyll.

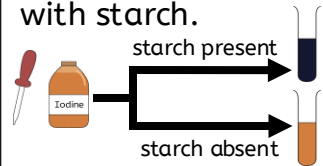


Uses of glucose:

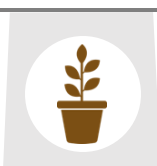
1. used by the plant for respiration to release energy
2. turned into cellulose to build cell walls
3. turned into starch and stored for use later by the plant

Photosynthesis is an endothermic process because it requires energy to be transferred from its surroundings.

We can test a leaf for starch using iodine. Iodine will turn from orange-brown to blue-black when it is in contact with starch.



Plants and Their Processes

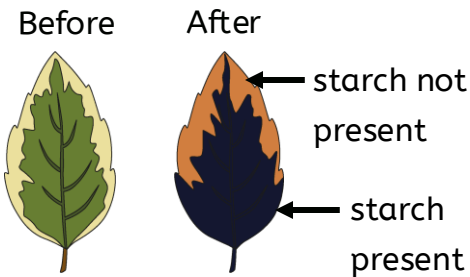


Photosynthesis Continued

A leaf is tested for starch using the following steps:

Step	Reason
Hold the leaf in the hot water	soften leaf
Cover the leaf with ethanol	remove chlorophyll
Place the boiling tube into the beaker of hot water	speed up removal
Rinse the leaf in the beaker of hot water	soften leaf again
Place the Petri dish containing the leaf on white tile	see colour change
Add a few drops of iodine solution to cover the leaf	test for starch

Results of the iodine test for starch on a variegated leaf:



Only green parts of the leaf photosynthesise and make starch, so iodine stays orange-brown on non-green parts.

When testing for starch, control measures should be taken using the hazardous substances:

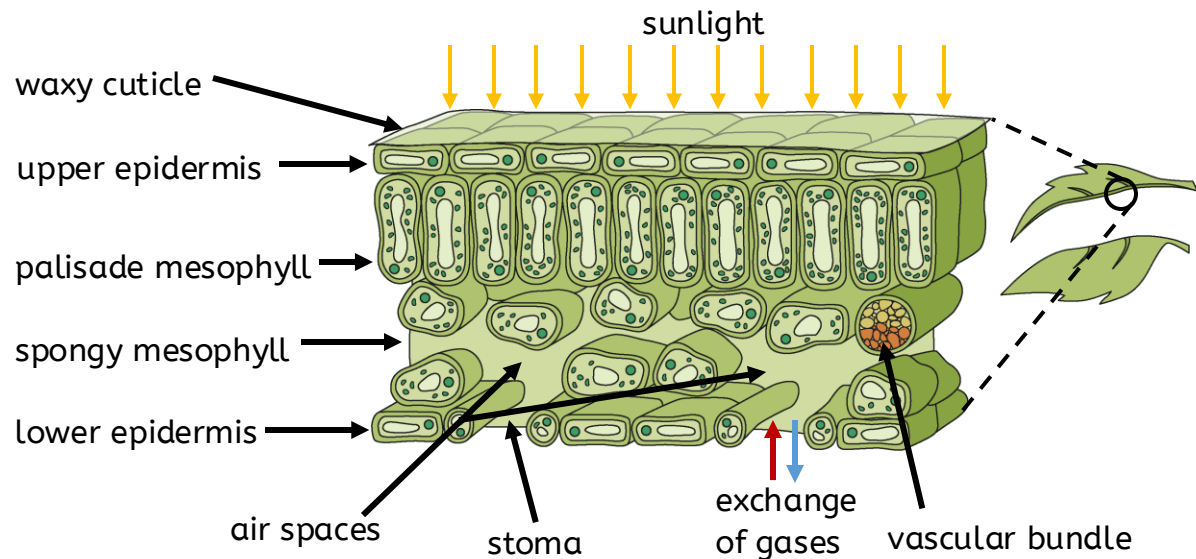
- iodine
- ethanol

Changing Understanding of Photosynthesis

People used to incorrectly believe that plants gain mass by taking in soil through roots. Van Helmont's experiment with the willow tree showed plants gain mass from water, not soil. Today, scientists know that plant mass comes from carbon dioxide, which is used in photosynthesis to make glucose for growth.

Leaf Structure and Adaptations

Leaf adaptation	Function of adaptation
Many chloroplasts	Contain chlorophyll to absorb light
Large surface area	Absorbs more light
Thin	Short diffusion distance for gases
Veins	Transport water, minerals, and sugars
Stomata (underside)	Allow gas exchange (CO ₂ in, O ₂ out)



Plants and Their Processes

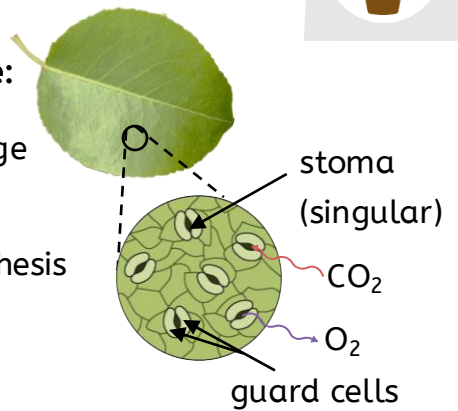


Leaf Structure and Adaptations Continued

Structure	Function	Adaptation
upper epidermis	allows light to pass through	thin and transparent
palisade mesophyll	photosynthesis	cells have lots of chloroplasts and are tightly packed
spongy mesophyll	supports diffusion of gases in and out of leaf	air spaces
lower epidermis	supports diffusion of gases in and out of leaf	stomata
vascular bundle	transports substances	xylem and phloem tissue
waxy cuticle	reduces water loss	waterproof

Guard cells and gas exchange:

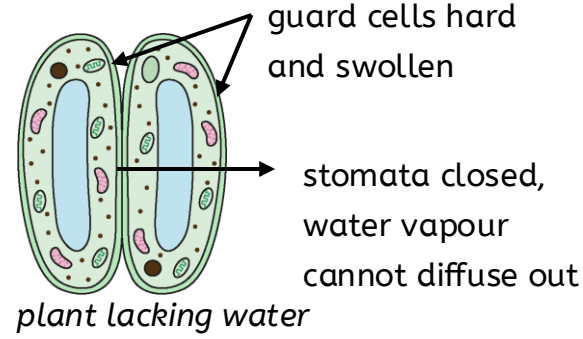
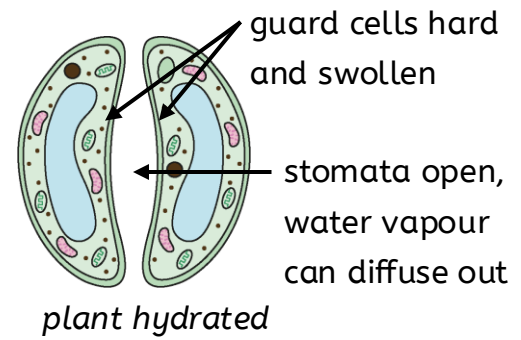
- Control opening/closing of stomata for gas exchange
- Sensitive to light
- Open stomata in day for CO₂ to enter for photosynthesis
- Close stomata at night when photosynthesis stops



A light microscope can be used to observe an imprint of the structure of the stomata. Stomata are on the underside of the leaf because it is cooler and more shaded.

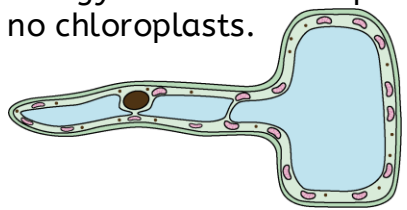
Guard cells and water loss:

- Guard cells open and close stomata to reduce water loss.



Root structure and adaptations

Root hair cells are adapted for the absorption of water and minerals, with a long extension to increase surface area. They contain many mitochondria to provide energy for active transport. They have no chloroplasts.



Water is essential for photosynthesis. It maintains the structure of the plant and enables chemical reactions by acting as a solvent in which reactants and products are dissolved.

Plants also need minerals:

- Nitrates → healthy growth
- Phosphates → healthy roots
- Potassium → healthy leaves and flowers
- Magnesium → makes chlorophyll

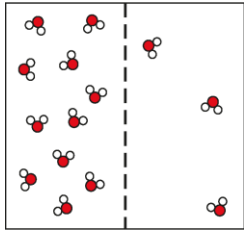


Plants and Their Processes



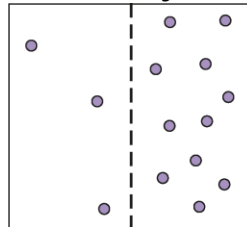
Root Structure and Adaptations Continued

Water is absorbed through osmosis, moving from an area of high water concentration in the soil to an area of lower concentration in root hair cells.



high → low
water concentration

Minerals are absorbed by active transport as they are in lower concentrations in soil than in root hair cells. Active transport requires energy from respiration, so root hair cells contain many mitochondria.

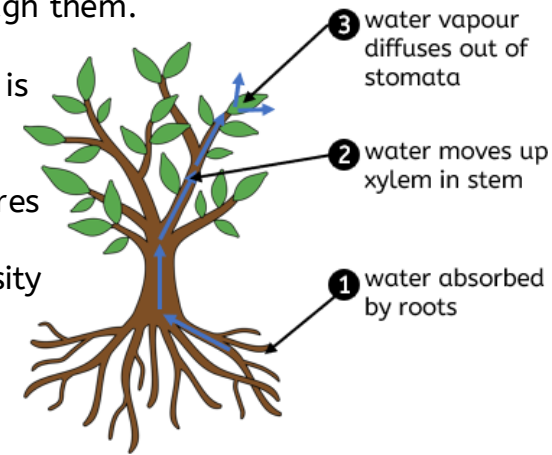


low → high
water concentration

Transpiration is the loss of water vapour from the leaves of plants, through the stomata. When the stomata are open, plants lose water vapour through them.

The rate of transpiration is increased by:

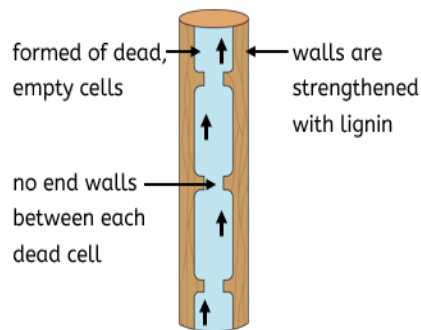
- increased temperatures
- increased light intensity
- increased wind
- decreased humidity



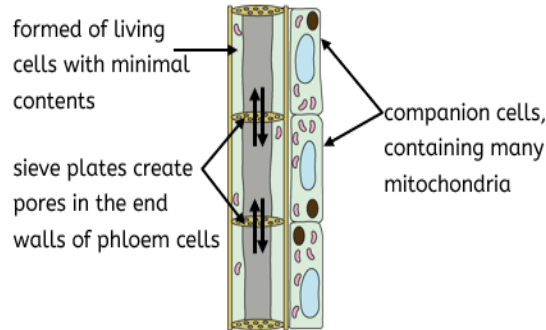
Transport in Plants

Xylem transports water and dissolved minerals up the stem, from roots to leaves. Phloem transports dissolved sugars. Sugars are transported up or down the stem, depending on where sugars are needed.

xylem adaptations



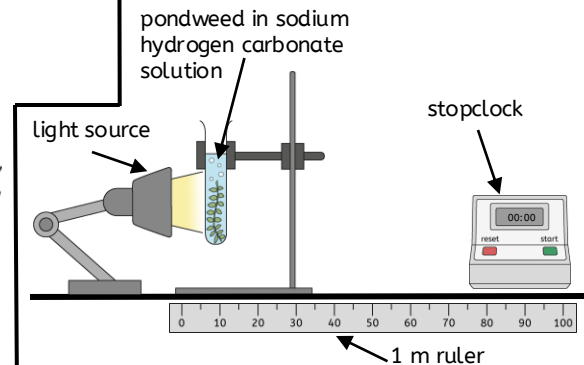
phloem adaptations



Rate of Photosynthesis

An increase in light intensity, temperature, chlorophyll, water and carbon dioxide increases the rate of photosynthesis.

Effect of light intensity on rate of photosynthesis



Variables

Independent: light intensity - distance between light and pondweed
Dependent: rate of photosynthesis - number of bubbles per minute
Control: temperature, CO₂, water, chlorophyll, time, size/mass of pondweed

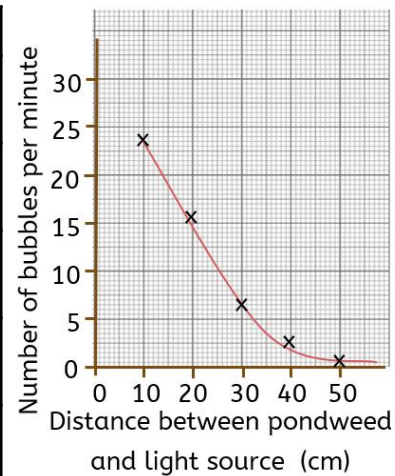
Plants and Their Processes



Rate of Photosynthesis Continued

Step	Explanation
1. Set up the LED light source and meter ruler	it doesn't heat up during use, so temperature won't be affected
2. Fill the boiling tube with the sodium hydrogen carbonate solution	to provide carbon dioxide
3. Put the piece of pondweed into the boiling tube with the cut end at the top and keep it underwater	to observe bubbles of oxygen
4. Place the boiling tube with pondweed 10cm from the light source	this is the first independent variable light intensity to test
5. Leave the pondweed for three minutes	allows the photosynthesis rate to stabilise

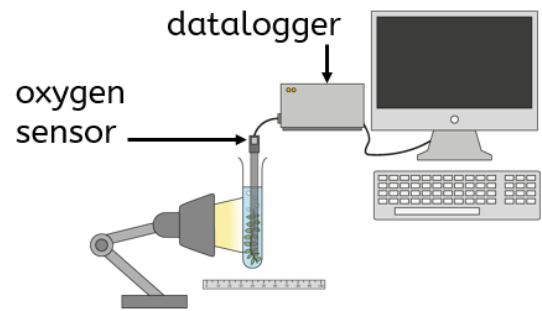
Typical results



As the distance between the pondweed and light increases, the number of bubbles per minute decreases. This is because less energy is transferred and absorbed by the chlorophyll for photosynthesis.

Datalogging and technology in science

Datalogging: Automatic data collection using sensors and computers (e.g. light, temperature, oxygen). Data is recorded at regular intervals (e.g., every second or minute). Technology improves experiments: Cameras, sensors, and computers make observations clearer and more accurate.

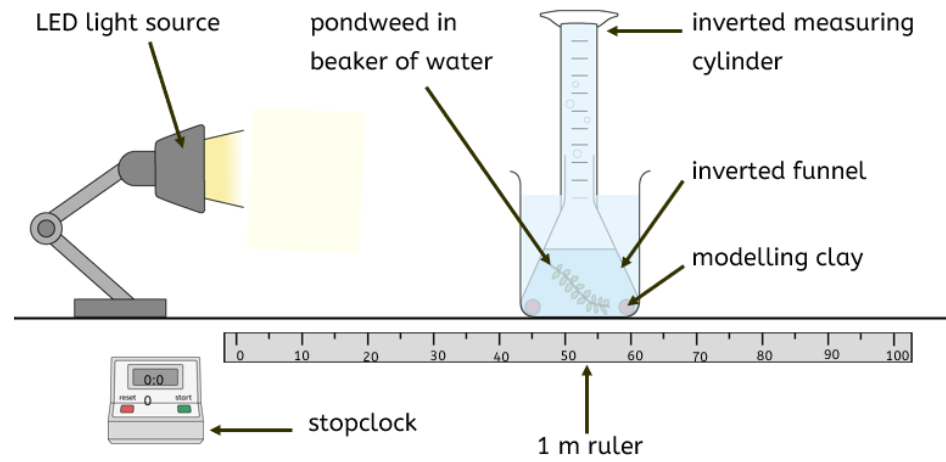


Limitations and improvements in measuring photosynthesis

Counting bubbles → Simple but inaccurate and biased (bubble size, bubble speed).

Better method → Measure volume of oxygen using inverted funnel and measuring cylinder (more accurate, objective).

Digital tools → Data loggers collect continuous data, reduce error and bias, improve validity and analysis.

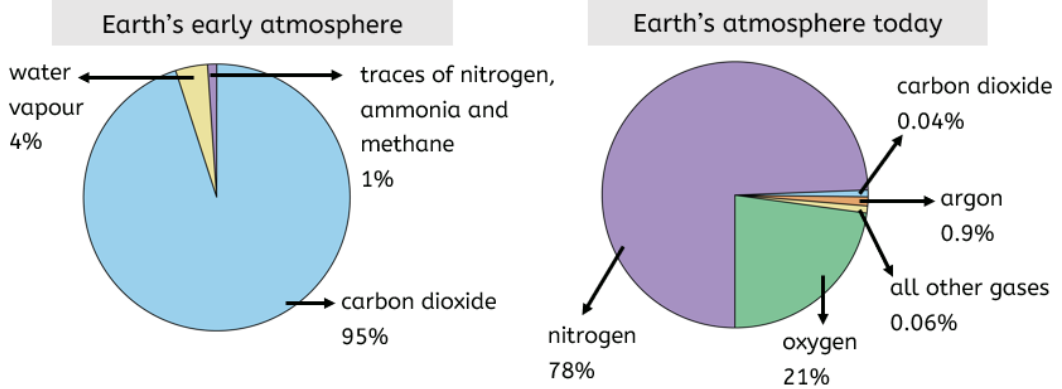


Plants and Their Processes

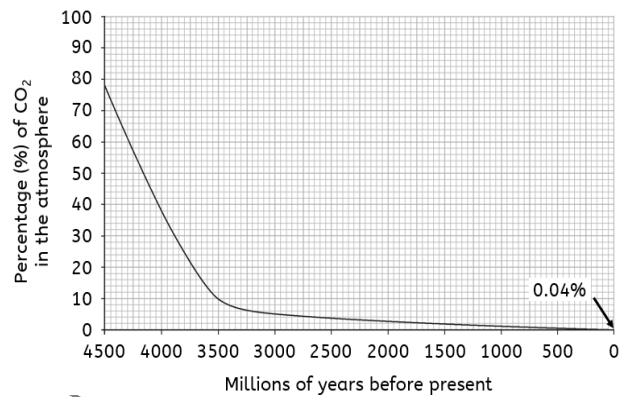


Plants and the Atmosphere

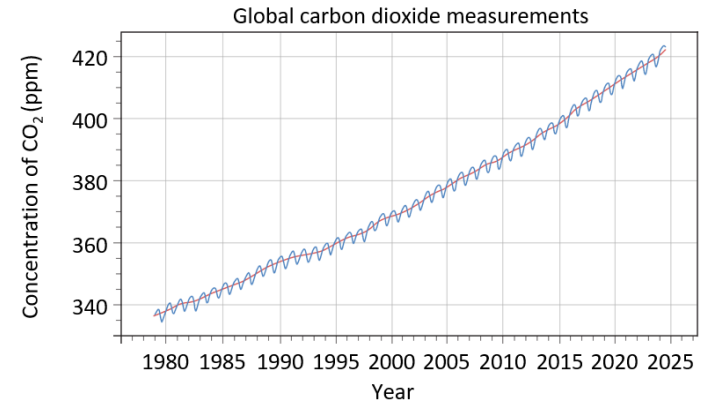
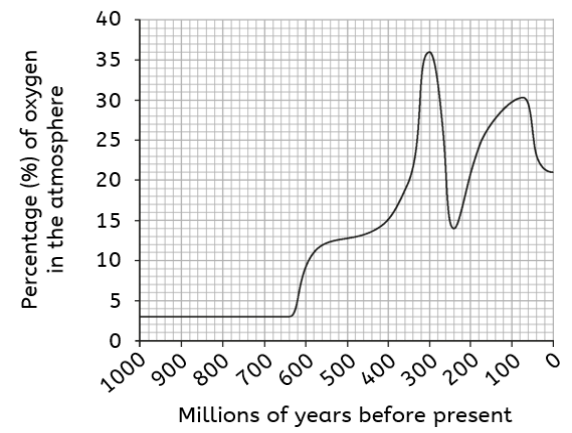
Early Earth's atmosphere was mostly carbon dioxide, with almost no oxygen. Over time, oxygen rose and CO₂ fell.



Carbon dioxide levels decreased because the oceans formed and carbon dioxide dissolved into them. Plants and algae then used it in photosynthesis.



Oxygen levels increased because algae and plants released oxygen during photosynthesis. Fluctuations occurred because early oxygen was absorbed by oceans and seabed rocks.



Deforestation reduces the number of plants, increasing carbon dioxide levels.

Plants as Producers

- Plants are producers that make their own food through photosynthesis. Plants provide food for humans and other animals, forming the basis of food chains.
- Foods that contain starch can be identified using iodine.
- Raw data in tables may need to be processed by finding frequency.
- Insect pollination is essential for crop growth and food production.
- A significant portion of our food relies on pollinators.
- The decline in bee populations threatens food security.

Starch Test Result	Tally	Frequency
Starch present	### ### ###	18
No starch	### ### //	12

