

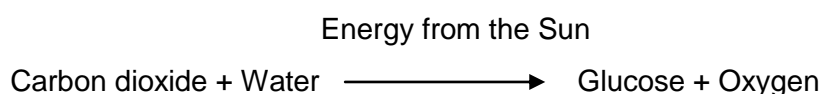
## Photosynthesis: an introduction

### Making plant food

Green plants make their own food molecules by a chemical process called photosynthesis. It takes place in the cells in their leaves. The green colour comes from chlorophyll which is found in tiny disc-shaped structures called chloroplasts.

The chlorophyll absorbs energy carried by sunlight and uses it to convert carbon dioxide and water into glucose. Oxygen is produced as a by-product. Glucose is the molecule from which all other food molecules can be made.

Photosynthesis can be summarised by the word equation:



Plants absorb water through their roots and carbon dioxide through the stomata (pores) in their leaves. Guard cells control the movement of gases in and out of leaves.

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. Oxygen is released into the atmosphere as a by-product of photosynthesis.

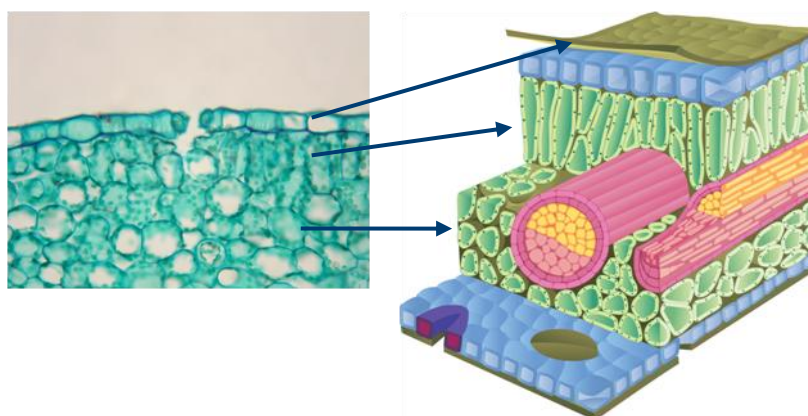
To make all the molecules that they need, plants have to obtain inorganic ions (often called mineral ions), including nitrate, phosphate, potassium and magnesium. They make the food that is used not only by the plants themselves, but also by all animals on Earth. Aerobic respiration also depends on the oxygen recycled by plants.

For healthy growth, plants must have all the inorganic ions that they need. In soils that lack essential minerals, they will show poor growth and develop deficiency symptoms such as yellowing or death of their leaves.

### Leaves

The structure of leaves is designed to achieve the best rate of photosynthesis. They are flat and thin to allow easy penetration of light and rapid diffusion of carbon dioxide into and oxygen out of the leaf.

The cells are also loosely packed to help diffusion of gases, and filled with chloroplasts to absorb the light energy.



**Figure 1** Leaves are designed to carry out photosynthesis.

### Factors limiting photosynthesis

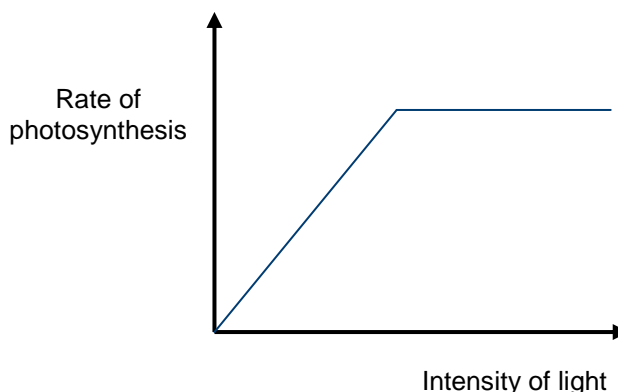
The rate of photosynthesis and the rate at which plants can grow depend on temperature, carbon dioxide concentration and light intensity. These factors can limit the rate of photosynthesis.

### Light intensity

Even if it is warm enough and there is enough water and carbon dioxide, photosynthesis will be slow if the intensity (brightness) of the light is low.

Increasing light intensity increases the speed of photosynthesis.

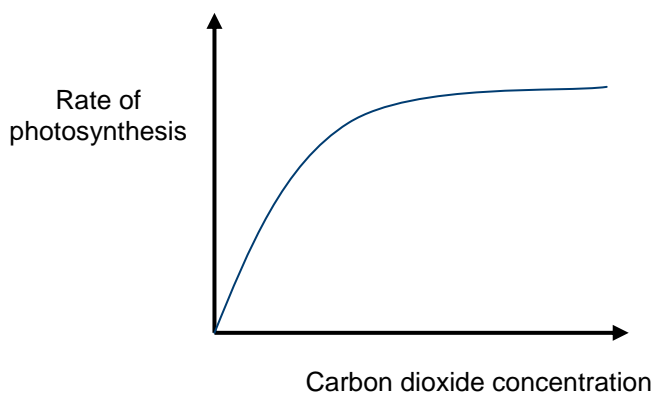
However, there is a limit beyond which the rate does not change.



### Carbon dioxide concentration

The concentration of carbon dioxide in the atmosphere is very low, typically about 0.04%.

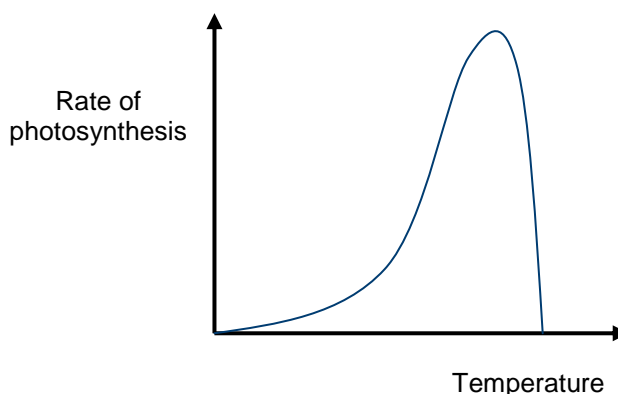
Even if it is warm enough, there is enough water and light intensity, photosynthesis will be slow if the concentration of carbon dioxide is low.



### Temperature

Even if there is enough water, carbon dioxide and light intensity the rate of photosynthesis will be slow if it is too cold.

On the other hand, plants cannot photosynthesise if it gets too hot. Enzymes used in photosynthesis are destroyed above about 45 °C.



### Finding out

Almost all tomatoes in Britain are grown in glasshouses.<sup>1</sup> How are conditions in a glasshouse controlled to increase the quality and yield of tomatoes?

**Figure 2** How different factors affect the rate of photosynthesis

Kew's famous glasshouses are one of the Gardens' most popular features. Under their domes botanical science, precision engineering and conservation come together in a unique setting.<sup>2</sup> How are the different environments in the glasshouses created?

<sup>1</sup> <http://www.britishtomatoes.co.uk/environment/index.html>

<sup>2</sup> <http://www.kew.org/visit-kew-gardens/garden-attractions-A-Z/glasshouses/index.htm>