NIGEL COLLINS

Photosynthesis

GCSE key words
Photosynthesis
Diffusion
Phloem
Xylem
Respiration

Plants are all around us. You know that most living things depend on plants, either directly or indirectly. But how much do you know about photosynthesis, beyond the basic equation? In this article we explore some of the basics but also take a detailed look at the intimate workings of the structures upon which life on Earth depends — green leaves.

The process of photosynthesis, by which plants make a range of biochemical compounds, is represented in Figure 1. It is important to realise that plants don't stop at making sugar (and starch). Almost all biochemical compounds are produced either directly or indirectly as a result of the activities of plants. The production of these compounds underpins growth.

PHOTOSYNTHETIC BASICS

Let us look at how photosynthesis actually ties in with growth. We must remember that respiration is happening all the time in all cells in all living things. Taken on its own, photosynthesis adds materials to the structure of a plant. By contrast, respiration causes a loss of materials. Neither process occurs at a fixed rate.

Plants need light for photosynthesis to take place. The rate at which they carry it out depends in part on light intensity. At low light intensities photosynthesis is slow. As the light intensity increases, so does the rate of photosynthesis. Often a limit is reached at which the plant cannot photosynthesise any faster — this is because there are other factors limiting photosynthesis — perhaps the supply of carbon dioxide or the temperature.

When plants are photosynthesising faster than they are respiring they are *adding* chemicals to their overall structure. When they are respiring faster than they are photosynthesising, there is an overall *loss* of chemicals from the structure of the plant. If you think carefully about this it means that the plant can shrink…well, sort of! Much of the structure of a plant is water, so the loss of biochemical compounds from the dry matter in a plant is neither noticeable to the naked eye nor easily detected, but it happens, nevertheless. Figure 2 summarises the relationship between photosynthesis and respiration in leaves as light intensity varies over 24 hours.

It is thought that the most common protein on Earth is the enzyme ribulose bisphosphate carboxylase-oxidase (RuBisCO for short) which is involved with trapping carbon dioxide during photosynthesis inside mesophyll cells.

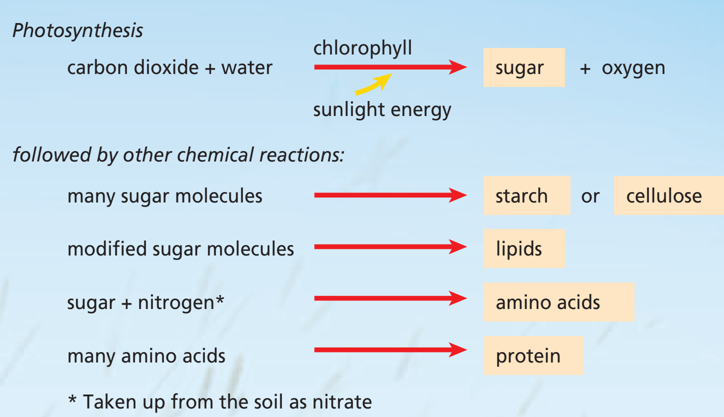

***Figure 1** Products of photosynthesis*

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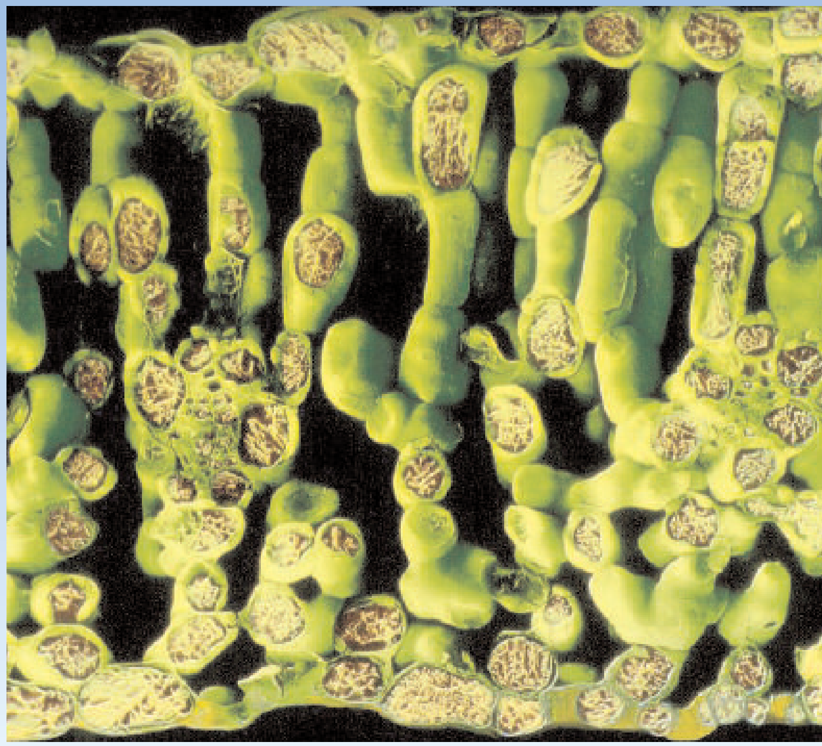
Right: *Coloured scanning electron micrograph of a fractured turnip leaf. The epidermis, palisade and spongy mesophyll cells can clearly be seen*



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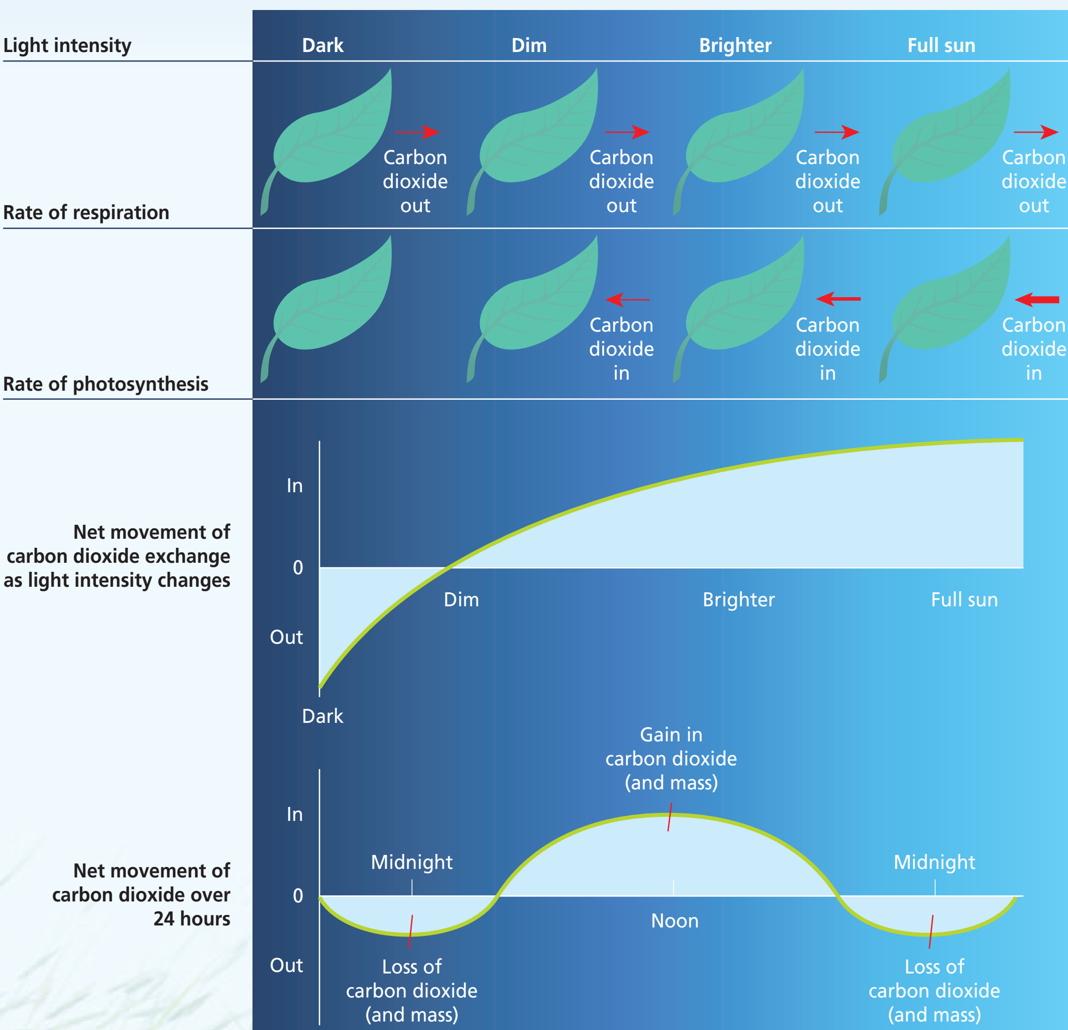
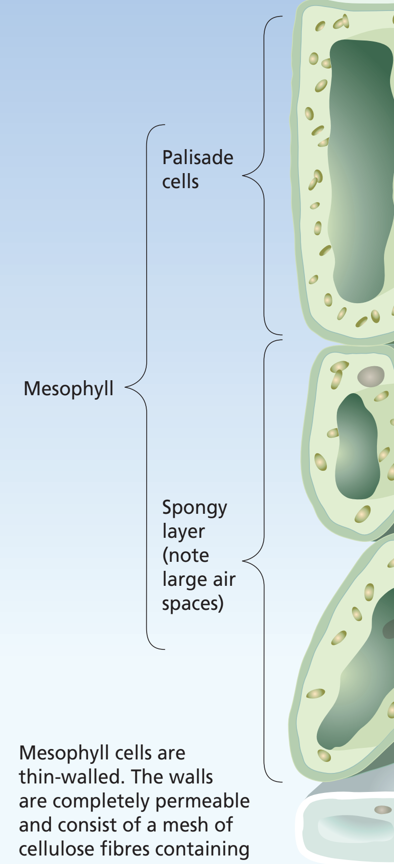
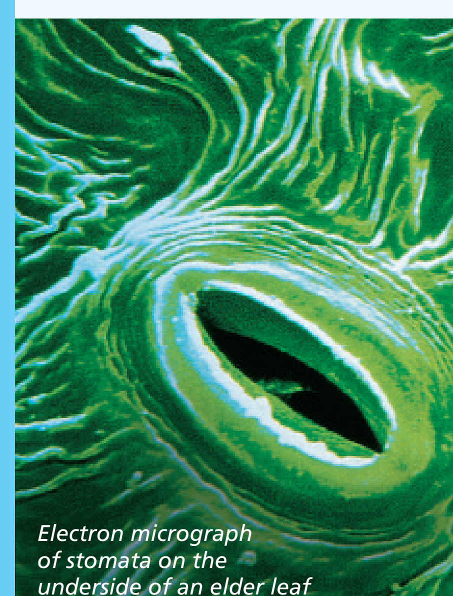


Figure 2 *The relationship between respiration and photosynthesis in leaves*

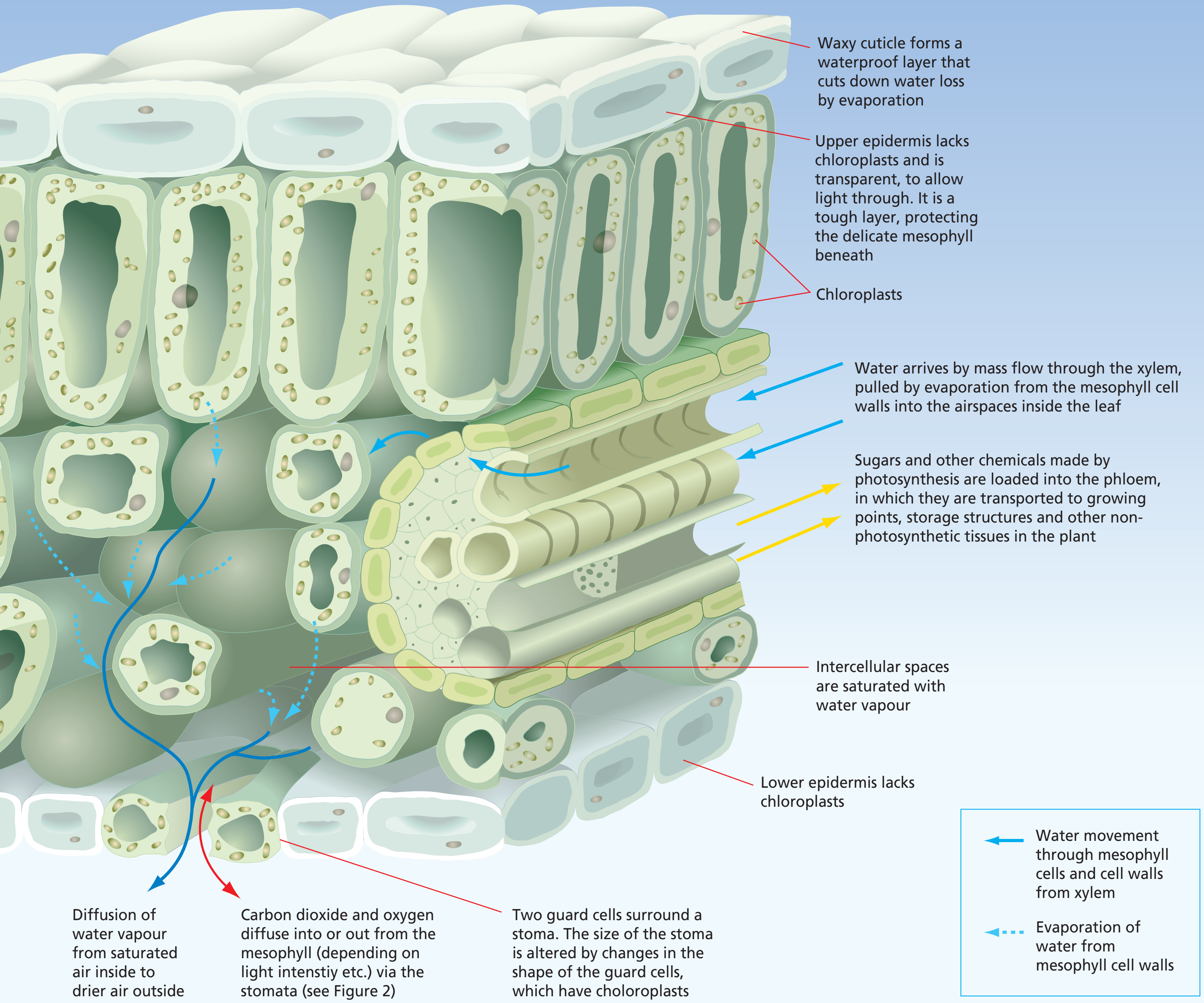
Figure 3
Leaf structure

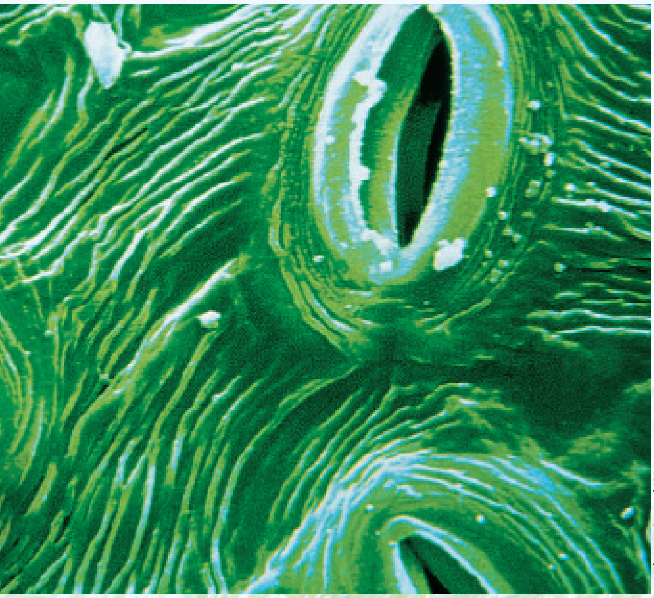


Mesophyll cells are thin-walled. The walls are completely permeable and consist of a mesh of cellulose fibres containing water, which evaporates into the air spaces. Oxygen and carbon dioxide can be dissolved in or released from this water without hindrance. The cell wall is tough, like a string bag or vest



Electron micrograph of stomata on the underside of an elder leaf





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LEAF STRUCTURE

Plants are multicellular organisms — some of them are huge, dwarfing the largest animals. As in all multicellular organisms with complex structures, there have to be some parts of the structure where they take materials in and give them out. However large the organism may be, these interfaces where exchanges occur with the surroundings are incredibly thin, delicate and potentially vulnerable.

In animals these surfaces occur in lungs, guts and the tubules inside kidneys. In plants they occur in the short-lived root hairs, near root tips that grow through the soil, and inside leaves, where mesophyll cells (literally the middle-leaf cells) are in contact with air spaces inside the leaves.

Nigel Collins teaches biology and is an editor of CATALYST.

Most details of the mechanism of photosynthesis were worked out in the first half of the twentieth century.

Mesophyll means middle leaf.

The plural of stoma is stomata.

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