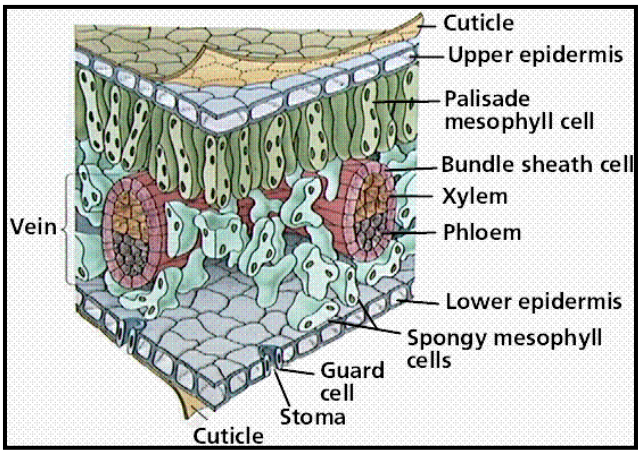
Section 3.1 + 3.2 – Photosynthesis and the light dependent reaction

Leaf adaptations

Leaves are adapted to brig together the 3 raw materials of photosynthesis.



Adaptations – Air spaces, waxy cuticle, xylem, stomata, thin upper epidermis, palisade layer.

There are three main stages of photosynthesis:

1. Capturing of light energy
2. LDR – splitting of water, products are reduced NADP, ATP and O2
3. LIR – CO2 is reduced to produce sugars + other organic molecules.

Oxidation and reduction

Oil rig is often used to remember the difference between oxidation and reduction

Oxidation **i**s **l**oss of electrons – as well as the loss of H+ ions and the gaining of Oxygen

Reduction **i**s **g**aining electrons – as well as gaining H+ ion and losing oxygen

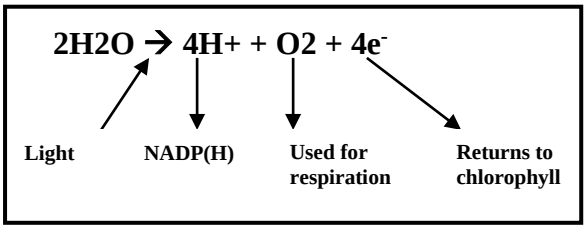
In oxidation, energy is released, in reduction, energy is required

The making of ATP

Chlorophyll absorbs light energy
2 electrons move to high energy levels and leave the chlorophyll molecule.
Electrons are taken up by electron carriers
Electrons are transferred along an electron transfer chain
Electrons loose energy at each stage, which is used to make ATP

Photolysis

The electrons that are lost from the chlorophyll are replaced by electrons released during the photolysis of water where oxygen is released as a bi-product.



Section 3.3 – The light – independent reaction

The products of the light dependent reaction are ATP and reduced NADP. These products are used to reduce carbon in the LID reaction.
This stage does not require light, however it does require the products form the light dependent reaction.

The Calvin cycle

The numbered stages of the Calvin cycle are:

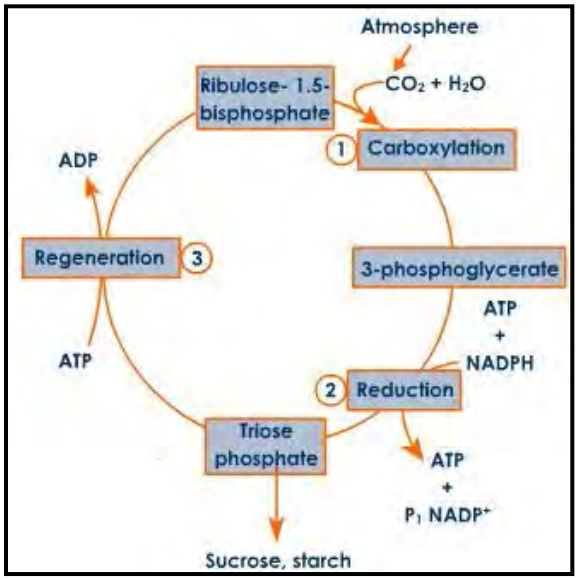
1. Carbon dioxide from the atmosphere diffuses into the leaf through the leaf stomata, in to the cell wall, then into the cytoplasm, and finally into the chloroplast stroma.
2. In the stroma, the carbon dioxide combines with a 5 carbon compound called **ribulose biphosphate (RuBP)** using an enzyme.
3. The combination of the carbon dioxide and the RuBP produces two new molecules of a 3 carbon compound called **glycerate 3-phosphate (GP)**
4. ATP and reduced NADP from the light independent reaction are used to activate the 3-phosphate to **triose phosphate (TP).**
5. The NADP is reformed and returns to the light dependent reaction cycle
6. Some triose phosphate molecules are converted to useful organic substances such as glucose.
7. Most triose phosphate molecules are used to regenerate ribulose biphosphate using ATP from the light dependent reaction.

Site of the light-independent reaction

The light independent reaction takes place in the stroma of the chloroplasts.

The chloroplast is adapted to carrying out the light independent reaction in the following ways:

- The fluid from the stroma contains all the necessary enzymes to carry out the light independent reaction. (Reduction of carbon dioxide).
- The stroma fluid surrounds the grana and so the products of the light dependent reaction I the grana can readily diffuse into the stroma.
- It contains both DNA and ribosomes so it can quickly and easily manufacture some of the proteins needed for the light-independent reaction.



Section 3.4 – Factors affecting photosynthesis

Limiting factors

The rate of photosynthesis is always restricted by just one factor. This is called a limiting factor. Changing the levels of other factors will not affect the rate of photosynthesis.

If light is a limiting factor, increasing the temperature for example will not affect the rate of photosynthesis.
If instead we increase the light intensity, the rate of photosynthesis will increase. However this will not continue indefinitely. Photosynthesis will eventually be limited by a different factor.

Photosynthesis is made up of a series of small reactions. It is the slowest of these reactions that determines the overall rate of photosynthesis.

The law of limiting factors – At any given moment, the rate of photosynthesis is limited by the factor that is at its least favourable value.

The effect of light intensity

The rate of photosynthesis can be measured by the volume of O_2 given off or CO_2 used up in a given time.
When light is a limiting factor, the rate of photosynthesis is proportional to light intensity.
The compensation point is the point at which O_2 used up in respiration is equal to the O_2 given off in photosynthesis. There is therefore no net gas exchange.

The effect of carbon dioxide on the rate of photosynthesis

The optimum CO_2 concentration for photosynthesis is 0.1% whereas the CO_2 concentration in the atmosphere is 0.04%.
High CO_2 concentrations can effect the enzyme catalysed reactions that combine ribulose biphosphate with CO_2.

The effect of temperature on the rate of photosynthesis

Between 0 - 25^{o}c the rate of photosynthesis approximately doubles for each 10^{o}c rise in temperature.
Higher temperatures often cause the rate of photosynthesis to decrease since enzymes become denatured.