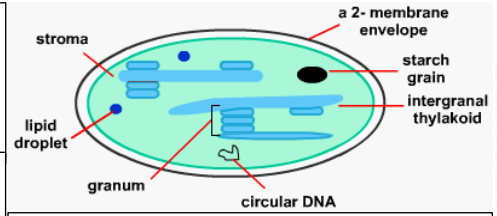
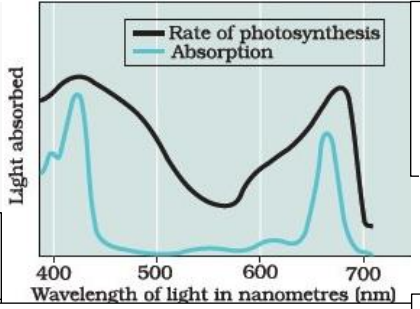
How the structure of the chloroplast is adapted to its function in photosynthesis
The membrane and disc shape gives a high S.A for light absorption
The grana contains a lot of pigment needed for light absorption
Permeable membrane allows the diffusion of gases
Membrane provides a surface for attachment of electron for the LDR
Stroma contains enzymes needed for the Calvin Cycle

Explain how the palisade cell is adapted for photosynthesis.
Contains many chloroplasts thus lots of chlorophyll:
To trap or absorb light (energy);
Elongated cells with long axis perpendicular to the surface:
Light has a longer pathway allowing maximum light absorption / light penetration;
Chloroplasts move;
To trap or absorb light (energy)
Range of pigments; carotenes, xanthophyll, chlorophylls
Can absorb a range of wavelengths / colours / for max light absorption;
Large S.A. or cell wall feature e.g. thin / permeable;



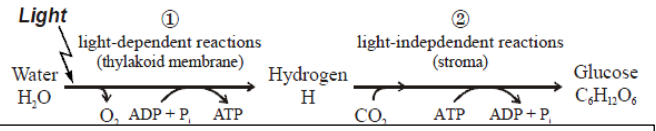
Photosynthesis is driven by the absorption of light. Plants contain pigments with allow the plant to absorb different wavelengths of light, maximising photosynthesis.



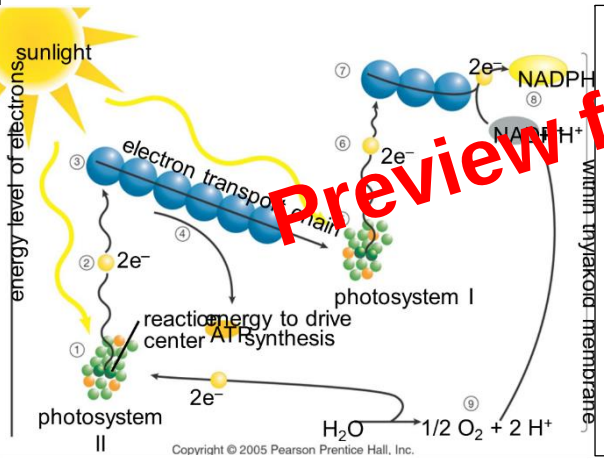
The absorption action spectrum shows that the level of light absorbed corresponds to a specific wavelength of light. Green light is reflected, therefore the plants look green. The action spectrum measures the rate of photosynthesis at a specific wavelength of light

Peaks occur at 650-700nm (red light) and 400-450nm (blue light), and there is a correlation between the peak for absorption and action . where most light is absorbed, there is more

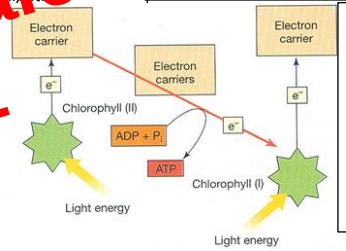
The light dependent reaction takes place in the thylakoid membrane. Light is used to excite electrons in chlorophyll and raise them to a higher energy level. They pass through a series of redox reactions as the electron is passed to electron carriers which are each in lower energy states. Photolysis of water occurs which produces oxygen and a hydrogen ion to replace the electron lost in the photosystem. The hydrogen produced is used to produce NADPH from NADP.



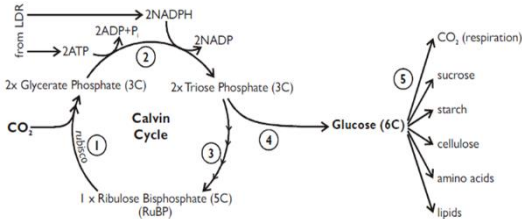
The light independent reaction occurs in the stroma. RuBP is a carbon dioxide acceptor and it combines with CO2 in a reaction catalysed by Rubisco. A 6C intermediate forms and splits into 2x 3GP molecules. GP is converted into TP and this reduction reaction where NADPH provides H and ATP provides energy. Some TP is converted to glucose, but most of it regenerates RuBP (ATP provides Pi).

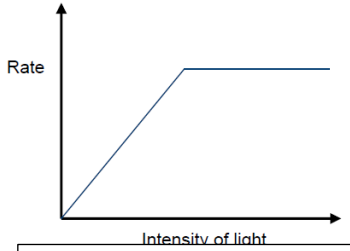


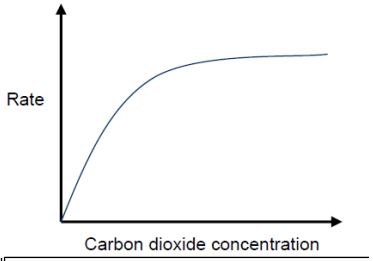
Process of LDR
1.light is absorbed by PSII
2.electrons are excited to a higher energy level
3.electrons are taken up by the primary electron acceptor
4.electrons are passed down the electron transport chain (PSII) through a series of redox reactions, releasing energy to form ATP (photophosphorylation)
5.electrons replace those lost in PSI
6.excited electrons leave PSI
7.electrons are accepted by the primary electron acceptor
8.electrons and hydrogen from photolysis reduce NADP
9.water is split through photolysis. Electrons replace those lost in PSII and the oxygen is either used in respiration or it is diffused in the atmosphere.

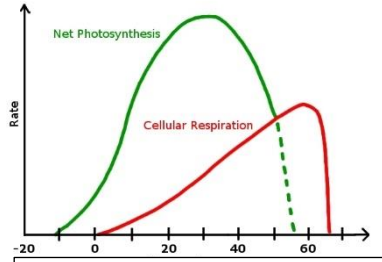


Cyclical photophosphorylation: only involves PSI, electrons cycle between it and the electron transport chain. This process will only produce ATP, no oxygen or reduced NADP, no photolysis of water occurs. This helps to match ATP levels with reduced NADP levels to maximise the production of hexose sugar in the









Light
A= Light is the limiting factor because..as light intensity increases, the rate of the light-dependent reaction, and therefore photosynthesis generally, increases proportionately (straight line relationship). The more light the greater the number of chlorophyll molecules that are ionised and the more ATP and NADPH are generated
B = The rate of photosynthesis is eventually limited by some other factor. So the rate plateaus.
Chlorophyll a is used in both photosystems. The wavelength of light is also important. PSI absorbs energy most efficiently at 700 nm and PSII at 680 nm. Light with a higher proportion of energy concentrated in these wavelengths will produce a higher rate of photosynthesis.

Carbon Dioxide
A = Carbon Dioxide concentration is the limiting factor because……An increase in the carbon dioxide concentration increases the rate at which carbon is incorporated into carbohydrate in the light-independent reaction, and so the rate of photosynthesis generally increases

B = Rate of photosynthesis is limited by another factor.

As it is normally present in the atmosphere at very low concentrations (about 0.04%), increasing carbon dioxide concentration causes a rapid rise in the rate of photosynthesis, which eventually plateaus when the maximum rate of fixation is reached.

Temperature
Light dependent reactions are not affected by temperature, the light *in*dependent reactions *are*. They are reactions catalysed by enzymes. As the enzymes approach their optimum temperatures the overall rate increases. It approximately doubles for every 10 °C increase in temperature. Above the optimum temperature the rate begins to decrease, as enzymes are denatured. Since temp will increase the rate of the LIS but have little effect on the LDS, eventually the availability of products form the LDS will limit the rate of photosynthesis.
Above 25, enzymes are not denaturing, but rate of respiration a more temperature dependent process (more enzymatic) is increasing more and the net uptake of carbon dioxide is actually decreasing.

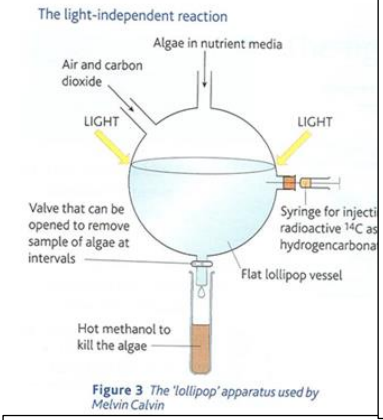


Figure 3 *The 'lollipop' apparatus used by Melvin Calvin*

Identifying the intermediates in the Light Independent Reactions
The 'Lollipop' experiment was used by **Melvin Calvin** to work out the details of the light independent reactions.
Suggest a reason why the carbon dioxide supplied to the algae was radioactively labelled.
Single celled algae are grown in a solution of radioactive hydrogencarbonate (^{14}C) which supplies radioactive Carbon dioxide and will be incorporated into the intermediate compounds which can then be identified.
Suggest an explanation of how the hot methanol might stop further chemical reactions taking place.
At 5 second intervals samples of the algae are dropped in to hot methanol (stops chemical reactions instantly, through enzyme denaturation), the compounds are separated (two way chromatography) out and those that are radioactive are identified and the pathway established by the time at which the substances appear.
Why use a rapid action tap? The rapid action tap is essential because the reactions occur quickly and the samples can be removed after a precise time period.

Algae are grown under light in the thin transparent lollipop.
Radioactive Carbon 14 in the form of hydrogencarbonate is injected
At intervals algae are dropped into the hot methanol to stop the reaction
The compounds are separated
The radioactive compounds are identified and the pathway is determined by the time at which each first appeared

The law of limiting factors states that the rate of a process that depends on numerous factors will be limited by the factor which is in the shortest supply. Any change in the level of a limiting factor will affect the rate of the reaction.

Compensation point: rate of photosynthesis = rate of respiration

PHOTOSYNTHESIS