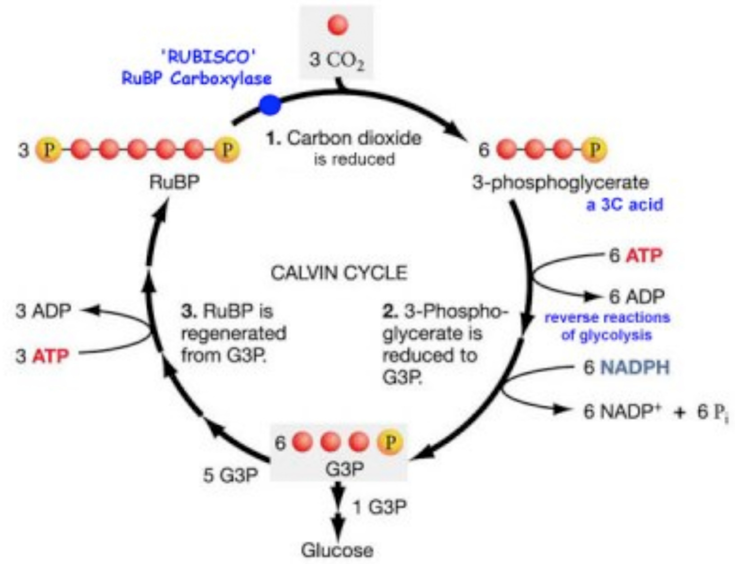
The Electron Transport Chain

This is crucial to both photosynthesis and respiration. In photosynthesis, it provides ATP and reduced NADH$^+$ for the Calvin cycle, and in respiration it uses NADH$^+$ to create ATP and water.

The electron carrier chain is based upon a sequence of increasingly electrophilic acceptors; each one is more electrophilic than the last, and so will tend to pinch the electron from the carrier preceeding it. As the electron moves along the chain, however, energy is released, as the electron falls down energy levels. In photosynthesis, this energy is used to pump H$^+$ ions into the stroma from the thykaloid space, creating a diffusion gradient. The same happens in mitochondria, except the ions are pumped into the cristae from the intercellular space. When the H$^+$ ions are released back into the space, they travel down a diffusion gradient, and this process is used by ATPase to make ATP from ADP + P (this requires energy, generated by the diffusion).

At the end of the process we have a load of hydrogen ions in the 'space' and lots of electrons. In photosynthesis, these are used together to reduce NAD to NADH$^+$. Therefore, we produced NADH$^+$ and ATP from the electron carrier chain in photosynthesis. These go on to fuel to the light independent reaction, the Calvin cycle.

In respiration, however, the resultant hydrogen ions and electrons are used in the reverse fashion. They originally came from water, photolysed by light in the chloroplasts, and as the final act of this grand cycle, they are recombined with oxygen to form water once more!



Photosynthetic electron carrier chain: H_2O ---> ATP + NADH$^+$

Respiratory electron carrier chain: NADH$^+$ + O_2 ---> ATP & H_2O

The Calvin cycle

The calvin cycle, or the light independent reaction, uses the ATP and NADH$^+$ made by the light dependent reaction to integrate CO_2 with hydrogen to form sugars. This is done by an enzyme called Rubisco.

These sugars are what are then used as fuel to power the TCA cycle in respiration.

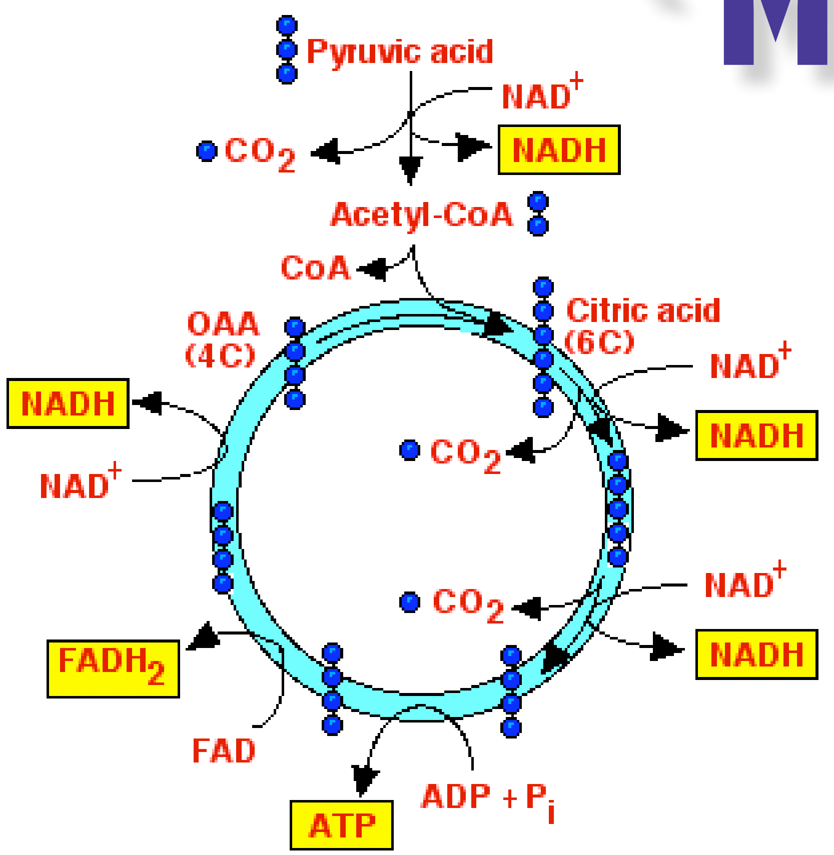
NADH$^+$ + ATP ← **Chloroplasts**

The link between **Chloroplasts** & **Mitochondria**

Glucose + O_2 → **Mitochondria** → H_2O + CO_2 → Chloroplasts

Mitochondria → ATP

Both chloroplasts and mitochondria have their own double membranes, and reproduce independent of the rest of the cell through binary fission. This indicates that before they became integrated into our cells, they were endosymbiotic bacteria. Due to their shared reliance on the electron transport chain, it seems likely that they also shared a common bacterial ancestor.



The Krebs/ TCA/ Citric Acid cycle

The citric acid cycle is essentially the manipulation of carboxylic acids with the aim of producing reduced NADH and $FADH_2$, along with a little ATP . The pyruvic acid which is an input at the top of this diagram is produced from glycolysis, a prior process which turns all the sugars that we eat into pyruvic acid so that the TCA acid can take place.

The NADP and $FADH_2$ are important because they carry hydrogen ions and electrons to the electron transport chain, which is similar to that in chloroplasts. From the reactions in the chain, ATP can be produced.

This ATP can then be reacted with water to form ADP + P, which releases a large amount of energy. ATP is therefore a useful 'energy currency' which can be util ized whenever, and wherever necessary.

ATP ---> ADP + P
+ Energy