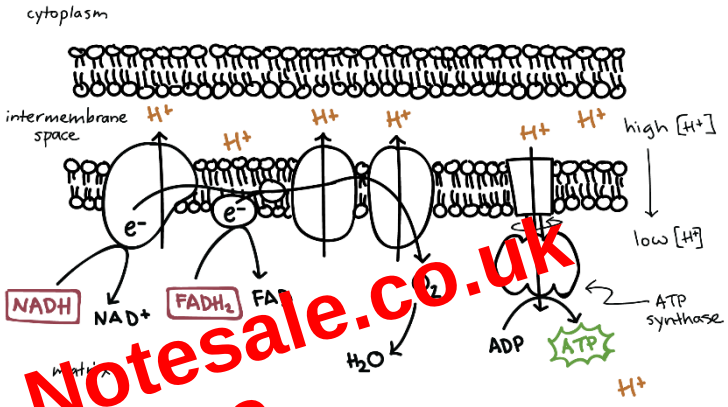
Oxidative Phosphorylation:

The hydrogen atoms or their electrons are transported along a series of carriers, from the reduced NAD or FAD, to be combined with oxygen to form water. Therefore, the role of oxygen in this process is that of the final hydrogen acceptor. This final reaction to form water only occurs after the energy level has been lowered by a series of transfers between carriers, bringing about the gradual transfer of energy.

As electrons are passed between the carriers, energy is transferred. Transfer of energy in this manner is controlled and can be used by the cell. The energy is transferred to the ADP and Pi, forming ATP. For every molecule of reduced NAD that is oxidised, approximately three molecules of ATP are produced.

This means that the total yield from aerobic respiration is about 38 ATPs per molecule of glucose – significantly more than from glycolysis. There are other pathways involved, making the value of 38 only approximate.

ATP formation by chemiosmosis:



Chemiosmosis is the process by which the synthesis of ATP is coupled to electron transport via the movement of protons. Electron carrier proteins are arranged in the inner mitochondrial membrane in a highly ordered way. These carrier proteins oxidise the reduced coenzymes, and the energy from this process is used to pump hydrogen ions from the matrix of the mitochondrion into the space between inner and outer mitochondrial membranes.

Here the H+ ions accumulate, causing the PH to drop. Because the inner membrane is largely impermeable to ions, a significant difference in proton concentration builds up, generating an electrochemical gradient across the inner membrane – a store of potential energy.

Eventually, the protons do flow back into the matrix, via channels in ATP synthetase enzymes, also found in the inner mitochondrial membrane. As the protons flow down their concentration gradient through the enzyme, the energy is transferred, and ATP synthesis occurs.

Anaerobic respiration:

In the absence of oxygen, many organisms will continue to respire through a process known as anaerobic respiration or fermentation. Oxygen is the final hydrogen acceptor in aerobic respiration, and therefore without it, the carriers of oxidative phosphorylation will all become reduced, and the flow of electrons and protons will cease. The Kreb's cycle will also cease, and therefore glycolysis is relied upon to produce the ATP. This reduces the net gain from 38 ATP molecules to 2, and therefore although respiration can still occur without oxygen, it is very inefficient.

The lack of oxygen causes a build up of pyruvic acid as there is no link reaction to use it up, and it is then channelled into other biochemical pathways. In animal cells this results in the formation of lactate (lactic acid), as the pyruvate acts as the acceptor for reduced NAD, whilst in plant cells ethanal acts as this acceptor, resulting in the formation of ethanol.

Both lactate and ethanol contain large quantities of chemical energy, indicating that the glucose has only been partially broken down and explaining the low ATP yield.