4.5 Anaerobic respiration

Anaerobic respiration in mammals and yeast

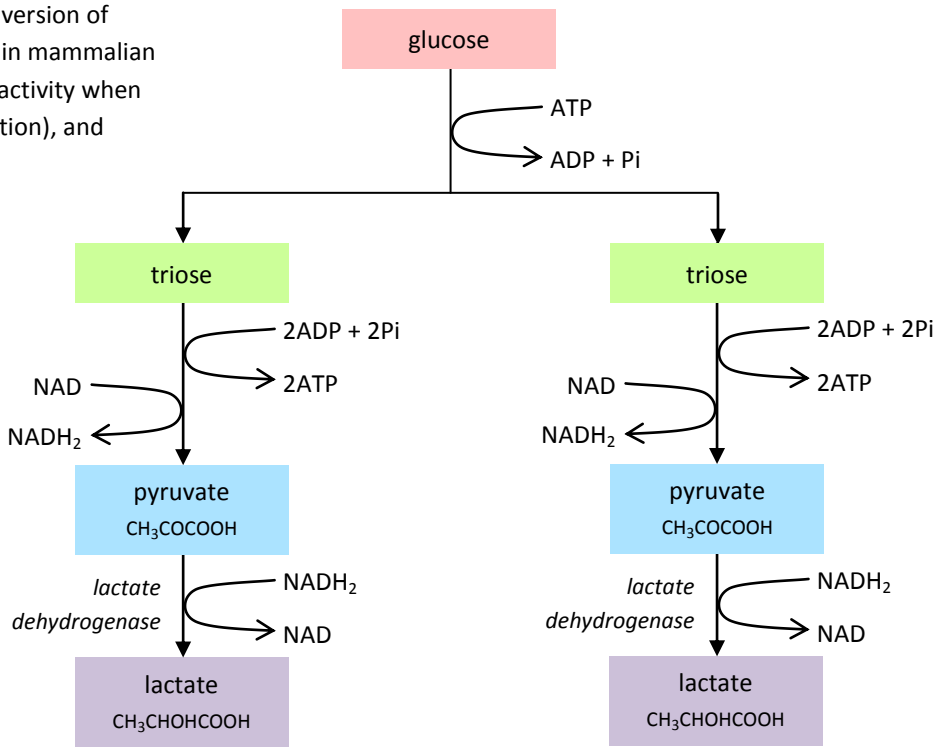
Oxidative phosphorylation, the 'end' process of the electron transport chain, uses oxygen as its final electron acceptor. This means that when oxygen is not present, the electron transport chain stops, and Krebs cycle (and the link reaction) must also stop too. This leaves only the anaerobic process of glycolysis to produce ATP.

The electron transport chain reoxidises any reduced NAD that have gained hydrogen during glycolysis, the link reaction and Krebs cycle, so without this process, how does the NAD which is reduced under anaerobic glycolysis get reoxidised? It has to be reoxidised to give the organism any chance of surviving, otherwise they will run out of NAD to use for glycolysis. Animals will use *lactate fermentation* and fungi such as yeast will use *alcoholic fermentation*.

Neither method produces any ATP, but they do reoxidise the reduced NAD, which allows it to be used once more for glycolysis, which in itself has a net yield of 2 ATP (although this is not a great deal of ATP).

Lactate fermentation

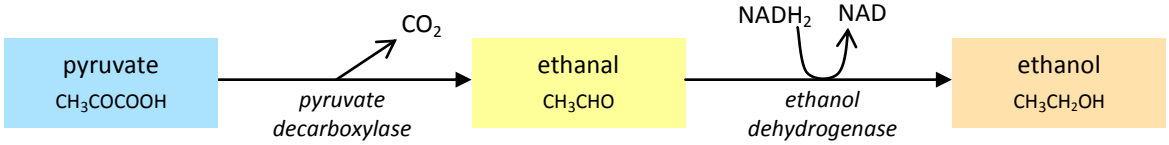
Anaerobic respiration is just a modified version of glycolysis. **Lactate fermentation** occurs in mammalian muscle tissue, during times of vigorous activity when ATP demand is high (for muscle contraction), and there is an oxygen deficit.



This pathway begins with glycolysis as normal, and the pyruvate molecules end up being the hydrogen acceptors to reoxidise the reduced NAD, forming **lactate** which is carried away from the muscle tissue by the blood, to the liver. When oxygen becomes later available again, the lactate may be converted back to pyruvate (so that it can be aerobically respired and go through Krebs cycle). However, if not, a build up of lactate can result in a decrease of the pH of muscles, so enzyme activity is reduced (it is not the lactate build up directly which causes muscular fatigue, it is this pH reduction). The enzyme which catalyses the oxidation of $NADH_2$ and the reduction of pyruvate to lactate is called **lactate dehydrogenase**.

Alcoholic fermentation

Under anaerobic conditions in yeast cells, each pyruvate molecule is *decarboxylated* (loses one carbon dioxide molecule), becoming **ethanal**. This reaction is catalysed by the enzyme **pyruvate decarboxylase**. The ethanol will begin to accept the hydrogen atoms from reduced NAD, reoxidising the NAD, but reducing the ethanal to **ethanol**, a reaction catalysed by the enzyme **ethanol dehydrogenase**. This reoxidised NAD can therefore be used once more to produce ATP in glycolysis.



Although yeast is able to survive in anaerobic conditions (without oxygen), it dies if the ethanol concentration builds up to around 15% as ethanol is a poisonous substance.