Name of Subject - Botany

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Oxidative Phosphorylation

During respiration (aerobic) there is a no. of oxidative steps. Almost at every oxidative steps hydrogen is removed. That removed hydrogen is usually accepted by NAD (Nicotinamide adenine dinucleotide). In some cases FAD (Flavin adenine dinucleotide) also functions as hydrogen acceptor. After accepting hydrogen NAD and FAD get reduced into $NADH_2$ and $FADH_2$.

These NAD and FAD which are co-enzyme and prosthetic group respectively, remain associated on the one hand with Krebs' cycle and on the other hand with electron transport system.

These reduced NAD and FAD i.e. $NADH_2$ and $FADH_2$ are oxidised through electron-transport system. During the oxidation of $NADH_2$ and $FADH_2$, molecules of ATPs are formed. This process of formation of ATP by the oxidation of substrate is called oxidative phosphorylation.

The following are the different steps of oxidative phosphorylation -

(A) During Glycolysis: ETS → 3ATP.

3 PGAL —(NAD → NADH$_2$)→ 1,3 diphosphoglyceric acid

(B) During Krebs' Cycle:

(I) Pyruvic acid —(NAD, NADH₂, ETS, 3ATP)→ Acetyl CoA

(II) Isocitric acid —(NAD, NADH₂, ETS, 3ATP)→ Oxalo-succinic acid

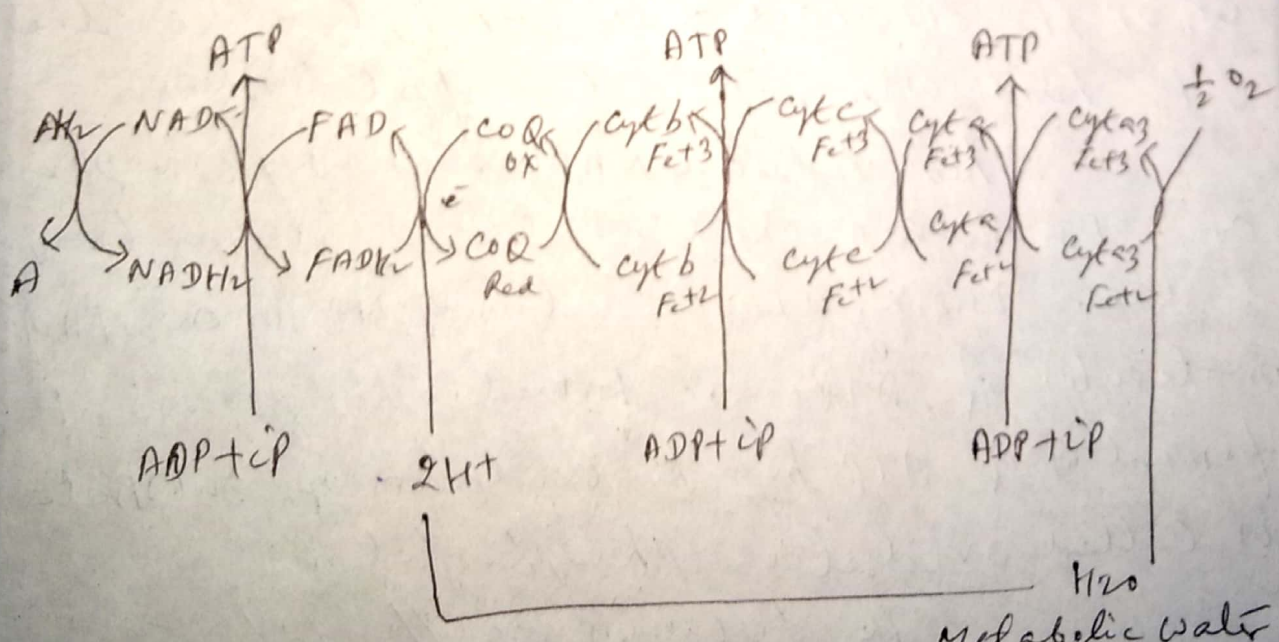
(III) α-Ketoglutaric acid —(NAD, NADH₂, ETS, 3ATP)→ Succinyl CoA

(IV) Succinic acid —(FAD, FADH₂, ETS, 2ATP)→ Fumaric acid

(V) Malic acid —(NAD, NADH₂, ETS, 3ATP)→ Oxaloacetic acid

From above oxidative steps it is quite clear that reduced NAD and FAD get oxidised through electron transport system. In electron transport system there are a no. of enzymes which remain arranged in a definite sequence.

Electron transport chain and steps of ATPs formation is excibited as under —



Electron Transport chain

Calculation of ATP formed during Aerobic Respiration

During glycolysis :-

① 3 molecules of ATPs are formed in the oxidation of PGAL into 1,3 diphospho glyceric acid. Because two molecules of PGAL are oxidised 6 molecules of ATP will be formed.

② Four molecules of ATPs are formed by substrate Phosphorylation, two from 1,3 diphospho glyceric acid and two molecules of ATPs from phospho-enol pyruvic acid.

Thus altogether 10 molecules of ATPs are formed. But two molecules of ATPs are consumed during Phosphorylation of hexoses. Thus there is a net gain of only eight molecules of ATP during glycolysis.

During Krebs' Cycle

As exhibited in connexion with different oxidative steps during Krebs' cycle there are 14 molecules of ATPs are formed from a molecule of pyruvic acid.

Thus from two molecules of pyruvic acid $14 \times 2 = 28$ ATP molecules are formed.

Two molecules of ATPs are formed during substrate phosphorylation during the conversion of Succinyl CoA to Succinic acid.

To make it more clear a molecule of Succinyl CoA causes the formation of a molecule of ATP.

Thereafter during aerobic respiration altogether 38 (30 ATP molecules of Krebs' cycle + 8 molecules of glycolysis) are formed from a molecule of glucose.

A molecule of ATP is believed to produce about 10 K.Cal. energy. Thus 38 molecules of ATP will produce 380 K. Cals. Energy. In a molecule of glucose 671 K. Cal. energy remains stored. Thus liberated is — $\frac{380}{671} \times 100 = 57\%$ approx.