Electron transport system

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In Krebs's cycle, there are four dehydrogenation steps which results formation of NAD^+ to NADH and FAD^+ to FADH. These compounds are reoxidized within the mitochondria. Although this oxidation involves O_2 uptake and H_2O production, neither NADH nor FAD can combine directly with O_2 to form H_2O. Rather their electrons are transferred via several intermediate compounds and constitute the **electron transport system** of mitochondria. This ETS also referred as respiratory chain.

In ETS, electrons flow through the chain **in a stepwise manner** from **more electronegative compounds to more electropositive compounds**. The electron will flow from a higher to a lower energy level. In each step of the system, the energy level of the electron is lowered and this energy difference is transformed into phosphate bond energy by the conversion of ADP to ATP. The process is called **oxidative phosphorylation.**

The ETS consists of four multi-protein complexes.

1. Complex-I: It consists of NADH-dehydrogenenase which contains a flavoprotein FMN and is associated with non-heme iron-sulphur(Fe-S) proteins. It is responsible for passing electrons from mitochondrial NADH to Ubiquinone (UQ).
   $NADH + UQ + H^+ \leftrightarrows NAD^+ + UQH_2$
2. Complex-II: This complex consists of succinate dehydrogenase which contains a flavoprotein called FAD and is associated with non-heme iron –sulphur(Fe-S) proteins. This complex receives electrons from succinic acid and passes them to Ubiquinone(UQ).
   Succinate +UQ → Fumarate + UQH_2
3. Complex-III: This complex consists of Dihydroubiquinone(UQH_2): Cytochrome- C Oxidoreductase, two forms of cytochrome b, Fe-S proteins and Cytochrome C_1. This complex receives electrons from UQH_2 and passes them to Cytochrome C. The protons received from are released out.
   UQH_2+ 2 ferricytochrome C $\leftrightarrows$UQ +2 ferrocytochrome C + $2H^+$

4. Complex-IV: This complex consists of Cytochrome C: Cytochrome oxidase, Cytochrome- a and Cytochrome a_3. The enzyme cytochrome oxidase contains two atoms of cupper in addition to two molecules of heme iron. This complex receives electrons from cytochrome C and passes them to $1/2O_2$. Two protons are needed and an H2O.molecule is formed.
2 ferrocytochrome –C+2H$^+$ + 1/2O_2 ⇆ 2 ferricytochrome-C +H_2O.

The transfer of electrons from NADH to O_2 via complex I through IV coupled to the synthesis of ATP from ADP and inorganic phosphate is known as **oxidative phosphorylation**. There are three sites of phosphorylation during ETS.

1. During the transport of electrons from NADH to UQ through Fe-S in complex-I.
2. From within the complex-III to cytochrome C, and
3. From cytochrome a to cytochrome a_3 in the complex –IV.

In this way in terminal oxidation of NADH results in the formation of 3ATP molecules while oxidation of $FADH_2$ results in production of 2ATP molecules.

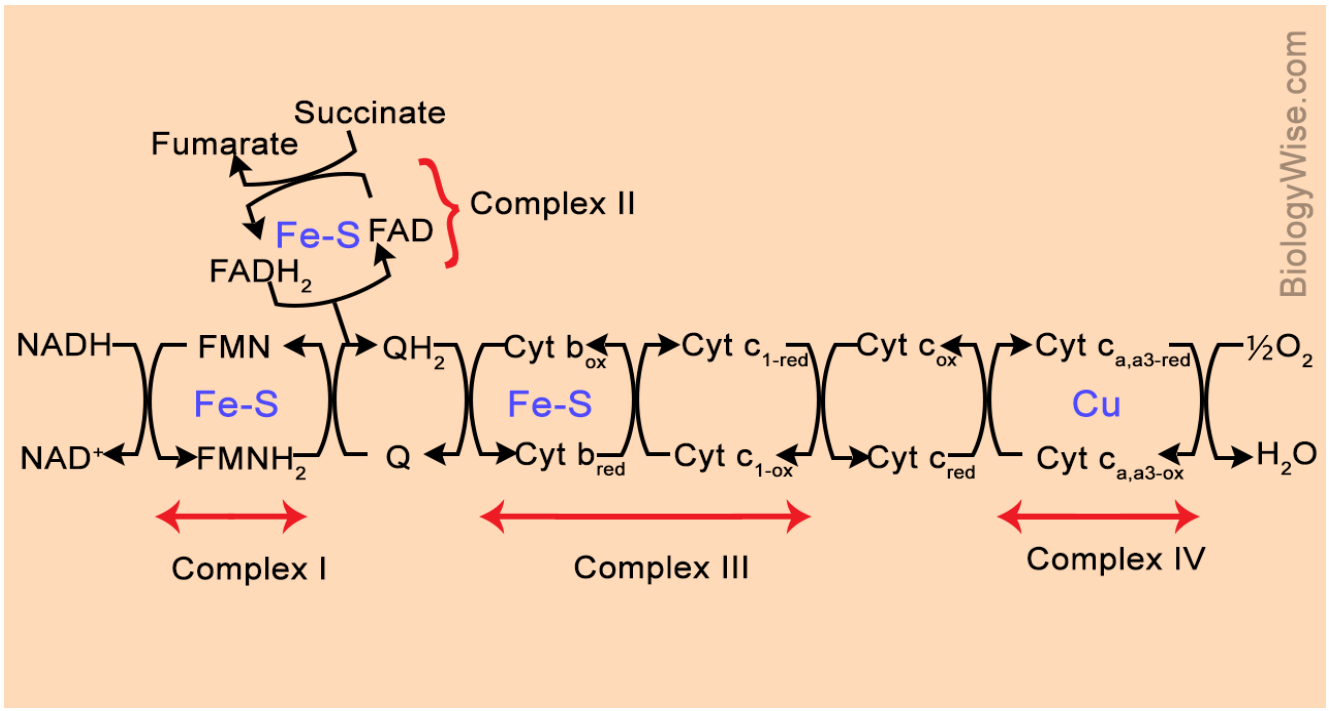

Fig: ETS. Flow of electron.