

# Mitochondrial Electron Transport chain and Oxidative Phosphorylation (Part I)

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Introduction :- Mitochondria are power houses of cell because respiratory chains or Electron Transport chain are power generators of mitochondria. Respiratory chains are sets of proteins, non-protein complexes, as constituent of inner membrane (IM) arranged in sequence of increasing redox potential. The chain allows electrons to flow through its constituent to meet finally oxygen forming  $H_2O$  using protons from matrix. While electrons are transferred through respiratory chain, protons from matrix are pumped out of IM creating a proton gradient across IM. This proton gradient creates a proton motive force that drives protons into matrix through specific sites of  $F_0-F_1$  particles. Proton flow through  $F_0$  subunit induces

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cyclic conformational changes in  $F_1$  subunit, which attains Adenosine triphosphate (ATP) synthase activity. The ATP synthase brings about phosphorylation of Adenosine Diphosphate (ADP) to ATP.

This Electron Transport chain gets electrons from reduced Nicotinamide Adenine Dinucleotide (NAD), a carrier of electron pair as hydride ion and from reduced Flavin Adenine Dinucleotide (FAD), a carrier of electron pair as hydrogen. Reduced NAD is generated by dehydrogenases in cytosol through glycolysis (Glyceraldehyde-3-Poy dehydrogenase) and in mitochon-  
dria by Krebs Cycle. (Pyruvate dehydrogenase,  $\alpha$ -keto glutarate dehydrogenase, Iso-citrate dehydrogenase and malate dehydrogenase) and fatty acid Oxidation ( $\beta$ -hydroxyacyl CoA dehydrogenase). Reduced FAD is generated in cytosol by glyceraldehyde-3-Poy dehydrogenase and in mitochon-  
dria by Succinate dehydrogenase of Krebs Cycle and acyl CoA dehydrogenase of fatty acid oxidation.

Structure of Respiratory Chain :- The components of

Electron Transport chain are identifiable into four molecular complexes, such as Complex I, II, III and IV. They are arranged closely in sequence of increasing redox potential. In addition to these complexes, two other molecules named Coenzyme Q and Cytochrome c (Cyt c) are present in the chain as mobile connecting links between Specific complexes. The CoQ connects Complex I and II and Cyt c connects Complex III and IV. These four complexes, while transferring electrons also acts as proton pumps and create proton gradient across IM. There is also a complex V named ATP Synthase, which does not participate in electron transfer but uses proton gradient in ATP synthesis.

The four complexes of respiratory chain possess one or more redox centres for transfer of electrons. The redox centres are basically Iron centres present as heme or nonheme Iron. Heme centres are in the form of heme a, heme b, and heme c present in cytochromes a, b and c, respectively. Cytochromes a and c are of two types. They are cytochromes a and a<sub>1</sub> and cytochromes c and c<sub>1</sub>. The cytochromes differ from each other on account of substituent groups attached to heme and also due to differences in R-groups of proteins present around heme or linked to heme.

All these cytochromes are present as fixed components of different complexes, which are immobile except cytochrome c. Cytochrome c is small and has electrostatic interaction with membrane surface. This imparts mobility to cyt c along the membrane surface.

### Substituent Groups in Hemes of Different

Cytochromes: - The Non-heme Iron Centers are present in association with free sulfur atoms or bonded with cysteinyl sulfur of proteins. There are some copper iron centers present in association with heme or in association with cysteinyl sulfur and other ligands of proteins. The different non-heme iron and copper iron centers are as follows -

1. It is a type of Fe-S center, four Fe and four sulfur atoms are arranged alternately forming a cube with each non-linked to additional sulfur of cysteinyl residues of proteins.
2. It is another type of Fe-S center, 2 Fe and 2 S atoms are arranged alternately forming a square with each iron linked to two additional sulfur of cysteinyl residues of proteins.
3. In Subunit II of Complex IV is found a 2 Cu-2S center. Here, two Cu ions are in interaction with two -SH groups of cysteinyl residues of proteins forming a binuclear center. Other groups in interaction are with Cu A are R groups of histidines, aspartate & so on.