subunit 1.3

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

By Dr. Sunita Kumari Sharma
A.P. & Head.
P.G. Dept. of Zoology
Maharaja College
Ara 802301

Introduction :- Mitochondria are power houses of Cell because respiratory chains or Electron Transport chain are power generators of mitochondria. Respiratory chains are set of protein, non-protein Complexes, as constituent of inner membrane (IM) arranged in sequence of increasing redox potential. The chain allows electrons to flow through it constituent to meet finally oxygen forming H_2O using protons from mitosol. while electrons are transferred through respiratory chain, protons from mitosol are pumped out of IM creating a proton gradient across IM. This proton gradient create a proton motive force that drives protons into mitosol through specific sites of F_o-F_1 particles. Proton flow through F_o subunit induces —

Cyclic Conformational changes in F_1 subunit which attains Adenosine triphosphate (ATP) synthesis activity. The ATP synthase brings about phosphorylation of Adenosine Diphosphate (ADP) to ATP.

This Electron Transport chain gets electrons from reduced Nicotinamide Adenine Dinucleotide (NADH), a Carrier of Electron pair as hydride ion and from reduced Flavin Adenine Dinucleotide (FADH), a Carrier of electron pair as hydrogen pair. Reduced NADH is generated by dehydrogenases in cytosol through glycolysis (Glyceraldehyde-3-Phy. dehydrogenase) and in mitosol by Krebs Cycle. (Pyruvate dehydrogenase, α-Keto glutarate dehydrogenase, Isocitrate dehydrogenase and malate dehydrogenase) and fatty acid Oxidation (β-hydroxy acyl CoA dehydrogenase). Reduced FADH is generated in cytosol by glyceraldehyde-3-Phy dehydrogenase and in mitosol 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, knot 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 doesn't 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_3 and cyto-chrome c and c_1. The cytochromes differ from each other on account of substituent groups attached to and also due to difference in the protein 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 outer surface. This impart 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 protein
2. In 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 protein forming a binuclear Cu A and other groups in interacting are R groups of histidines, aspartate & so on.