Electron Transport Chain

Fundamentals: Aerobic cellular respiration is made up of three parts: glycolysis, the citric acid (Krebs) cycle, and oxidative phosphorylation. In glycolysis, glucose metabolizes into two molecules of pyruvate, with an output of ATP and nicotinamide adenine dinucleotide (NADH). Each pyruvate oxidizes into acetyl CoA and an additional molecule of NADH and carbon dioxide (CO2). The acetyl CoA is then used in the citric acid cycle, which is a chain of chemical reactions that produce CO2, NADH, flavin adenine dinucleotide (FADH2), and ATP. In the final step, the NADH and FADH2 amassed from the previous steps are used in oxidative phosphorylation, to make water and ATP.

Oxidative phosphorylation has two parts: the electron transport chain (ETC) and chemiosmosis. The ETC is a collection of proteins bound to the inner mitochondrial membrane and organic molecules, which electrons pass through in a series of redox reactions, and release energy. The energy released forms a proton gradient, which is used in chemiosmosis to make a large amount of ATP by the protein ATP-synthase.

The electron transport chain is a collection of membrane-embedded proteins and organic molecules, most of them organized into four large complexes labeled I to IV. In eukaryotes, these protein complexes are found in the inner mitochondrial membrane. In prokaryotes, the electron transport chain components are found in the plasma membrane.

In the electron transport chain (ETC), the electrons go through a chain of proteins that increases its reduction potential and causes a release in energy. Most of this energy is dissipated as heat or utilized to pump hydrogen ions (H+) from the mitochondrial matrix to the inter-membrane space and create a proton gradient. This gradient increases the acidity in the inter-membrane space and creates an electrical difference with a positive charge outside and a negative charge inside.

The ETC proteins in a general order are: complex I, complex II, coenzyme Q, complex III, cytochrome C, and complex IV.

All of the electrons that enter the transport chain come from NADH and $FADH_2$ molecules produced during earlier stages of cellular respiration: glycolysis, pyruvate oxidation, and the citric acid cycle.

* NADH is very good at donating electrons in redox reactions (that is, its electrons are at a high energy level), so it can transfer its electrons directly to complex I, turning back into NAD+. As electrons move through complex I in a series of redox reactions, energy is released, and the complex uses this energy to pump protons from the matrix into the intermembrane space.

* $FADH_2$ is not as good at donating electrons as NADH (that is, its electrons are at a lower energy level), so it cannot transfer its electrons to complex I. Instead, it feeds them into the transport chain through complex II, which does not pump protons across the membrane.
Because of this "bypass," each $FADH_2$ molecule causes fewer protons to be pumped (and contributes less to the proton gradient) than an NADH.

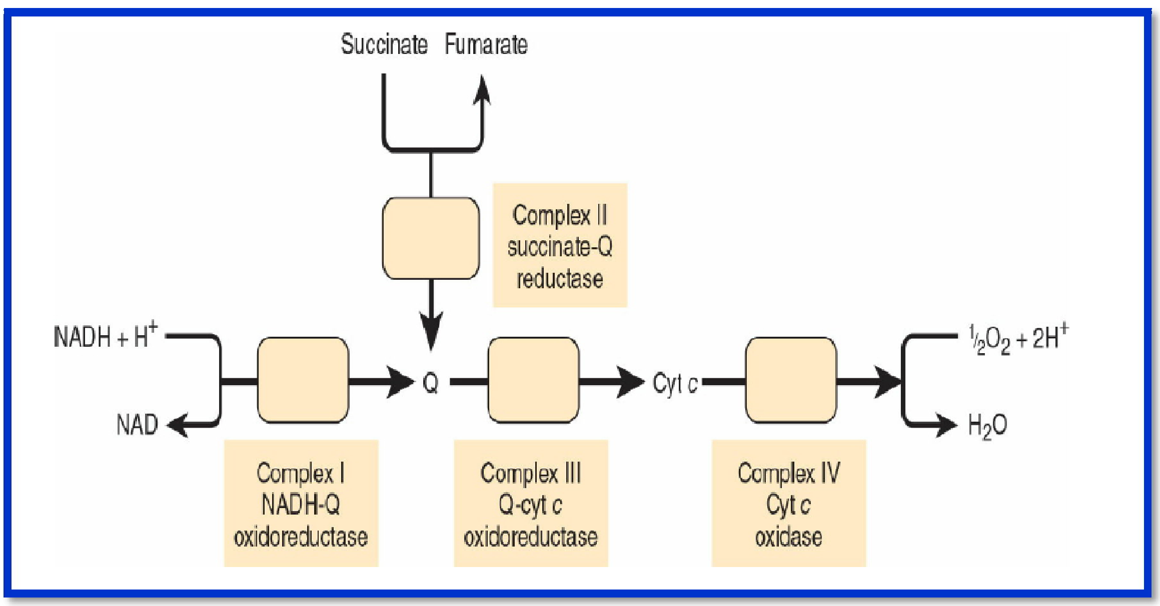

Fig : Overview of electron flow through the respiratory chain.