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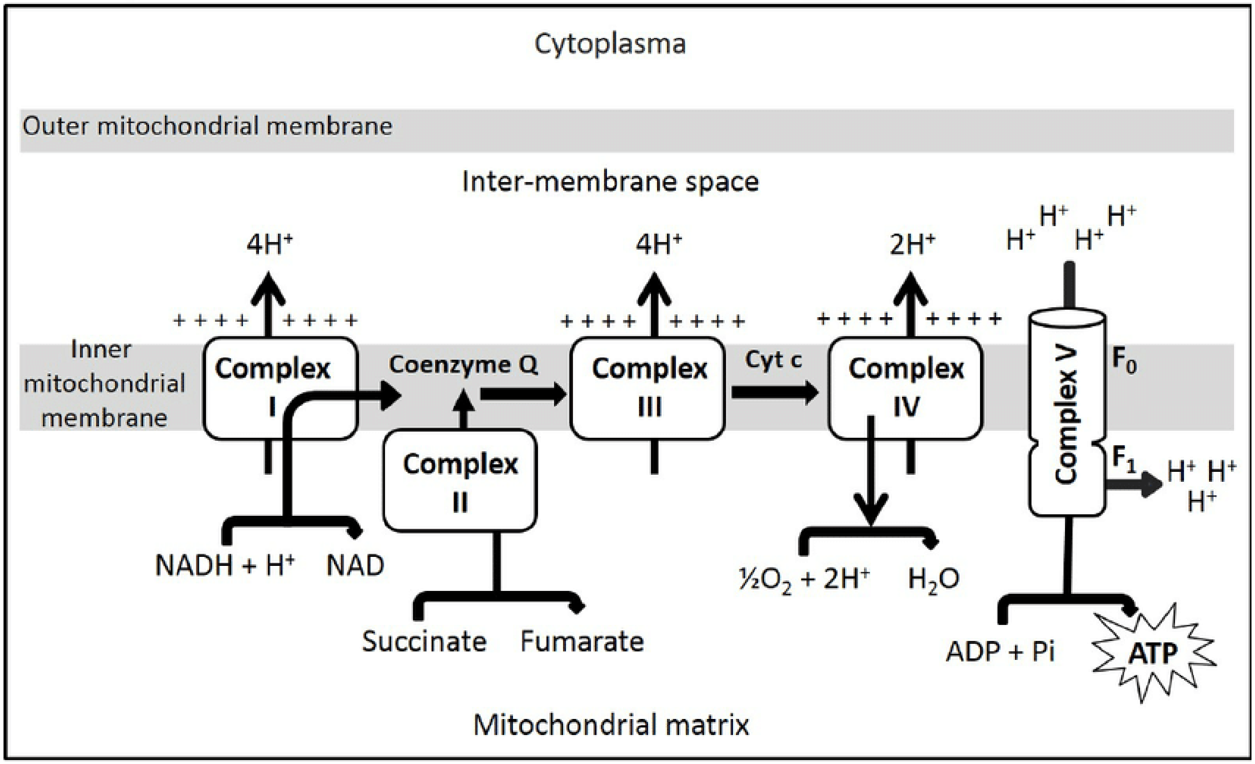
BIOLOGICAL OXIDATION

ELECTRON TRANSAPORT CHAIN

- Electron Transport Chain is a series of compounds where it makes use of electrons from electron carrier to develop a chemical gradient. It could be used to power oxidative phosphorylation.
- The molecules present in the chain comprises enzymes that are protein complex or proteins, peptides and much more.
- Large amounts of ATP could be produced through a highly efficient method termed oxidative phosphorylation. ATP is a fundamental unit of metabolic process.
- The electrons are transferred from electron donor to the electron acceptor leading to the production of ATP. It is one of the vital phases in the electron transport chain. Compared to any other part of cellular respiration the large amount of ATP is produced in this phase.
- Electron transport is defined as a series of redox reaction that is similar to the relay race. It is a part of aerobic respiration. It is the only phase in glucose metabolism that makes use of atmospheric oxygen.
- When electrons are passed from one component to another until the end of the chain the electrons reduce molecular oxygen thus producing water.
- The requirement of oxygen in the final phase could be witnessed in the chemical reaction that involves the requirement of both oxygen and glucose.



Electron Transport Chain in Mitochondria

A complex could be defined as a structure that comprises a weak protein, molecule or atom that is weakly connected to a protein. The plasma membrane of prokaryotes comprises multi copies of the electron transport chain.

Complex 1- NADH-Q oxidoreductase: It comprises enzymes consisting of iron-sulfur and FMN. Here two electrons are carried out to the first complex aboard NADH. FMN is derived from vitamin B2.

Q and Complex 2- Succinate-Q reductase: FADH2 that is not passed through complex 1 is received directly from complex 2. The first and the second complexes are connected to a third complex through compound ubiquinone (Q). The Q molecule is soluble in water and moves freely in the hydrophobic core of the membrane. In this phase, an electron is delivered directly to the electron protein chain. The number of ATP obtained at this stage is directly proportional to the number of protons that are pumped across the inner membrane of the mitochondria.

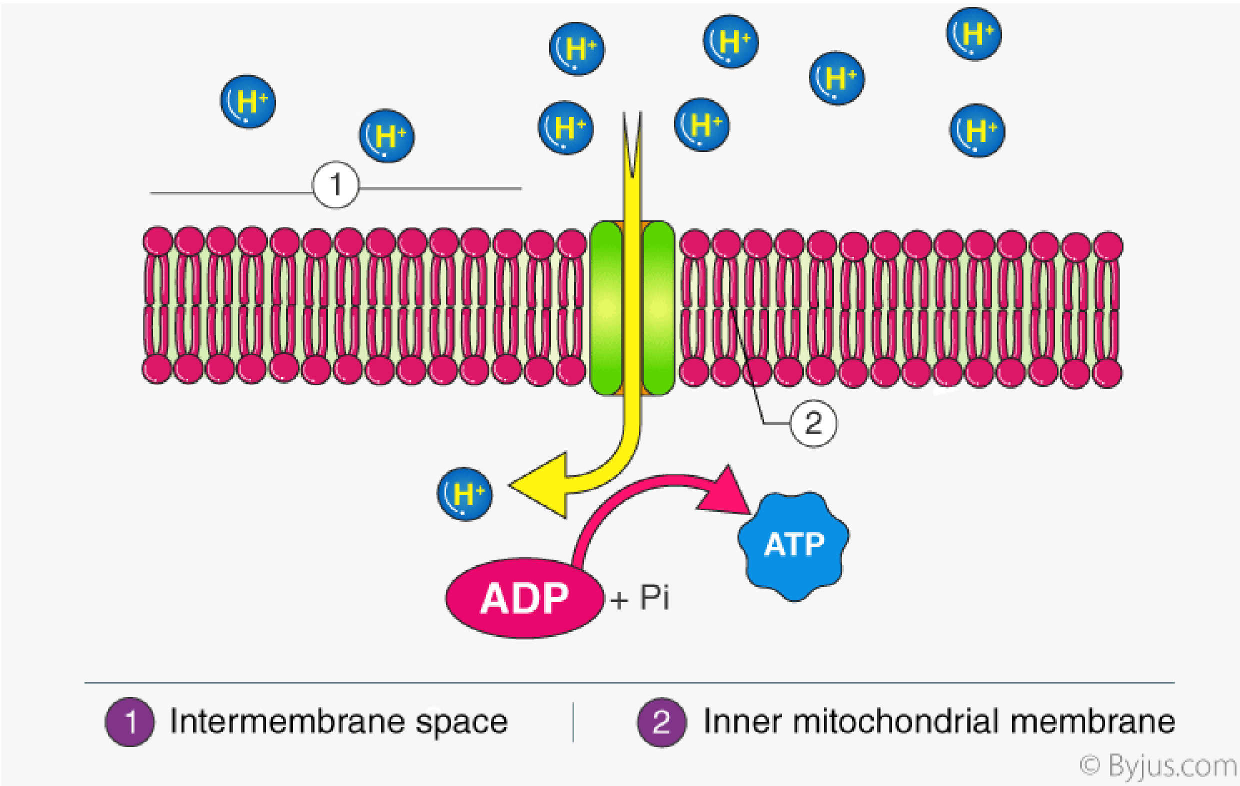
Complex 3- Cytochrome c reductase: The third complex is comprised of Fe-S protein, Cytochrome b, and Cytochrome c proteins. Cytochrome proteins consist of the heme group. Complex 3 is responsible for pumping protons across the membrane. It also passes electrons to the cytochrome c where it is transported to the 4th complex of enzymes and proteins. Here, Q is the electron donor and Cytochrome C is the electron acceptor.

Complex 4- Cytochrome c oxidase: The 4th complex is comprised of cytochrome c, a and a3. There are two heme groups where each of them is present in cytochromes c and a3. The cytochromes are responsible for holding oxygen molecule between copper and iron until the oxygen content is reduced completely. In this phase, the reduced oxygen picks two hydrogen ions from the surrounding environment to make water.

OXIDATIVE PHOSPHORYLATION

- Oxidative phosphorylation is the final step in cellular respiration. It occurs in the mitochondria. It is linked to a process known as electron transport chain.
- The electron transport system is located in the inner mitochondrial membrane.
- The electrons are transferred from one member of the transport chain to another through a series of redox reactions.

- During oxidative phosphorylation, electrons derived from NADH and FADH2 combine with O2, and the energy released from these oxidation/ reduction reactions is used to drive the synthesis of ATP from ADP.



Oxidative Phosphorylation Steps

The major steps of oxidative phosphorylation in mitochondria include:

Delivery of Electrons by NADH and FADH2

Reduced NADH and FADH2 transfer their electrons to molecules near the beginning of the transport chain. After transferring the electrons, they get oxidised to NAD+ and FAD and are utilised in other steps of cellular respiration.

Electron Transport and Proton Pumping

The electrons move from a higher energy level to a lower energy level, thereby releasing energy. Some of the energy is used to move the electrons from the matrix to the intermembrane space. Thus, an electrochemical gradient is established.

Splitting of Oxygen to form Water

The electrons are then transferred to the oxygen molecule which splits into half and uptakes H+ to form water.

ATP Synthesis

The H+ ions pass through an enzyme called ATP synthase while flowing back into the matrix. This controls the flow of protons to synthesize ATP.

Chemiosmosis

The electrons that flow through electron transport chain is an exergonic process and the synthesis of ATP is an endergonic process. These two processes are ingrained within a membrane. As a result, energy will be transmitted from the electron transport chain to ATP synthase by the movement of proteins. This process is termed as chemiosmosis.

Endergonic Process is a chemical reaction in which energy is absorbed. There will be a change in free energy and it is always positive. Exergonic Process is a chemical reaction in which there will be a positive flow of energy from the system to the surrounding environment. Chemical reactions are also considered exergonic when they are spontaneous.

Electron Transport Chain

The electrons are separated from the NADH and then passed to the oxygen with a series of enzymes releasing a small amount of energy. All these series of enzymes having complexes is known as electron transport chain.

In the case of eukaryotes, the enzymes make use of energy that has been released in the electron transport system from the oxidation of NADH that pumps protons across the inner membrane of the mitochondria. This results in the generation of the electrochemical gradient across the membrane. This can be considered as one of the best examples to understand the concept of oxidative phosphorylation.