Difference Between Electron Transport Chain in Mitochondria and Chloroplasts

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Key Difference - Electron Transport Chain in Mitochondria vs Chloroplasts

Cellular respiration and photosynthesis are two extremely important processes which assist living organisms in the biosphere. Both processes involve the transportation of electrons which create an electron gradient. This causes the formation of a proton gradient by which energy is utilized in synthesizing ATP with the assistance of the enzyme ATP synthase. **Electron transport chain which takes place in the mitochondria is called 'oxidative phosphorylation,' since the process utilizes chemical energy from redox reactions. In contrast, in the chloroplast this process is called 'photo-phosphorylation' since it utilizes light energy.** This is the **key difference** between Electron Transport Chain (ETC) in Mitochondria and Chloroplast.

What is Electron Transport Chain in Mitochondria?

The electron transport chain which occurs in the inner membrane of the mitochondria is known as oxidative phosphorylation where the electrons are transported across the inner membrane of the mitochondria with the involvement of different complexes. This creates a proton gradient which causes the synthesis of ATP. It is known as oxidative phosphorylation due to the energy source: that is the redox reactions which drives the electron transport chain.

The electron transport chain consists of many different proteins and organic molecules which include different complexes namely, complex I, II, III, IV and ATP synthase complex. During the movement of electrons through the electron transport chain, they move from higher energy levels to lower energy levels. The electron gradient created during this movement derives energy which is utilized in pumping H^+ ions across the inner membrane from the matrix into the intermembrane space. This creates a proton gradient. Electrons that enter the electron transport chain is derived from FADH2 and NADH. These are synthesized during earlier cellular respiratory stages which include glycolysis and TCA cycle.

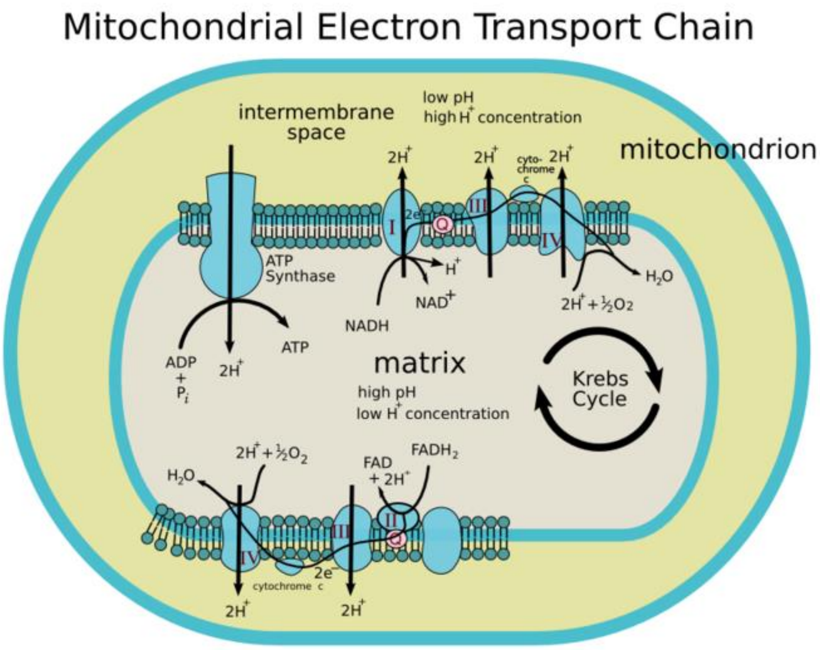

Figure 01: Electron Transport Chain in Mitochondria

Complexes I, II and IV are considered as proton pumps. Both complexes I and II collectively pass electrons to an electron carrier known as Ubiquinone which transfers the electrons to complex III. During the movement of electrons through complex III, more H^+ ions are delivered across the inner membrane to the intermembrane space. Another mobile electron carrier known as Cytochrome C receives the electrons which are then passed into complex IV. This causes the final transfer of H^+ ions into the intermembrane space. Electrons are finally accepted by oxygen which is then utilized to form water. The proton motive force gradient is directed towards the final complex which is ATP synthase that synthesizes ATP.

What is Electron Transport Chain in Chloroplasts?

Electron transport chain which takes place inside the chloroplast is commonly known as photophosphorylation. Since the energy source is sunlight, the phosphorylation of ADP to ATP is known as photophosphorylation. In this process, light energy is utilized in the creation of a high energy donor electron which then flows in a unidirectional pattern to a lower energy electron acceptor. The movement of the electrons from the donor to the acceptor is referred as Electron Transport Chain. Photophosphorylation can be of two pathways; cyclic photophosphorylation and noncyclic photophosphorylation.

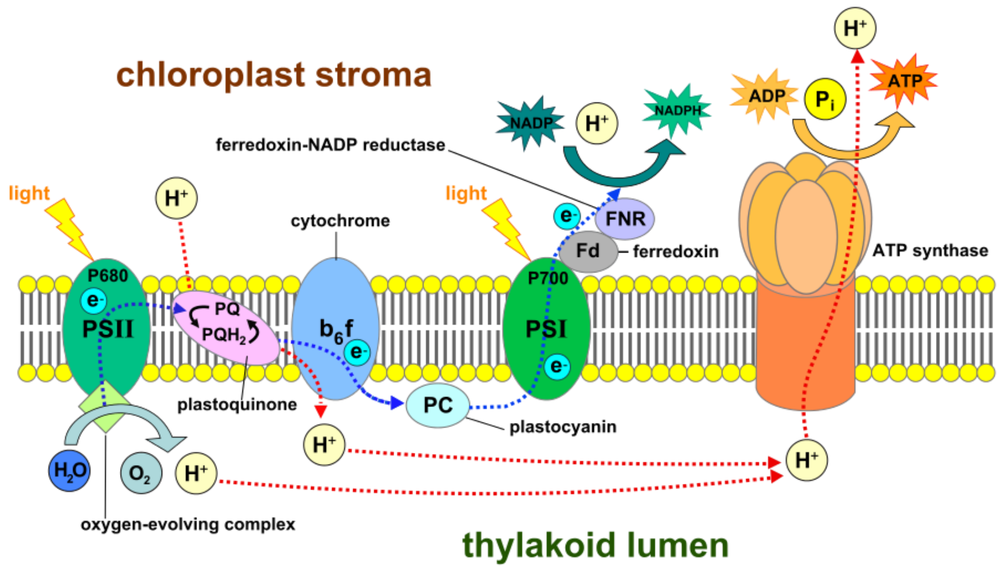

Figure 02: Electron Transport Chain in Chloroplast

Cyclic photophosphorylation occurs basically on the thylakoid membrane where the flow of electrons is initiated from a pigment complex known as photosystem I. When sunlight falls on the photosystem; light absorbing molecules will capture the light and pass it to a special chlorophyll molecule in the photosystem. This leads to the excitation and eventually the release of a high energy electron. This energy is passed from one electron acceptor to the next electron acceptor in an electron gradient which is finally accepted by a lower energy electron acceptor. The movement of the electrons induces a proton motive force which involves in the pumping of H^+ ions across the membranes. This is used in the production of ATP. ATP synthase is used as the enzyme during this process. Cyclic photophosphorylation does not produce oxygen or NADPH.

In noncyclic photophosphorylation, the involvement of two photosystems occurs. Initially, a water molecule is lyzed to produce $2H^+ + 1/2O_2 + 2e^-$. Photosystem II keeps the two electrons. The chlorophyll pigments present in the photosystem absorb light energy in the form of photons and transfer it to a core molecule. Two electrons are boosted from the photosystem which is accepted by the primary electron acceptor. Unlike cyclic pathway, the two electrons will not return to the photosystem. The deficit of electrons in the photosystem will be provided by lysis of another water molecule. The electrons from photosystem II will be transferred to photosystem I where a similar process will take place. The flow of electrons from one acceptor to the next will create an electron gradient which is a proton motive force which is utilized in synthesizing ATP.

What are the Similarities Between ETC in Mitochondria and Chloroplasts?

- ATP synthase is utilized in ETC by both mitochondria and chloroplast.
- In both, 3 ATP molecules are synthesized by 2 protons.

What is the Difference Between ETC in Mitochondria and Chloroplasts?

ETC in Mitochondria vs ETC in Chloroplasts	
The electron transport chain which occurs in the inner membrane of the mitochondria is known as oxidative phosphorylation or Electron Transport Chain in Mitochondria.	Electron transport chain which takes place inside the chloroplast is known as photophosphorylation or the Electron Transport Chain in Chloroplast.
Type of Phosphorylation	
Oxidative phosphorylation occurs in ETC of Mitochondria.	Photo-phosphorylation occurs in ETC of chloroplasts.
Source of energy	
Source of energy of ETP in mitochondria is the chemical energy derived from redox reactions..	ETC in chloroplasts utilizes light energy.
Location	
ETC in mitochondria takes place in the cristae of mitochondria.	ETC in chloroplasts takes place in the thylakoid membrane of the chloroplast.
Co-enzyme	
NAD and FAD involve in ETC of mitochondria.	NADP involves in ETC of chloroplasts.
Proton gradient	
Proton gradient acts from the intermembrane space up to the matrix during the ETC of mitochondria.	The proton gradient acts from thylakoid space to the stroma of the chloroplast during the ETC of chloroplasts.
Final electron acceptor	
Oxygen is the final electron acceptor of ETC in mitochondria.	Chlorophyll in cyclic photophosphorylation and NADPH+ in noncyclic photophosphorylation are the final electron acceptors in ETC in chloroplasts.

Summary - Electron Transport Chain in Mitochondria vs Chloroplasts

Electron transport chain which occurs in the thylakoid membrane of the chloroplast is known as photo-phosphorylation since light energy is utilized to drive the process. In the mitochondria, the electron transport chain is known as oxidative phosphorylation where electrons from NADH and FADH2 that are derived from glycolysis and TCA cycle is converted into ATP through a proton gradient. This is the key difference between ETC in mitochondria and ETC in chloroplasts. Both processes utilize ATP synthase during the synthesis of ATP.

Reference:

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