Difference Between Oxidative phosphorylation and Photophosphorylation

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Key Difference - Oxidative phosphorylation vs Photophosphorylation

Adenosine Tri-Phosphate (ATP) is an important factor for the survival and function of living organisms. ATP is known as the universal energy currency of the life. Production of ATP within the living system occurs in many ways. Oxidative phosphorylation and photophosphorylation are two major mechanisms that produce most of the cellular ATP within a living system. Oxidative phosphorylation utilises molecular oxygen during the synthesis of ATP, and it takes place near the membranes of the mitochondria while photophosphorylation utilizes sunlight as the energy source for the production of ATP, and it takes place in the thylakoid membrane of the chloroplast. The **key difference** between oxidative phosphorylation and photophosphorylation is that **ATP production is driven by electron transfer to oxygen in oxidative phosphorylation while sunlight drives ATP production in photophosphorylation.**

What is Oxidative Phosphorylation?

Oxidative phosphorylation is the metabolic pathway that produces ATP using enzymes with the presence of oxygen. It is the final stage of the cellular respiration of aerobic organisms. There are two main processes of oxidative phosphorylation; electron transport chain and chemiosmosis. In electron transport chain, it facilitates redox reactions which involve many redox intermediates to drive the movement of electrons from electron donors to electron acceptors. The energy derived from these redox reactions are used to produce ATP in chemiosmosis. In the context of eukaryotes, oxidative phosphorylation is carried out in different protein complexes within the inner membrane of the mitochondria. In the context of prokaryotes, these enzymes are present in the intermembrane space of the cell.

The proteins that are involved in oxidative phosphorylation are linked with each other. In eukaryotes, five main protein complexes are utilized during electron transport chain. Final electron acceptor of the oxidative phosphorylation is oxygen. It accepts an electron and reduces to form water. Hence, oxygen should be present to produce ATP by the oxidative phosphorylation.

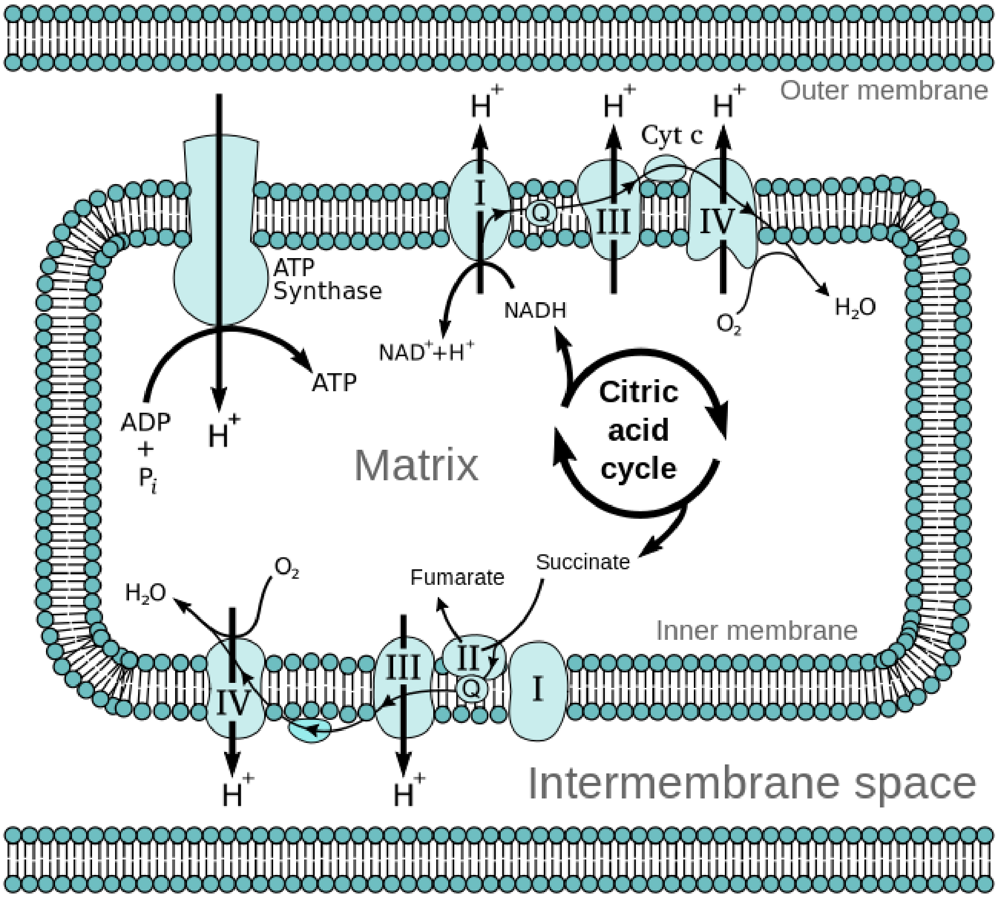

Figure 01: Oxidative Phosphorylation

The energy that is released during the flow of electrons through the chain is utilized in the transportation of protons across the inner membrane of the mitochondria. This potential energy is directed to the final protein complex which is ATP synthase to produce ATP. ATP production occurs in the ATP synthase complex. It catalyses the addition of phosphate group to ADP and facilitates the formation of ATP. ATP production using the energy released during the electron transfer is known as chemiosmosis.

What is Photophosphorylation?

In the context of photosynthesis, the process that phosphorylates ADP to ATP using the energy of sunlight is referred to as photophosphorylation. In this process, sunlight activates different chlorophyll molecules to create an electron donor of high energy that would be accepted by a low energy electron acceptor. Therefore, light energy involves the creation of both high energy electron donor and a low energy electron acceptor. As a result of an energy gradient created, the electrons will move from donor to acceptor in cyclic and non-cyclic manner. The movement of electrons takes place through the electron transport chain.

Photophosphorylation could be categorized into two groups; cyclic photophosphorylation and non-cyclic photophosphorylation. Cyclic photophosphorylation occurs in a special place of the chloroplast known as the thylakoid membrane. Cyclic photophosphorylation does not produce oxygen and NADPH. This cyclic pathway initiates the flow of electrons to a chlorophyll pigment complex known as photosystem I. From the photosystem I high energy electron is boosted. Due to the instability of the electron, it will be accepted by an electron acceptor that is at lower energy levels. Once initiated, the electrons will move from one electron acceptor to the next in a chain while pumping H+ ions across the membrane that produces a proton motive force. This proton motive force leads to the development of an energy gradient which is utilised in the production of ATP from ADP using the enzyme ATP synthase during the process.

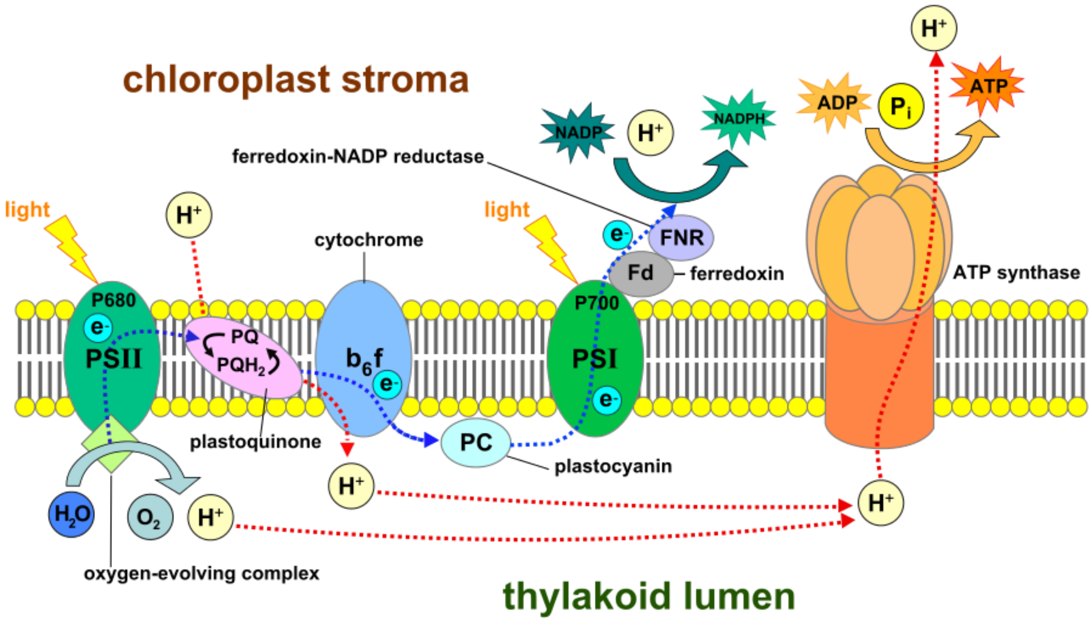

Figure 02: Photophosphorylation

In non-cyclic photophosphorylation, it involves two chlorophyl pigment complexes (photosystem I and photosystem II). This takes place in the stroma. In this pathway photolysis of water, molecule takes place in the photosystem II that retains two electrons derived from the photolysis reaction within the photosystem initially. Light energy involves the excitation of an electron from photosystem II which undergoes chain reaction and finally transferred to a core molecule present in the photosystem II. The electron will move from one electron acceptor to the next in a gradient of energy that will be finally accepted by a molecule of oxygen. Here in this pathway, both oxygen and NADPH are produced.

What are the Similarities Between Oxidative phosphorylation and Photophosphorylation?

- Both processes are important in energy transfer within the living system.
- Both involved in the utilisation of redox intermediates.
- In both processes, the production of a proton motive force leads to the transfer of H^+ ions across the membrane.
- The energy gradient created by both processes is used to produce ATP from ADP.
- Both processes use ATP synthase enzyme to make ATP.

What is the Difference Between Oxidative phosphorylation and Photophosphorylation?

Oxidative Phosphorylation vs Photophosphorylation	
Oxidative Phosphorylation is the process that produces ATP using enzymes and oxygen. It is the last stage of aerobic respiration.	Photophosphorylation is the process of ATP production using sunlight during the photosynthesis.
Energy Source	
Molecular oxygen and glucose are the energy sources of oxidative phosphorylation.	Sunlight is the energy source of photophosphorylation.
Location	
Oxidative phosphorylation occurs in mitochondria	Photophosphorylation occurs in chloroplast
Occurrence	
Oxidative phosphorylation occurs during cellular respiration.	Photophosphorylation occurs during photosynthesis.
Final Electron Acceptor	
Oxygen is the final electron acceptor of oxidative phosphorylation.	$NADP^+$ is the final electron acceptor of photophosphorylation.

Summary - Oxidative phosphorylation vs Photophosphorylation

Production of ATP within the living system occurs in many ways. Oxidative phosphorylation and photophosphorylation are two major mechanisms that produce most of the cellular ATP. In eukaryotes, oxidative phosphorylation is carried out in different protein complexes within the inner membrane of the mitochondria. It involves many redox intermediates to drive the movement of electrons from electron donors to electron acceptors. At last, using the energy released during the electron transfer is used to produce ATP by ATP synthase. The process that phosphorylates ADP to ATP using the energy of sunlight is referred to as photophosphorylation. It happens during the photosynthesis. Photophosphorylation occurs via two main ways; cyclic photophosphorylation and non-cyclic photophosphorylation. Oxidative phosphorylation occurs in mitochondria and photophosphorylation occurs in chloroplasts. This is the difference between oxidative phosphorylation and photophosphorylation.

Reference:

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