Paper: 204 (Plant Biochemistry and Metabolism)

By: Dr. Shubhi Avasthi (Botany Department)

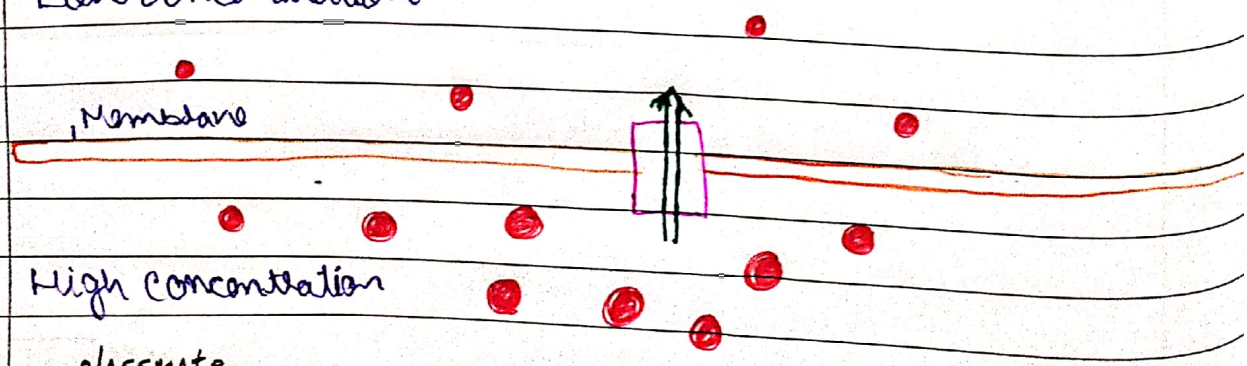
DATE

Chemiosmatic regeneration of ATP

* Chemiosmosis is the movement of ions across a selectively permeable membrane, down their electrochemical gradient. It relates to the generation of ATP by the movement of hydrogen ions across a membrane during cellular respiration or photosynthesis.

* Protons will diffuse from an area of high proton concentration to an area of lower proton concentration and an electrochemical concentration gradient of proton across a membrane can be harnessed to make ATP. This process is related to osmosis, the diffusion of water across a membrane, that why it is called chemiosmosis.

* ATP synthase is the enzyme that makes ATP by chemiosmosis. It allows proton to pass through the membrane and uses the kinetic energy to phosphorylated ADP, making ATP. The generation of ATP by chemiosmosis occurs in chloroplast & mitochondria as well as in most bacteria.



DATE

Chemiosmatic Theory

* Peter. D. Mitchell proposed the chemiosmotic hypothesis in 1961.

* chemiosmotic theory suggests essentially that most ATP synthesis in respiring cells come from electrochemical gradient across the inner membranes of mitochondria by using the energy of $NADH$ and $FADH_2$ formed from the breaking down of energy rich molecule (glucose).

* The carriers pass electrons to the electron transport chain in the inner mitochondrial membrane, which in turn pass them to other protein in ETC.

* The energy available in the electrons is used to pump protons from the matrix across the inner mitochondrial membrane, storing energy in the form of a transmembrane electrochemical gradient.

* The proton (H^+ ions) move back across the inner membrane through the enzyme ATP synthase.

* The flow of proton back into the matrix of mitochondria via AT synthase provide enough energy for ADP to combine with inorganic phosphate to form ATP.

* The electrons & protons at the last pump in the ETC are taken up by oxygen to form water.

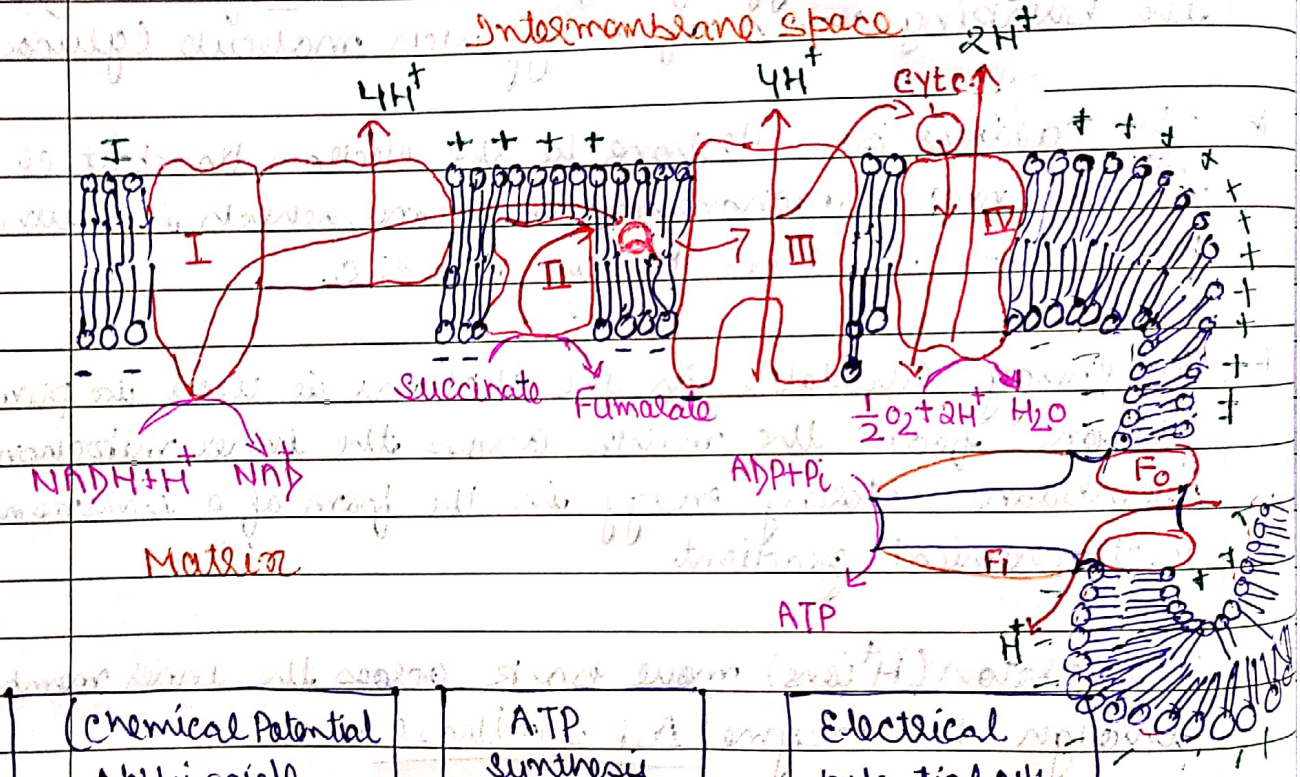
PAGE

classmate

DATE

- As electron all passed down the chain, protons are pumped across the membrane (between the inner membrane and outer membrane of thylakoid).

- This results in a pH and electric gradient. The proton move back into the matrix through a pore created by ATP synthase allowing the enzyme to make ATP at the expense of this gradient.

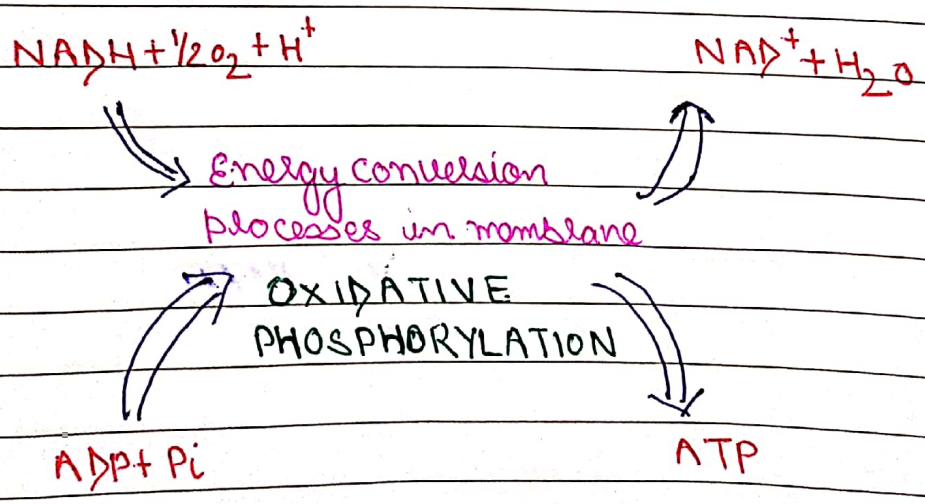


Chemical Potential (pH inside alkaline)	ATP synthesis driven by proton motive force	Electrical potential ΔΨ inside negative

Chemiosmatic Model

DATE

- Chemiosmosis is used to generate 90% of the ATP made during aerobic glucose catabolism.
- The production of ATP using the process of chemiosmosis in mitochondria is called oxidative phosphorylation
- It is also the method used in the light reaction of photosynthesis to harness the energy of sunlight in the process of photophosphorylation.
- The overall result of these reaction is the production of ATP from the energy of electrons removed from hydrogen atoms.
- At the end of the pathway, the electron are used to reduce an oxygen molecule to oxygen ions. The extra electrons on the oxygen attract hydrogen ions (proton) from surrounding medium & water is formed.



Coupling of electron transfer, proton pumping and ATP synthesis