

Biological oxidation, electron transport
chain, P/O ratio; oxidative
phosphorylation

- **Oxidation:** Loss of electron



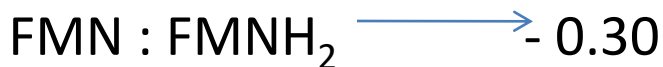
- **Reduction :** Gain of electron



- **Redox Pair:** The compound which exist in both oxidised and reduced state

Example: NAD : NADH, FMN : FMNH₂, FAD : FADH₂

- **Redox potential/ Electron transfer potential:** It is a quantitative measurement of tendency of redox pair to loose or gain electron



Biological Oxidation

- Biological oxidation is the cellular process in which the organic substances release energy (ATP), produce CO_2 and H_2O through oxidative-reductive reactions

Oxidative phosphorylation

- It is the process of converting high redox potential in to energy rich ATP molecules.
- The proton gradient runs downhill to drive the synthesis of ATP
- OP involves reduction of O_2 to H_2O with electrons donated by NADH and $FADH_2$

- Mitochondria have two membranes: Outer and Inner
- **Outer membrane** : Permeable to small molecules (<5000 Mr) and ions, which move through transmembrane channels formed by integral membrane proteins (**PORINS**)
- **Inner membrane**: Impermeable to most small molecules and ions (including protons H⁺) (**Protons** are only species that cross this membrane through **specific transporters**)
- Inner membrane bears the components of **respiratory chain** and **ATP synthase**

- **Specific transporters** carry pyruvate, fatty acids and amino acids **ATP and Pi** are specifically transported into the matrix; while newly **synthesized ATP** is transported out
- OP begins with entry of electrons into respiratory chain
- Most of these electrons (e-) arise from action of dehydrogenase (DH)
- Electrons then funnel into **ELECTRON ACCEPTORS**

- In eukaryotes, these redox reactions are catalysed by a series of protein complexes within the inner membrane of cell's mitochondria, whereas in prokaryotes, these proteins are located in the cell's intermembrane space. These linked sets of proteins are called **electron transport chains**.

Electron transport chain

- Electrons are transferred from $-ve$ electron potential to $+ve$ electron transfer potential
- Electrons carried by reduced coenzymes are passed through a chain of proteins and coenzymes (in ETC) to drive the generation of a proton gradient across the inner mitochondrial membrane
- **Site:** Inner mitochondrial membrane

ETC complexes

- Four protein complexes (I to IV) in the inner mitochondrial membrane and one ATP synthase complex
- A lipid soluble coenzymes (UQ, CoQ) and a water soluble protein (cytc) shuttle between protein complexes.
- **Complex I:** NADH-CoQ10 oxidoreductase (Electron transfer from NADH to CoQ10) = 4H⁺ pumped. This complex accept H⁺ and Hydride ion from reduced NAD.

- **Complex II**

- succinate dehydrogenase (succinate CoQ10 oxidoreductase)
- This complex accept H^+ and Hydride ion from reduced FAD and no H^+ pumped
- CoQ : Lipid soluble Ubiquinone called coenzyme Q that accept H atoms from complex I and II to transfer it into complex III.

- **Complex III:** CoQ10-cytochrome c oxidoreductase (contains cytochromes b and c) passes electron to Cyt c (and pump H⁺) in a unique redox cycle known as the Q cycle. 4H⁺ Pumped.
(Cyt c: is a water-soluble electron carrier, transfer electrons from complex III to complex IV)
- **Complex IV:** Cytochrome oxidases (a + a₃ and copper center). Electrons from Cyt c are used in a four-electron reduction of O₂ to produce 2H₂O.
- O₂ is the final electron acceptor. 2H⁺ pumped.

Complex V = ATP synthase

- It is H⁺ channel responsible for the coupling of the energy from e⁻ transport and H⁺ flow with oxidative phosphorylation to produce energy as ATP.
- The enzyme use the proton gradient across the inner membrane to drive the synthesis of ATP.