## 7. Oxidative phosphorylation

### 7.1. Mitochondria

Mitochondria generate most of the energy needed for cells to function optimally. Mitochondria are responsible for 95% of ATP production in the cells, and are very numerous in tissues that require large amounts of energy such as the heart, skeletal muscle and neurons. Only mitochondria of the cardiac muscle are responsible for producing approximately six kilos of ATP/day. The double-membrane-bound organelles present an inner matrix and an intermembrane space separated by the inner membrane. The outer membrane completes the structure and separates this cell compartment from the rest of the cytoplasm. The inner and outer membranes differ mainly in their selective permeability to molecules of different sizes.

The outer membrane, a porins that function as voltage-dependent, anion-selective channels, is permeable to ions and small molecules, including NADH and ATP, while proteins and larger molecules cannot pass through porins and need to be imported by translocases. The inner membrane is impermeable to molecules and ions of any size, which can only penetrate through selective proteins channels. Oxidative phosphorylation occurs in the inner membrane through the activity of the electron transport chain complexes incorporated into the membrane along with ATP synthase. The spatial organization of the internal membrane is essential to the correct functioning of oxidative phosphorylation.

### 7.2. Electron transport and energy production

Substrates such as glucose, fatty acids and amino acids are converted into energy within the mitochondria in the cycle of Krebs by the electron transport system for the production of ATP.

The Krebs cycle is the major metabolic pathway of energy production in cells providing most of the reduced cofactors, such as NADH and $FADH_2$ that will be oxidized by the electron transport chain complexes to produce energy. Electron transport chain complexes contain multiple polypeptides and various prosthetic groups; their main function is to carry electrons ($e^-$) from respiratory coenzymes to oxygen, and they are functionally coupled by cytochrome c and coenzyme Q. These complexes including:

- **Complex I** (NADH-ubiquinone oxidoreductase)
- **Complex II** (succinate-ubiquinone oxidoreductase),
- **Complex III** (ubiquinol-cytochrome c oxidoreductase)
- **Complex IV** (cytochrome c oxidase)

- **Complex V** (ATP synthase)

In this manner, the flow of electrons through the electron transfer chain links oxidation to phosphorylation. Electrons enter the electron transfer chain at two primary sites: complex I, where the electron donor is NADH, and complex II, where the electron donor is $FADH_2$. Electrons are passed from complex I and II by coenzyme Q or ubiquinone (CoQ) to complex III. Cytochrome C (cyt c) is the mobile electron carrier from complex III to complex IV where electrons are passed to the terminal electron acceptor, $O_2$, which is then reduced to water in this step. $H^+$ are pumped across the inner membrane at complex I, III and IV. ATP synthase, also known as complex V, uses the energy stored in the mitochondrial membrane potential to drive the phosphorylation of ADP to yield ATP, the universal energy currency in cells.

The respiratory chain or electron transport chain uses electron flow to create a proton gradient (proton motive force) that is used to drive adenosine tri-phosphate (ATP) synthesis. Mitchell P, proposed the theory of coupling of phosphorylation to electron and hydrogen transfer by a chemiosmotic type of mechanism.

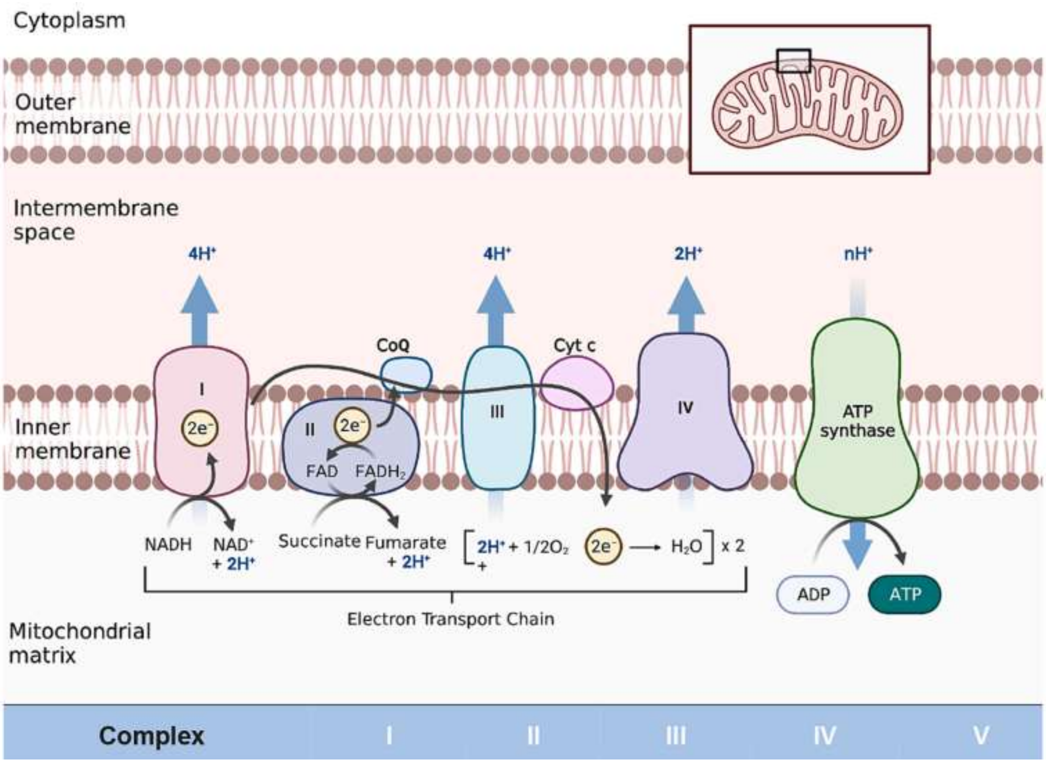


**Figure** : Oxidative phosphorylation mitochondria.