

## \*\*\* mitochondria \*\*\*

**Archaea** and **Bacteria** are the two primal domains of life that ruled Earth for two billion years. Then - 1,800,000,000 years ago - certain bacterial cells entered certain archaean cells and took up *symbiotic residence*, dividing along with the host cell whenever it split to become two. This event proved transcendent for the future diversification of life on the planet. These internalized bacteria became powerhouses for this new type of cell, using the redox energy of metabolism to power *electron transport*, creating a **proton (H<sup>+</sup>) gradient** across the inner membrane, with **oxygen** as the final acceptor of electrons. Oxygen was becoming more plentiful back then, as *photosynthetic cyanobacteria* stripped hydrogen from water to combine with CO<sub>2</sub>, making carbohydrates for themselves and releasing O<sub>2</sub> as a byproduct. **Eukaryotes** had arrived.

**Eukaryota** is the third domain of life and contains **Protists** and **Plants** and **Fungi** and **Animals**. The eukaryotic endosymbionts are called **mitochondria**. With oxygen available, the electron transport chain is used to create a proton (H<sup>+</sup>) gradient across the inner mitochondrial membrane. Protons (H<sup>+</sup>) move back across this gradient through specific membrane channels in **ATP synthase**, spinning a part of the protein complex and powering the cyclical conversion of ADP to **ATP**, the singular currency of energy in living systems: "oxidative phosphorylation of ADP".

Other mitochondrial membrane channels allow *leakage* of protons and create "**futile cycling**", which is the **basis of heat production** in living systems.

Articles linked on the [\\*mitochondria\\*](#) webpage give more details.

