Mitochondria

Introduction

Mitochondria are double-membrane-bound organelles present in the cytoplasm of almost all eukaryotic cells.

They are often referred to as the “powerhouse of the cell” because they produce adenosine triphosphate (ATP) through aerobic respiration.

They contain their own DNA and ribosomes, divide independently, and are maternally inherited.

History

- 1850s: First observed by Albert von Kölliker in muscle cells.

- 1886: Richard Altmann described them as "bioblasts".

- 1898: Carl Benda coined the term “mitochondria”.

- 20th century: Electron microscopy revealed double-membrane structure with cristae.

- 1960s: Discovery of mitochondrial DNA confirmed endosymbiotic origin.

Structure

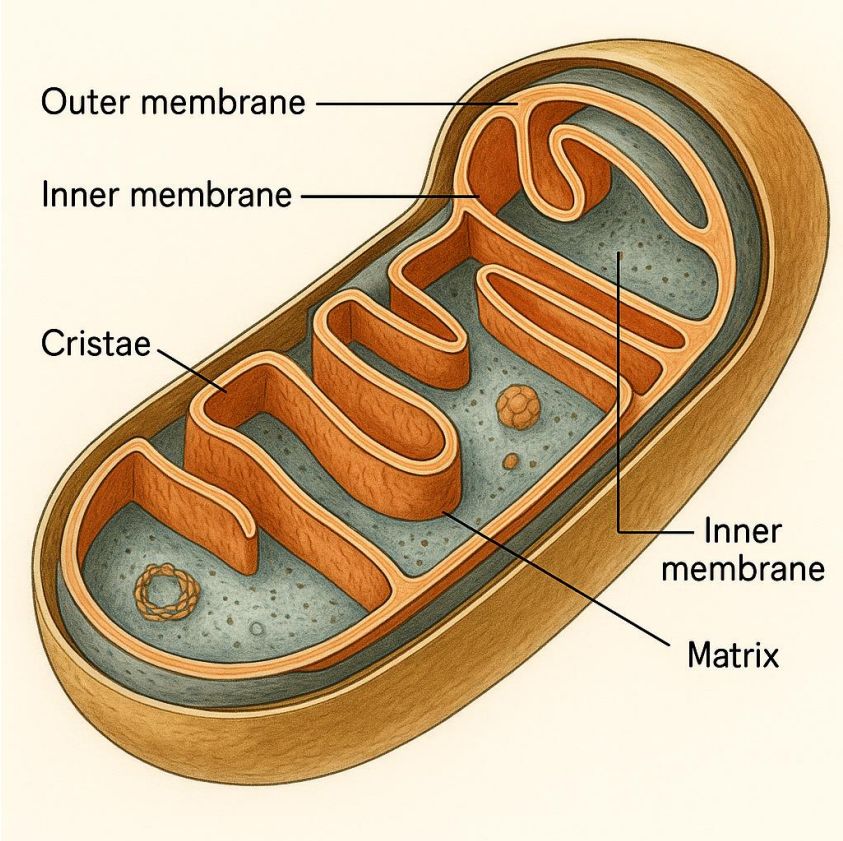
Mitochondria have four main compartments:

1. Outer Membrane – smooth, permeable to small molecules, contains enzymes.

2. Intermembrane Space – space between membranes, contains enzymes using ATP.

3. Inner Membrane – folded into cristae, houses ETC and ATP synthase.

4. Matrix – innermost part, contains enzymes for Krebs cycle, mtDNA, ribosomes, tRNA.



Oxidative Phosphorylation

1. Electron Transport Chain (ETC): Electrons from NADH and FADH2 pass through complexes I–IV, pumping protons into intermembrane space.

2. Proton Gradient: Creates electrochemical gradient (proton motive force).

3. ATP Synthase: Protons flow back into matrix, driving ADP + Pi → ATP.

4. Oxygen as Final Acceptor: Combines with electrons and protons to form water.

Function

1. ATP production through oxidative phosphorylation.

2. Metabolic roles: Krebs cycle, fatty acid oxidation, amino acid metabolism.

3. Calcium homeostasis and signaling.

4. Apoptosis: release of cytochrome c.

5. Heat production in brown fat (thermogenesis).

6. Synthesis of biomolecules (steroids, heme, amino acids).

7. ROS production and detoxification.Oxidative Phosphorylation Flowcha

Realistic Mitochondria Diagram