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MITROCHONDRIA

INTRODUCTION

Mitochondria are **double-membrane bound cell organelles** found in most eukaryotic cells. They are known as the **"Powerhouse of the Cell"** because they produce **ATP (Adenosine Triphosphate)** through cellular respiration.

- Discovered by **Richard Altmann (1890)**
- Term "mitochondria" given by **Carl Benda (1898)**
- Present in all eukaryotic cells except mature RBCs
- Abundant in metabolically active cells (muscle, liver, neurons)

2. Occurrence

- Present in **eukaryotic cells**
- Absent in **prokaryotes**
- Number varies:
    - 100–1000 per cell (average)
    - Very high in muscle cells

3. Structure of Mitochondria

Mitochondria are **rod-shaped or oval** structures (0.5–1 µm wide, 1–10 µm long).

A. Outer Membrane

- Smooth
- Contains **porin proteins**
- Permeable to small molecules

B. Inner Membrane

- Highly folded forming **cristae**
- Impermeable to most molecules
- Contains:
    - Electron transport chain (ETC)

- ATP synthase particles (F_o–F_1 particles)

C. Intermembrane Space

- Space between outer and inner membrane
- Important for proton accumulation

D. Matrix

- Inner fluid-filled region
- Contains:
  - Circular DNA
  - 70S ribosomes
  - RNA
  - Enzymes of Krebs cycle
  - Calcium and phosphate granules

6. Functions of Mitochondria

1. ATP Production

- Site of **oxidative phosphorylation**
- Electron Transport Chain present on inner membrane

2. Krebs Cycle (TCA Cycle)

- Occurs in mitochondrial matrix

3. Beta-Oxidation of Fatty Acids

4. Calcium Storage

5. Apoptosis (Programmed Cell Death)

6. Heat Production

- In brown adipose tissue (thermogenesis)

7. Mechanism of ATP Production

Step 1: Glycolysis

- Occurs in cytoplasm

Step 2: Link Reaction

- Pyruvate → Acetyl CoA

Step 3: Krebs Cycle

- Produces NADH & $FADH_2$

Step 4: Electron Transport Chain (ETC)

- Located on inner membrane
- Oxygen is final electron acceptor
- Proton gradient formed

Step 5: Oxidative Phosphorylation

- ATP synthase converts ADP → ATP

8. Mitochondrial DNA (mtDNA)

- Circular
- Double stranded
- Lacks histones
- Inherited maternally
- Codes for:
    - Some respiratory enzymes
    - rRNA & tRNA

9. Endosymbiotic Theory

Proposed by **Lynn Margulis**

States that:

- Mitochondria evolved from **aerobic bacteria**
- Evidence:
    - Own DNA
    - 70S ribosomes
    - Binary fission
    - Double membrane

10. Biogenesis and Division

- Divide by **binary fission**
- Semi-autonomous
- Some proteins synthesized in cytoplasm

11. Types of Mitochondria (Based on Shape)

- Filamentous
- Granular
- Rod-shaped
- Spherical

12. Mitochondrial Disorders

- Caused by mutation in mtDNA
- Examples:
    - Leber's Hereditary Optic Neuropathy (LHON)
    - Myoclonic epilepsy
- Affect high-energy organs (brain, muscles)

13. Comparison: Mitochondria vs Chloroplast

Feature	Mitochondria	Chloroplast
Function	Respiration	Photosynthesis
DNA	Present	Present

Feature	Mitochondria	Chloroplast
Found in	All eukaryotes	Plants only
Cristae/Grana	Cristae	Grana

14. Conclusion

Mitochondria are essential organelles responsible for **energy production**, metabolic regulation, and apoptosis.
Their semi-autonomous nature supports the **endosymbiotic theory** and shows their evolutionary importance.