MITOCHONDRIA

Dr Anita Kumari

Assistant Professor (Guest faculty)

Dept of Zoology

L S College

Mitochondria (singular: *mitochondrion*) are double membrane-bound cell organelles with a typical size of 0.75-3 μm². They are found in most mammalian cells, with notable exceptions including mature **erythrocytes.** Classically referred to as the 'powerhouse of the cell', they are the site of the majority of ATP synthesis and are therefore exceptionally important to function both microscopically and macroscopically. Mitochondria are oxygen-consuming rod or ribbon-shaped cellular organelles of immense importance floating free throughout the cell.

The enzymatic oxidation of chemical compounds in the mitochondria releases energy. Since mitochondria act as the power-houses, they are abundantly found on those sites where energy is earnestly required such as sperm tail, muscle cell, liver cell (up to 1600 mitochondria), microvilli, oocyte (more than 300,000 mitochondria), etc.

Typically, there are about 2000 mitochondria per cell, representing around 25% of the cell volume.

History

In 1890, mitochondria were first described by Richard Altmann and he called them bioblasts. Benda in the year 1897 coined the term 'mitochondrion'.

UltraStructure of Mitochondria

Mitochondria are double-membrane organelles . It ranges from 0.5 to 1.0 micrometer in diameter. It has four distinct domains: the outer membrane, the inner membrane, the intermembrane space, and the matrix.

The organelle is enclosed by two membranes—a smooth outer membrane and a markedly folded or tubular inner mitochondrial membrane, which has a large surface and encloses the matrix space.

The intermembrane space is located between the inner and outer membranes.

The number and shape of the mitochondria, as well as the numbers of cristae they have, can differ widely from cell type to cell type.

Tissues with intensive oxidative metabolism— e. g., heart muscle— have mitochondria with particularly large numbers of cristae.
Even within one type of tissue, the shape of the mitochondria can vary depending on their functional status.
Both mitochondrial membranes are very rich in proteins.

Outer mitochondrial membrane

The outer mitochondrial membrane resembles more with the plasma membrane in structure and chemical composition.
Porins in the outer membrane allow small molecules to be exchanged between the cytoplasm and the intermembrane space.

Inner mitochondrial membrane

The inner mitochondrial membrane is rich in many enzymes, coenzymes, and other components of electron transport chain. It also contains proton pumps and many permease proteins for the transport of various molecules such as citrates, ADP, phosphate, and ATP.
The inner mitochondrial membrane gives out finger-like outgrowths (cristae) towards the lumen of the mitochondrion and contains tennis-racket shaped F1 particles that contain ATP-ase enzyme for ATP synthesis.
The inner mitochondrial membrane is completely impermeable even to small molecules (with the exception of O2, CO2, and H2O).
Numerous transporters in the inner membrane ensure the import and export of important metabolites.

Intermembrane space

It is the space between the outer and inner membrane of the mitochondria, it has the same composition as that of the cell's cytoplasm.
There is a difference in the protein content in the intermembrane space .

Mitochondrial Matrix

The mitochondrial matrix which is the liquid (colloidal) area encircled by the inner membrane, contains the soluble enzymes of the **Krebs cycle** which completely oxidize the acetyl-CoA to produce CO2, H2O and hydrogen ions. Hydrogen ions reduce the molecules of NAD and FAD, both of which pass on hydrogen ions to respiratory or electron transport chain where oxidative phosphorylation takes place to generate energy-rich ATP molecules.

Mitochondria also contain in their matrix single or double circular and double-stranded DNA molecules called mt DNA and also the 55S ribosomes, called mitoribosomes. Since mitochondria can synthesize 10 percent of their proteins in their own protein-synthetic machinery, they are considered as **semi-autonomous organelles**.

Functions:

1. The most important function of mitochondria is to produce energy. Mitochondria produce the molecule adenosine triphosphate (ATP), one of the cell's energy currencies that provide the energy to drive a host of cellular reactions and mechanisms.
2. The simpler molecules of nutrition are sent to the mitochondria to be processed and to produce charged molecules. These charged molecules combine with oxygen and produce ATP molecules. This process is known as oxidative phosphorylation.
3. Mitochondria may also produce heat (brown fat), and accumulate iron-containing pigments (Heme ferritin), ions of Ca2+ and HPO_4^{2-} (or phosphate; e.g., osteoblasts of bones or yolk proteins).
4. Mitochondria help the cells to maintain the proper concentration of calcium ions within the compartments of the cell.
5. The mitochondria also help in building certain parts of blood and hormones like testosterone and estrogen.
6. The liver cell's mitochondria have enzymes that detoxify ammonia.
7. The mitochondria also play an important role in the process of apoptosis or programmed cell death.
8. Abnormal death of cells due to the dysfunction of mitochondria can affect the function of an organ.

Reference:

1. Cell biology-C.B.Power
2. Cell-biology-Veer Bala Rastogi
3. Alberts, B. (2004). Essential cell biology. New York, NY: Garland Science Pub.
4. Verma, P. S., & Agrawal, V. K. (2006). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology (1 ed.). S .Chand and company