

Quadrant II – Notes

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ULTRASTRUCTURE OF MITOCHONDRIA

The mitochondria are bounded by two membranes, the outer membrane and the inner membrane. The space between the two membranes is called the outer chamber or inter-membrane space. The space bounded by the inner chamber is called the inner chamber or inner membrane space. The inner membrane space is filled with a matrix which contains dense granules, ribosomes and mitochondrial DNA.

Outer Membrane

The outer mitochondrial membrane is made of simple phospholipid bilayer. The outer membrane is smooth and has many copies of a transport protein called porin. Porins in the outer membrane allow small molecules to be exchanged between the cytoplasm and the intermembrane space. The outer mitochondrial membrane has high permeability to molecules such as ions, nutrient molecules, ATP, ADP etc.

Inner membrane

The inner mitochondrial membrane is rich in many enzymes, coenzymes, and other components of electron transport chain. The inner mitochondrial membrane gives out finger-like outgrowths (cristae) towards the matrix 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).

Cristae are specialized folds of the inner membrane. The cavity of the cristae is called the **intercristae space** and is continuous with the inter-membrane space. Cristae increases inner membrane surface area enhancing its ability to produce ATP.

The inner membrane divides the mitochondrial space into two distinct chambers:

- Outer chamber
- Inner chamber

The side of the inner membrane facing the matrix side is called the M-side.

The side facing the outer chamber is called the C-side.

On the M-side of the Inner Mitochondrial membrane there are stalked particles - F₁ Particles.

Outer Chamber

Outer chamber is also known as outer compartment, peri - mitochondrial space, inter-membrane space. The outer chamber is between the outer membrane and inner membrane.

Inner Chamber

Inner chamber is also known as inner compartment, matrix space. It is filled with a dense, homogenous, gel like proteinaceous material, called mitochondrial matrix.

Matrix

Contains lipids, proteins, circular DNA molecules, 55 S ribosome's and certain granules. The matrix is important in the production of ATP with the aid of the ATP synthase contained in the inner membrane.

Mitochondria DNA

Mitochondrial DNA is double stranded circular DNA and is found in multiple copies within the matrix. It stores biological information required for growth and multiplication of mitochondria.

FUNCTIONS OF MITOCHONDRIA

Mitochondria are regarded as the power house of the cell as it is the site of respiration. Aerobic respiration – Mitochondria uses complex molecules and oxygen to produce a higher energy molecule known as ATP.

Cell Respiration

Mitochondria are the respiratory centres of the cell. Cell respiration can be divided into four phases:

- **Glycolysis** – involves the breakdown of glucose to pyruvic acid. The enzymes for glycolysis are found in the cytosol, outside the mitochondrion.
- **Oxidation of pyruvic acid**- pyruvic acid is degraded to acetyl CoA, with the liberation of a pair of hydrogens.
- **Krebs cycle**- Acetyl CoA condenses with oxalo-acetic acid to form citric acid. After several steps, OAA is generated. Four dehydrogenation reactions take place during the cycle, in each of which a pair of hydrogens is liberated. One ATP molecule is formed at substrate level during Krebs cycle. The enzymes for Krebs cycle are found in the matrix of the mitochondrion.
- **Oxidative phosphorylation** – it has been seen that pairs of hydrogen are liberated during aerobic glycolysis, oxidation of pyruvic acid and the Krebs cycle. These hydrogen pairs are passed down the Electron Transport Chain and oxidative phosphorylation takes place. Three molecules of ATP are generated per pair of electrons passing down the Electron Transport Chain. The enzymes for Electron Transport Chain are located in the inner membrane of mitochondrion.

Apoptosis

Mitochondria in addition to energy production have a second major function related to programmed cell death by apoptosis.