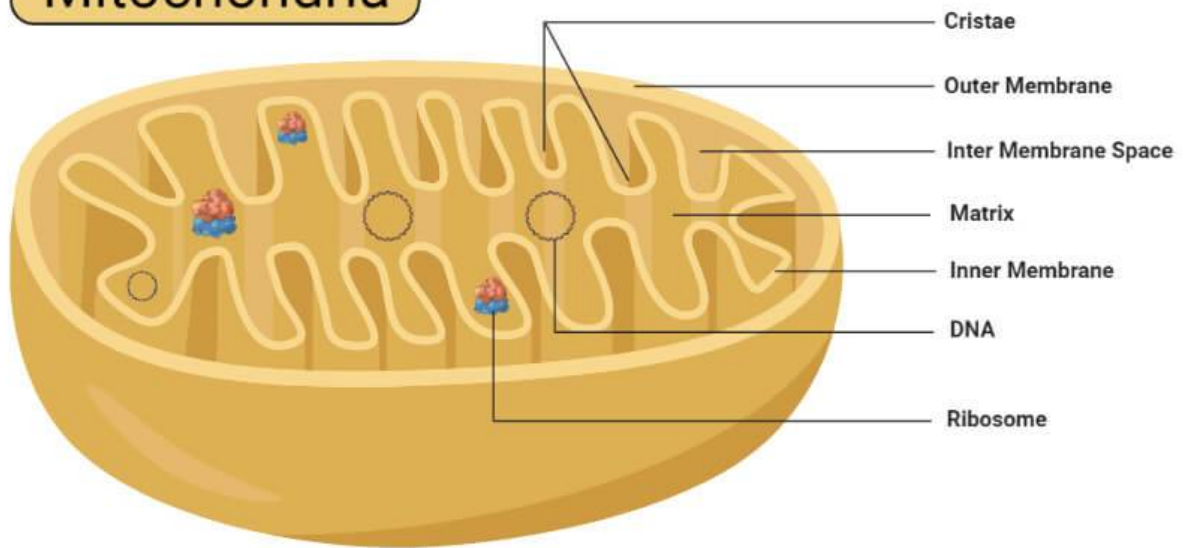


Mitochondria- Definition, Properties, Structure, Functions

Mitochondria Properties

- Mitochondria is the cell organelle which is filamentous and granular structure.
- It is present in higher plants, animals, and some microorganisms.
- It is absent in bacteria but is found in algae, protozoa, and fungi.
- To carry out the energy metabolism, mitochondria have got the lipoprotein framework.
- It consists of the different enzymes and coenzymes.
- Mitochondria also consist of specific DNA and ribosomes.
- Ribosomes are involved in protein synthesis whereas specific DNA is involved in the cytoplasmic inheritance.
- Mitochondria were first observed in 1850 by Kolliker.
- In the striated muscles, it was observed as the granular structure.
- Later in 1888, he isolated them from the insect muscles.
- It was named fila by Flemming in 1882.
- In the early days, mitochondria were given the different names such as
 - Fuchsinophilic granules
 - parabasal bodies
 - plasmosomes
 - plastosomes
 - fila
 - vermicules
 - bioblasts
 - chondriosomes
- In the cytoplasm, mitochondria are uniformly distributed.
- But it is also found that their distribution is restricted in many cells.
- Depending on the function of the cell, the mitochondria are distributed accordingly.
- The distribution of mitochondria varies according to species and cell type.
- But some cell may contain a large number of mitochondria as:
 - 50,000 in *Chaos chaos*
 - 140,000 to 150,000 in eggs of sea urchin
 - 300,000 in oocytes of amphibians.

Mitochondria



- It is found that only 500 to 1600 mitochondria are present in the liver cells of the rat.
- As compared to the animal cell, the number of mitochondria is less in green plants.
- It is because in the green plants there is the presence of chloroplast which carries out the function as of mitochondria.
- In the animal cell, sarcosomes are the mitochondria present in the myocardial muscle cell. They are numerous and large.
- The shape of the mitochondria can be filamentous or granular.
- Depending upon the physiological condition of the cell, their shape may change from one form into another.
- So the shapes can be of club, racket, vesicular, ring or round-shape.
- In the rat or primary spermatocyte, mitochondria are granular.
- In the liver cell mitochondria are club-shaped.
- Mitochondria may fuse and separate the cell which causes the changes in shape.
- During the day the mitochondria may fuse into the reticulate structure in certain cells of euglenoid.
- Then it separates or dissociates during the darkness.
- In the case of yeast depending on the different cultural condition changes occurs in it.
- The size of the mitochondria is 0.5 to 2.0 μm , so it cannot be seen clearly under the light microscope.

- It is also found sometimes the length reaches 7 μm .

Structure of mitochondria

- Mitochondria consists of mitochondrial membrane and mitochondrial chamber.

. Mitochondrial membrane

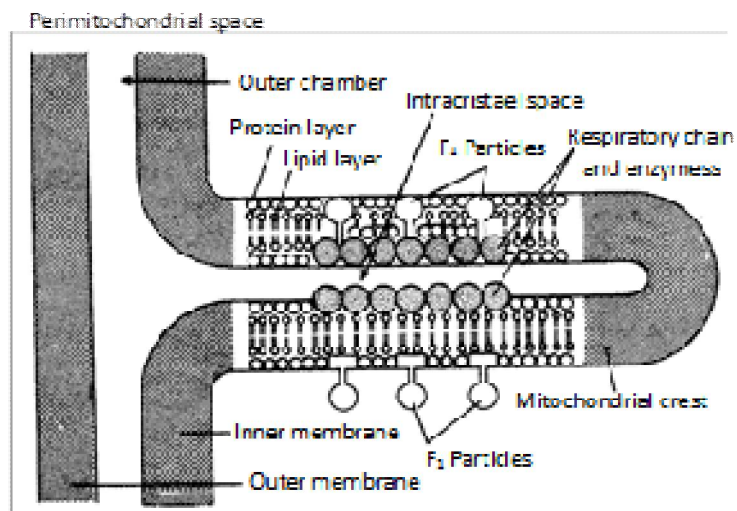
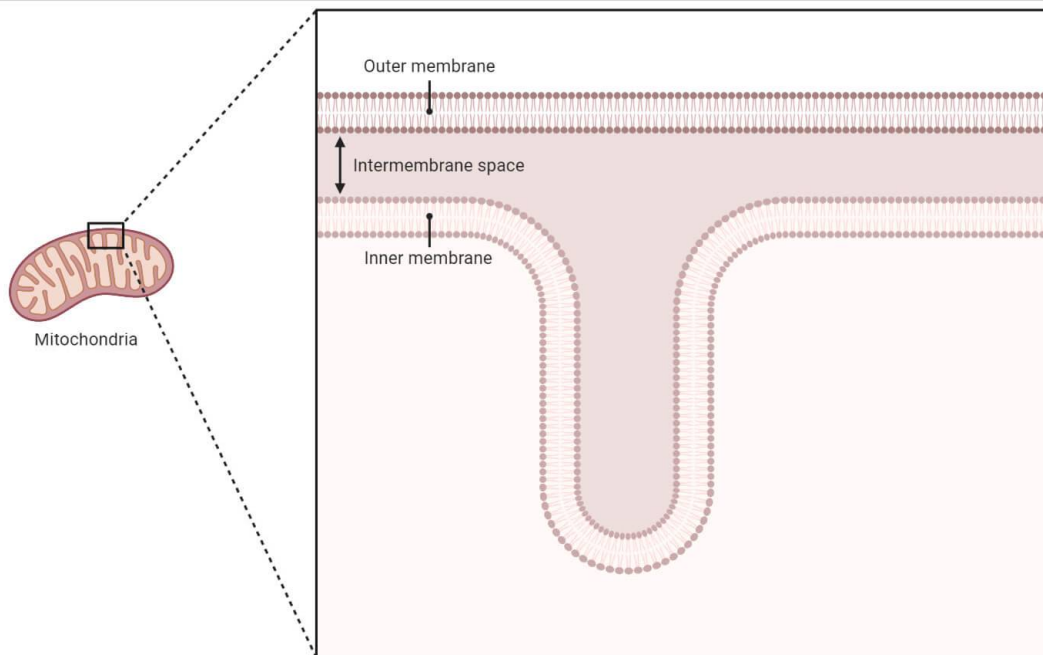
It consists of two membranes. They are:

a. Outer membrane

- It is a smooth membrane.
- It is made up of 40% **lipids** and 60% **proteins**.
- Due to the presence of the pores or porins, it is permeable.

b. Inner membrane

- It is made up of 20% lipids and 80% proteins.
- It is the selectively permeable membrane.
- Since the membrane is folded inwards and there is the presence of cristae, it is said as the rough membrane.
- Cristae are the numerous and finger-like projections.
- Tennis racket-like particles are present in each crista.
- The particles were previously named as the inner membrane subunits, F₀-F₁ particles, elementary particles, or oxysomes.
- Each F₁ particle is a complex of proteins and is attached by a short protein neck to a F₀ complex (an assembly of hydrophobic proteins embedded within the inner membrane .
- The combination of F₀ and F₁ is called F₀F₁ complex. Functionally it is called ATP synthetase because it is the structure responsible for ATP generation .
- It was called the electron transport particles (ETP)by Parsons in 1963.
- In each mitochondrion about 104-105 particles are present.
- Base, stalk, and head are present in each elementary particle.
- Base and head are also called the F₀ and F₁ particles respectively.
- Stalk acts as the link which connects the base and head.
- The base is made up of hydrophobic proteins and is embedded in the lipid molecules of the membrane.
- The Head is made up of five types of the polypeptide.
- ATPase or ATP synthetase is the enzyme present in it.
- The ADP aids in the formation of ATP.
- Similarly, inorganic phosphate is also formed. It is due to oxidative phosphorylation.
- The stalk also consists of the coupling factors which connect the respiratory chain with the elementary particle.



Structure of inner membrane of mitochondria

2. Mitochondrial chambers

Two chambers are present in the mitochondria i.e Outer and inner chamber.

a. Outer chamber (peri-mitochondrion space)

- Between the outer and the inner mitochondrial membrane, a space is present in between them which is known as the peri-mitochondrion space.
- Few enzymes are also present in the fluid present in it.

b. Inner chamber

- It is present in the inner part of the inner membrane.
- A semi-fluid matrix is present in it which consists of:
 - [Water](#)
 - Minerals
 - Protein particles
 - 70s ribosomes
 - RNA
 - Circular DNA
 - [Enzymes](#)

The mitochondrial enzymes show a distinct compartmentalization:

Outer Membrane :

- 1) Mono amine oxidase
- 2) Rotenone- insensitive NADH Cytochrome c- reductase
- 3) Kynurenine hydroxylase
- 4) Fatty acid COA ligase

Space between outer and inner membranes :

1. Adenylate kinase
2. Nucleoside diphospho kinase

Inner membrane :

1. Respiratory chain enzymes
2. ATP synthase
3. Succinate dehydrogenase
4. B – hydroxybutyrate dehydrogenase
5. Carnitine fatty acid acyl transferase

Matrix

1. Malate
2. Isocitrate dehydrogenase
3. Fumarase
4. Aconitase
5. Citrate synthetase
6. Alpha keto acid dehydrogenase
7. Enzymes of beta -oxidation

Semi-autonomous nature of mitochondrion

Mitochondria contain all requirements of protein synthesis :

(1) 70 S ribosomes.

(2) DNA molecules (rich in G-C ratio) to form mRNA and also replicate.

(3) ATP molecules to provide energy.

The mitochondria can form some of the required proteins but for most of proteins, these are dependent upon nuclear DNA and cytoplasmic ribosomes, so the mitochondria are called semi-autonomous organelles.

According to endosymbiotic origin of mitochondria by Kirns Altman, mitochondria were intially a free living, aerobic bacteria which during to the process of evolution entered an anaerobic cell and become established as mitochondria. This theory is supported by many similarities which exist between bacteria and mitochondria.

Origin

Mitochondria are self-duplicating organelles due to presence of DNA molecules so new mitochondria are always formed by growth and division of pre-existing mitochondria by binary fission.

Functions of mitochondria

- Mitochondria stores and releases energy in the form of ATP (Adenosine triphosphate). It occurs by the oxidation of carbohydrates, proteins, and fats. It will be further utilized in the different metabolic activities. So, mitochondria are known as the **powerhouse of the cell** or storage batteries of the cell.
- Mitochondria help in the formation of the heme of hemoglobin.
- During cellular respiration, mitochondria form the different intermediate products. They are utilized for the synthesis of cytochromes, chlorophyll, ferredoxin, steroids, alkaloids, pyrimidines, etc.
- Calcium can be stored and released by the mitochondria.
- It helps in the formation of amino acids.
- In the matrix of the mitochondria, several fatty acids can be synthesized.
- During the process of oogenesis, they help in the formation of the yolk.
- During the process of spermatogenesis, they help in the formation of the middle part of the sperms.

- By the process of maternal inheritance, traits are directly transferred by mitochondria from the mothers to the offsprings.
- Mitochondria are also present in the liver cell. They help in the detoxification of ammonia using their enzymes.
- Mitochondria are the site of heat generation which is known as thermogenesis.
- Sometimes there can be the abnormal death of the cell. It might be due to the dysfunctioning of the mitochondria. It can affect the function of the organ.
- It helps in the formation of some parts of the hormone of testosterone and estrogen.
- Cellular Respiration: Most Important Function performed by Mitochondria
 - Glycolysis [Occurs outside mitochondria]
 $\text{Glucose} + 2\text{ADP} + 2\text{P}_i + 2\text{NAD} \rightarrow 2 \text{Pyruvic Acid} + 2\text{NADH}_2 + 2\text{ATP}$
 - Krebs Cycle [Mitochondrial Matrix]
 - ETS- Inner Membrane of Mitochondria