# PDF MATERIAL

For Lecture of B.Sc. Part - 1

**Paper 2 (CELL BIOLOGY, GENETICS AND CROP IMPROVEMENT)**

**BOTANY HONOURS 2020-21**

**P D F  M A T E R I A L**

For  Lecture of B.Sc. Part - 1 Group A - **CELL BIOLOGY**
BOTANY HONOURS 2020-21

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*Topic* - ORIGIN, STRUCTURE AND FUNCTIONS OF MITOCHONDRIA

**ONLINE MODE LECTURE BY:**

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## Introduction:

Mitochondria are small granular or filamentous organoids of cytoplasm. These are regarded as biochemical machines that are associated with cell and convert the potential energy of food stuff into kinetic energy So these are called powerhouse of the cell.

## History:

⇒ KOLLIKAR in (1850) first observed the granular bodies in cell cytoplasm called sarcosome.
⇒ FLEMMING in (1882) named the sarcosome as filia.
⇒ ALTMANN (1892-94) described them as bioplast and introduced the bioplast theory.
⇒ BENDA (1897) coined the term Mitochondria.
⇒ KINGSBURY in (1912) suggested that the mitochondria were the site of cellular respiration.
⇒ BENSLEY & HORR (1913) isolated the mitochondria from liver cells.
⇒ PORTER & PALADE (1940 & 1950) describe the electron microscopic structure of mitochondria.
⇒ CLAUDE in (1914) seporated the mitochondrial fraction from other cell component by ultra-centrifugation.
⇒ FERNANDIZ discoved oxysome in mitochondria called $F_1$-particle.

## Distribution:

Mitochondria are found in all eukaryotic cells but are absent from prokaryotic cells where respiratory enzymes are located on the plasma-membrane. Some highly specialised cell like RBCs have lost their mitochondria.

The mitochondria either move freely in the cytoplasm or are permanently placed near the region which need more energy.

The size of mitochondria depends upon the functional stage of cells.

The width is almost constant and measures about 0.5 M - 2 M but length varies greatly and measuring 1.5 to 10 M.

SHAPE:

[Sausage and oval shapes are two common shapes in mitochondria. Typically the mitochondria are sausage-shaped but these may be granular, filamentous, rod-shaped, spherical or thread like.

NUMBER:

Number of mitochondria varies in the cells of different organism and in different cells of the some organism.

Generally 500 - 2000 mitochondria are found in normal cells.

→ Sea-Urchin egg cell = 13,000 - 14,000 /cell
→ Liver-cells = 1000 - 1600 /cell
→ Renal Canal cell = 300 - 400
→ Sperm cell = 22-25 /cell
→ Oocytes = 3,00,000 /cell
→ Giant amoeba = 50,000 /cell
→ Chaos-chaos
It is multinucleated also
→ Micrasterias (It is a green alga) = 01]

→ 1 per cell in Chlorella, Micrasterias & Trypansoma.

## STRUCTURE:

membranous

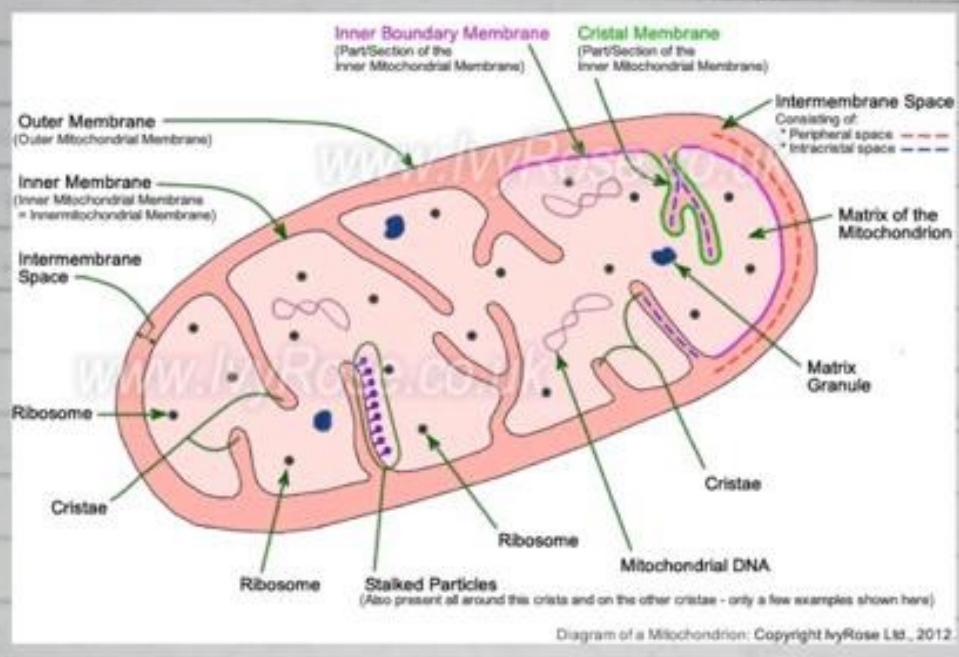
Under electron microscope mitochondrion appears as double structure. It consists of an outer and inner membrane and enclosed within them are two chambers.

Mitochondrial membranes → Both the membranes are trilaminar unit membranes about 60-70 Å. The space between the outer and inner membrane of mitochondria is called outer chamber.

It is about 60-80 Å and is filled with a fluid of low density.

(i) Outer mitochondrial membrane:

It forms uninterrupted boundary of mitochondria and isolates its content from the cytosol.




It is permeable and thickness about 60 Å. 90% area of outer membrane is rough and only 10% area is smooth. Roughness is due to the presence of stalked particles called sub-unit of parson. These were considered to be hollow cylinder 60 Å long, 60 Å wide with a central pore having 20 Å in diametre. The centre to centre spacing between the sub-unit was described as. 80 Å.

Subunit of parson does not allow to form anything on its surface. There are four co-enzymes are found under surface of outer-membrane.

[a] TPP (B1) Thiamin Pyrophosphate.
[b] Lipoic acid
[c] Co-A = Adenosin Tri-phosphate pento thenyl thio-ethanol- acetyl-amine.
[d] NAD = (Coenzyme) = Nicotinamide Adenin Dinucleotide.

These coenzymes doesnot allow to enters any foreign material inside the mitochondrial matrix.

Steroid formation takes place on the 10% smooth surface.

(ii) INNER MEMBRANE

Thickness of inner membrane is 60 Å. The surface area of the inner membrane is much greater than that of outer membrane.

It is projected into the canal space in the form of finger like projection known as CRISTAE.

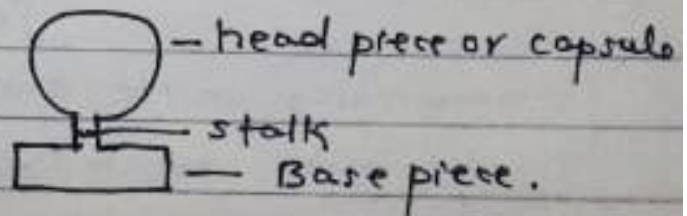
The wd number and size of cristae in mitochondrion directly affects its efficiency. The greater and larger are the cristae faster is the spread of oxidation.

Cristae shows large variation in their arrangement, it may be parallely, perpendicularly concentrically in the form of vesicles in tubular fashion and irregular etc.

The side of the inner membrane facing the matrix is called M-site while the side facing the outer chamber is called C-site.

The inner membrane and the cristae are covered with spherical stalked particle called elementary particle or $F_1$-particles or Oxysome.

$F_1$-Particle ~ ① These are about 85 Å and are evenly spaced at an interval of 100 Å.
② No. of $F_1$-particle / mitochondria is $10^4$ - $10^5$.
③ Each $F_1$-particle is differentiated into
(i) base piece
(ii) a stalk
(iii) a head piece



The head piece is 75-100 Å in diameter, stalk is about 50 Å (L) × 35 Å (D) and base piece is 110 Å (L) and 35 Å (D).

In stalk OSCP (Oligomycin sensitive conferring protein) is present and help in thicking of base piece. In normal condition these particles are embedded in thickness of inner mitochondrial membrane.

The base piece of $F_1$-particles contains the enzymes ETS and the head piece contains enzyme of ATPase and coupling factors which bring about oxidative phosphorylation coupled with oxidation of food and release of ATP.

The space inclosed with in innermembrane is called inner chamber.

It is wide space filled with a homogenous mitochondrial matrix.

The matrix is a gel like and contains

(i) Soluble protein
(ii) Osmophilic liquid maintain osmophilic potential.
(iii) Ribosome 55 (S) It is synthesize protein from amino-acid.
(iv) Few fine filaments of granules these are sites for binding bivalent cations of $Mg^{++}$ and $Ca^{++}$
(v) DNA → Mitochondrial DNA may contains one or more DNA molecules depending upon its size.

It may be circular or filamentous DNA molecule is about 5 μ long as appears as a highly twisted double stranded.

It has higher GC (Guanosine-Cytosine) and have mol.wt. varies from 9-11 millions. They may free in the matrix or may attached to the membrane.

(vi) RNA →

Mitochondrial RNA is found in matrix. It resistant to the action of ribonuclease.

(vii) Enzymes for Krebs cycle is located in the matrix.

# FUNCTION OF MITOCHONDRIA :

(I) CELL RESPIRATION – It is generally known as power house of the cell. In mitochondria cell respiration takes place.

(II) ATP TRANSPORT – The ATP molecules produced as a result of cellular respiration accumulate in the mitochondria.

(III) It helps in lipid synthesis.

(IV) Elongation of fatty-acid –
Mammalian mitochondria have a gr. of enzyme that carry out elongation of fatty-acid by adding acetyl CoA and reducing the keto acid produced.

(V) It helps in the formation of yolk in a developing ovum.

(VI) They form middle piece of sperm in the process of sperm maturation.

(VII) Secretion –
HORNBERG has traced relation of mitochondria with zymogen granules and these contains proteolytic enzyme.

→ In plants, mitochondria were discovered first in Olympiaeo by MEVES (1904)

→ Mitochondria shows maternal (cytoplasmic) inheritance.

# THANK YOU