Mitochondria

(Gr. mitos = threads; chondros = granule)

Mitochondria are microscopic, rod-shaped, filamentous or granular organelles, found in the cytoplasm of all eukaryotic cells, which taken the name of **Powerhouse of the cell** as they provide an energy transducing system, by which chemical energy in foodstuff is converted by oxidative phosphorylation into high-energy phosphate bonds (ATP)

History - Kolliker (1850) - Credited as first observer
Flemming (1880) - as thread-like structure in many types of cells.
Benda (1897) - Coined the term 'Mitochondria'
Lewis & Lewis (1914) - first observed in living cells.
Hoseboom and coworkers (1948) - Proved mitochondria to be site of cellular respiration.
Nass (1963) - Proved the presence of the DNA molecule in the mitochondria.

Nomenclature - Previously the mitochondria have been known by various names as, Parabasal body, Plasmosome, Plastosome, fila, Vermicule, bioblast & chondriosome

Number - 1000 - 1600 in liver cells; 300000 in some ooeyte, fewer in green plant cells; none in bacteria.

Position 1. Uniformly distributed in cytoplasm, but concentrated in region where energy is needed
2. Inner segment of retinal rods and cones
3. Junction of two nerve cells
4. In 'neck' of sperm cells.

Size - Variable, Size 7μm x 0.5μm. Size also varies with osmotic pressure and pH of fixative.

Structure under light microscope - Rod-shaped or filamentous or granular; sometimes even vesicular and racket-shaped depending upon the functional state of the cell.

Ultra structure

(1) Mitochondria are present in all eukaryotic cells including animal cells and plant cells, they are bound by a double membrane envelop which provide good tensile strength, stability and flexibility to them,

(i) Smooth outer &

(ii) Corrugated inner surface - enclosing a space called outer chamber.

(2) Inner membrane encloses a large inner chamber filled with mitochondrial matrix, containing soluble protein as dense granules, considered to be sites of binding ions particularly Ca^{++} and Mg^{++}

~~The inner mitochondrial membrane lines the innermost compartment which remains filled with Matrix. Matrix contains lipids protein circular DNA molecule, ribosome at certain granules.~~

(3) The inner membrane increase its surface area by giving out plate like invagination called cristae (inner mitochondrial membrane), which penetrate the mitochondrial matrix.

(4) Outer surface of cristae is situated with elementary particles (F_0-F_1 particle) attached to the basal membrane by a stalk (50×30 Å) there are 10,000 - 100000 such particles, spaced 100 Å intervals in each mitochondrion

(5) The membrane of cell & cristae are trilaminar. (double layer of protein separated by a middle lipid layer)

Chemical composition

(1) Mitochondria are made up of Lipo-protein. Protein + other substances - 65%; glycerides - 29%, Lecithin and cephalin - 4% and cholesterol - 2%.

(2) Other matters :- Carotenoids, vitamin E, mitochondrial RNA & DNA, Iron, Sulphur, Copper and numerous enzymes as co-enzymes,

(3) Lipid/protein ratio is 0.8 in outer and 0.3 in inner membrane

Mitochondrial enzymes

1) outer membrane has - mono amine oxidase, retenone insensitive hydroxylase, fatty acids etc.
2) outer chamber - adenylate kinase and nucleoside diphosphokinase
3) Inner membrane - has all components of respiratory chain and oxidative phosphorylation
4) Matrix has all Krebs cycle enzymes (dehydrogenases & oxidation enzymes)

Functions of Mitochondria

Mitochondria are the sits of cellular respiration and energy production hence they are 'powerhouse' of the cell. The energy is utilized for various activities of the organism.

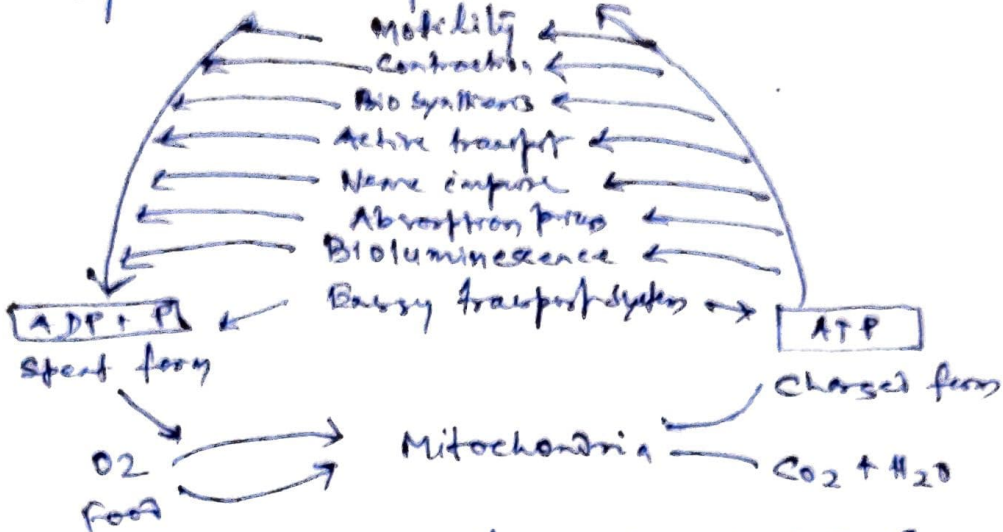
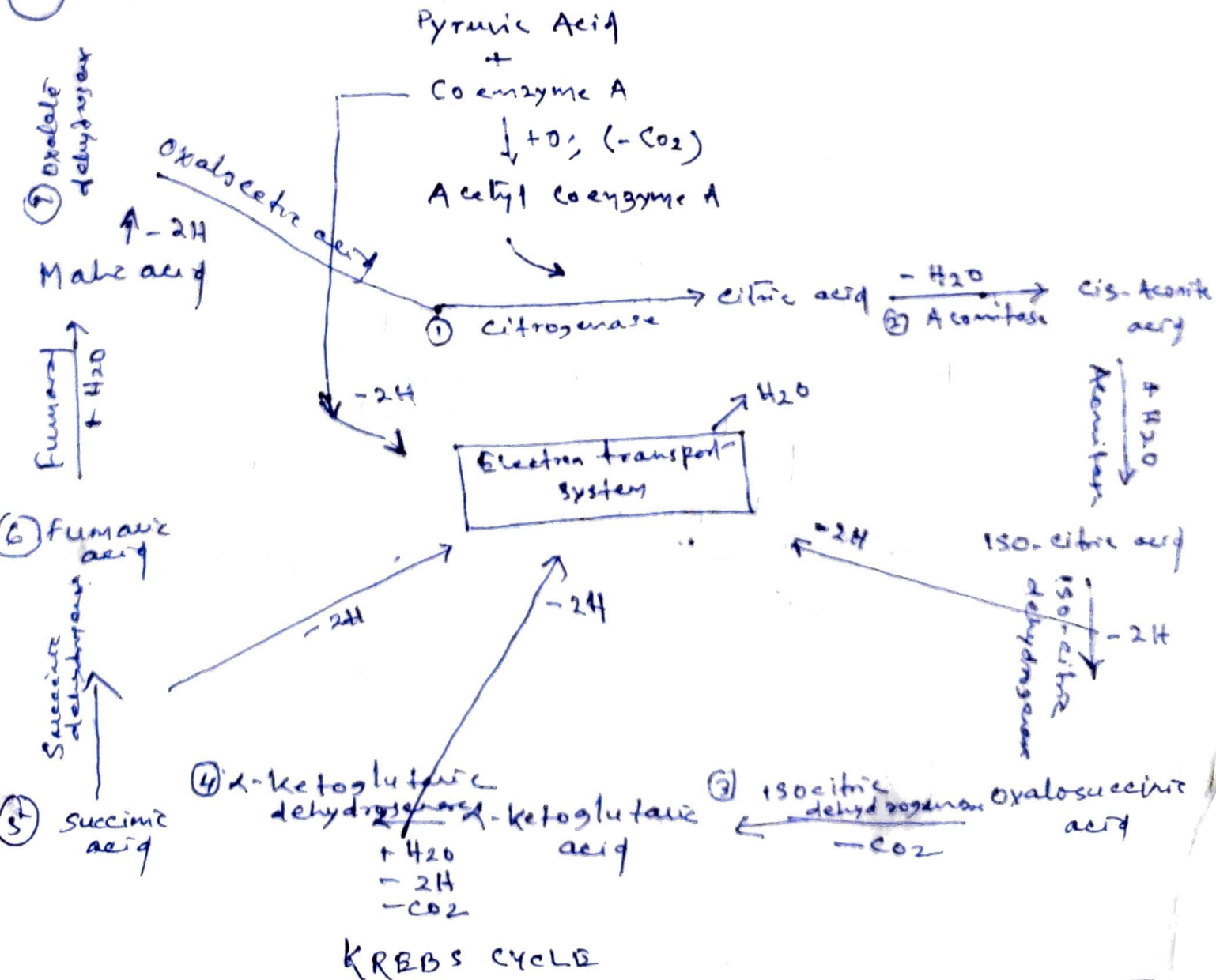


Diagram to show that Mitochondria is the Central power plant of the Cell,

(2) Aerobic biological oxidation of food stuff - Krebs cycle



(3) Respiratory chain - Electron transport system

(4) Energy packaging in ATP Molecule - Oxidative phosphorylation

(5) Mitochondria provide many cofactors & co-enzymes necessary for chemical reactions involved in Krebs cycle or electron transport system
(8) regulate activity in other parts of the cell
(7) Active engagement in synthesis of steroid hormone
(6) Mitochondria in oocytes of planorbis are transformed into yolk bodies
(9) Accumulation of pigment - in mitochondria of amphibia.
(10) Synthesis of mitochondrial protein
(11) uptake & extrusion of intracellular fluids - transport of substances.
(12) active process of fat utilization takes place with the action of fatty acid oxidase present in the mitochondria.

It is thus clear that Mitochondria are important for life. They are the best example of structural - functional integration within the cell.