(i) **Osmosis : -** Movement of only solvent molecules from solution of lower concentration to solution of high concentration across the plasma membrane is called osmosis.

(ii) **Diffusion: -**Movement of ions or molecules from their higher cone. to lower concentration is called **diffusion.**

(iii) **Facilitated or mediated diffusion: -**This type of diffusion occurs according to concentration gradient but it involves carriers like permeasea. Translocases etc (passive transport) .

☞ Expendituer of metabolic energy/ATP. Is not involved in diffusion.

(iv) **Active-transport: -**In this type of transport movement of substances takes place active transport

(v) **Endocytosis (Bulk transport)**

(a) **Pinocytosis or Cell Drinking : -**Term proposed by **W. H. Lewis** (1934) . Ingestion of liquid material by plasmlemma in the formof the vesicles or bag like structure **(pinosome)** is called pinocytosis.

(b) **Phagoctosis or Cell eating : -**Term given by Mechnik off. Ingestion of solid complex materials by Memmbranes in the form of vesicles (Phagosome) iscalled Phagocytosis.

(vi) **Exocytosis/Emiocytosis/Cell vomitting : -**Egestion of waste materials from cell through plasma membrane.

(vii) **Rophaeocytosis: -**This is transfer ;of complex materials from one cell to another cell, through membrane in vescicular form . (Transfer of Hb from Red Bone marrow cells to maturing RBCs is good example of Rophaeocytosis) .

CYTOPLASM

☞ **Term " Cytoplasm" ,** was given by strasburger for the part of cell, presents between the nucleus and cell membrane. Cytoplasm can be divided into two part.

☞ **Ground plasm/Hyaloplasm/Cytoso** → Liquid matrix of cytoplasm except organelles.

☞ **Trophoplasm** → part of cytoplasm containing organelles & non living Inclusions.

CELL ORGANELLES

Permanent **Metabolucally active** and **living structures of cytoplasm are called organelles.**

MITOCHONDRIA

☞ **Kollilrt** (18890) first observed mitochondria as cytoplasmic granules in striped muscles of insects

☞ **Altmen** (1894) established them as cell organelles and called **Bioplast. Flemming** and **Altman** was credited for the disovery of mitochondria . Term **'Mitochondria ,** was given by **c. Benda.**

☞ **F. Meves** (1904) first observed them in plants **(Nymphea)**

☞ **Kinsbury and Hogeboom** (1948) related them with cell respiration.

☞ **Seikevitz** called them power house of cell.

☞ Number 1000-1600 per cell.

☞ One in **Microasterias, Chlorella fusca** (alga) .

☞ 5 lakhs mitochondria in an Amoeba **Chaos Chaos.**

☞ All the mitochondria present in a cell are called **chondriome.**

☞ Usually plant cells have fewer mitochondria as compared to animal cell.

☞ In higher animals maximum mitochondria are found in flight muscles of birds.

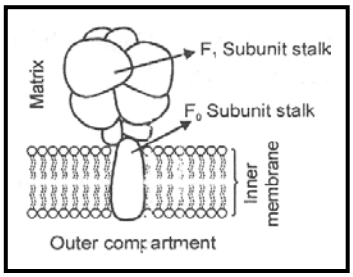
☞ Mitochondria can make its shape as ellipsoidal, oval , spherical or spiral'

Mitochondria

- Power house of cell or ATP –mill in cell
- Cell within cell/second larganelle
- Cellfuranaces or storage batteries
- Most busy and active organellein cell
- Semi autonomous cell organelle

STRUCTURE:

- Mitochondria is covered by double unit membrane. Outer membrane has more phospholipids (Phosphatidyl choline) and cholesterol as compared to inner membrane. Phospholipid in inner membrane is mainly diphosphatidyl glycerol and Inner membrane have more protein.
- Each membrane is 60-75 Ao thick and separated by a space (80-100A0) called **perimitochondrial space.** This space is rich in coenzymes and enzymes required for oxidation of fats.
- If outer membrane of mitochondria is removed then structure is called as **mitoplast.**
- Outer surface of inner membrane is called C-face while inner surface called M-face.
- Some sessile particles attached to outer membrane are known as **" subunit of parsons" .**
- Inner membrane is folded into a number of fonger olike cristae. Cristae are tubular finger like but in fungi cristae are plate like while in Euglena **cristae** are vesicle shaped. Cristae word coined by **palade.**
- In metabolically active mitochondria number of cristae is higher.
- Many electron carrier cytochromes are arranged in a definite sequence in Inner membrane of mitochondria, which forms **Electron transport system (ETS)** for oxidative phosphoylation.
- Inner membrance is studded with pin head particled called **oxysomes** or **elsmentary particles** or **F_1-F_0 particles** (104 to 106 in number) . These particles first described by **Fernandez Moran (1962) .**
- Head of Oxysomes composed of ATPase (ATPsynthase) enzymes and concerned with **Oxidative phosphorylation(Recker 1967)**
- Mitochondrial matrix have enzyme for kreb's cycle. Beside these enzymes matrix have a complete protein synthesis apparatus **(Ribosome-70-s, DNA & RNA, enzymes)** so mitochondria called as semi autonomous **cell organelles.**
- One to many (6 kb to 36 kb long) double stranded mainly circular **naked DNA** present in mitochondria matrix.

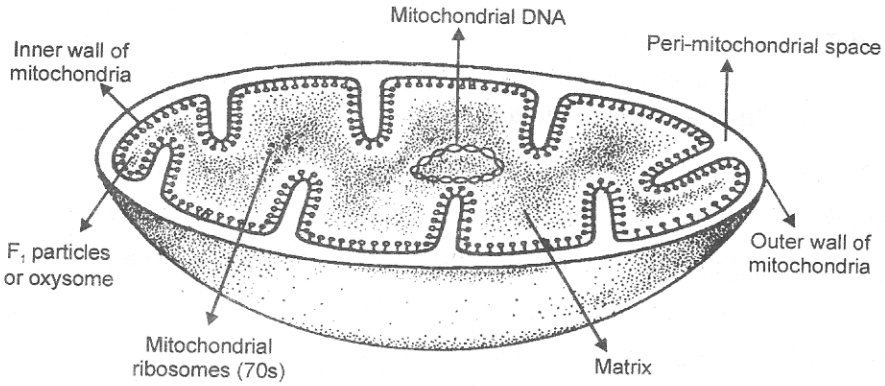


- Mitochondrial DAN is 1% of total DNA in a cell. It is rich in G-C content.
- Mitochondrial DNA can coda the synthesis of 10to37 different types of proteins. Rest of the proteins and enzymes of mitochondria are synthesis under the control of nuclear gens
- Mitochondrial DNA was discovered by Nass and Margit.
- Enzymes for replication and transcription of DAN like Dan-polymerase and RAN-polumerase are found in mitochondrial matrix.
- Mitochondria of mammals have 55s ribosmes (35s, 25s units)
  In scurvy disease several mitochondria fu se to form large bodies called chondriospnere

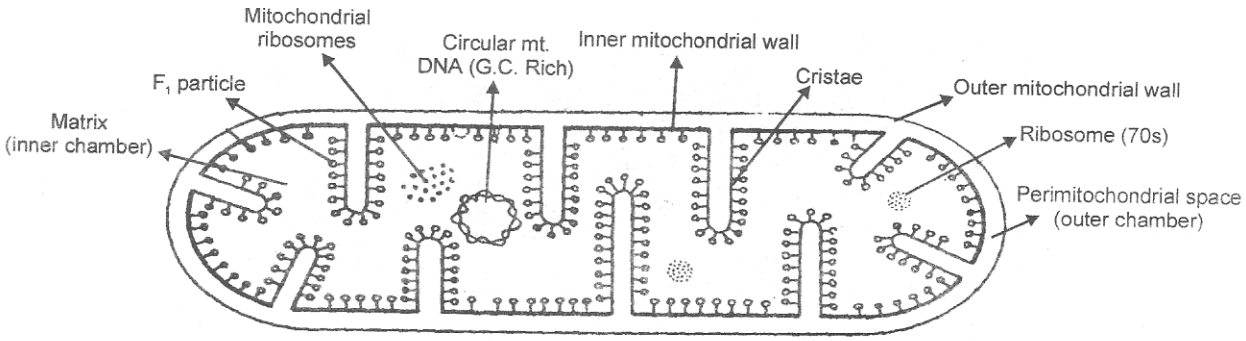
In scurvy disease several mitochondria fu se to form large bodies called chondriospnere

FUNCTIONSOF MITOCHONDRIA:

(1) Most of the oxidative metabolism and ATP production occurs in mitochondria, thus mitochondria are the **power house of cell,** where organic compounds are broken down to release & storc metabolic in the form of molecules. (Resp. metabolism)



Structure of mitochondria



Diagrammatic view of the internal structure of a mitochondrion

(2) Mitochondria help in Vitellogeness in oocytes, Mitochondria Kinase mades the yolk viscous and insoluble for a longer duration storage. Mitochndria of oocytes called Yolk nuclei.
(3) In cytoplasmic inheritance.

Biogenesis of mitochondria-(1) By Division

☞ (2)**Endosymbiotic origin** from Purple sulphur or prokarytic cells, because mitochondria are similar to prokaryotic cell (rickettsial bacteria) in-
(i) Structure of DAN and Fan sequences.
(ii) Typy of ribosome (70s)
(iii)Sensitivity of Antibiotic chloremphenicol with protein synthesis.
(iv) Divide by amitosis or fission.

GOLGI COMPLEX

☞ Discovered by V. Golgi (1898) -In nerve cells of owl and named" internal reticular apparatus " (Golgi body first observed by L. S George)

☞ Golgi body also named as

- Golgi body
- Daliton complex
- Golgi complex
- Lipochondria (rich in lipids)
- Baker' body
- Idiosome
- Dictyosome (plant golgi body)
- Trophspogium

Number of Golgi body ⇒ One to many in a cell located near nucleus.

☞ The cytoplasm surrounding Golgi body have fewer or no other organelles. It is called golgi ground substance or **zone of exclusion. Golgi bodies are pleomorphic structures** because component of golgi body are differ in structure & shape in different cells.

STRUCTURE

Golgi complex is made up of four parts-

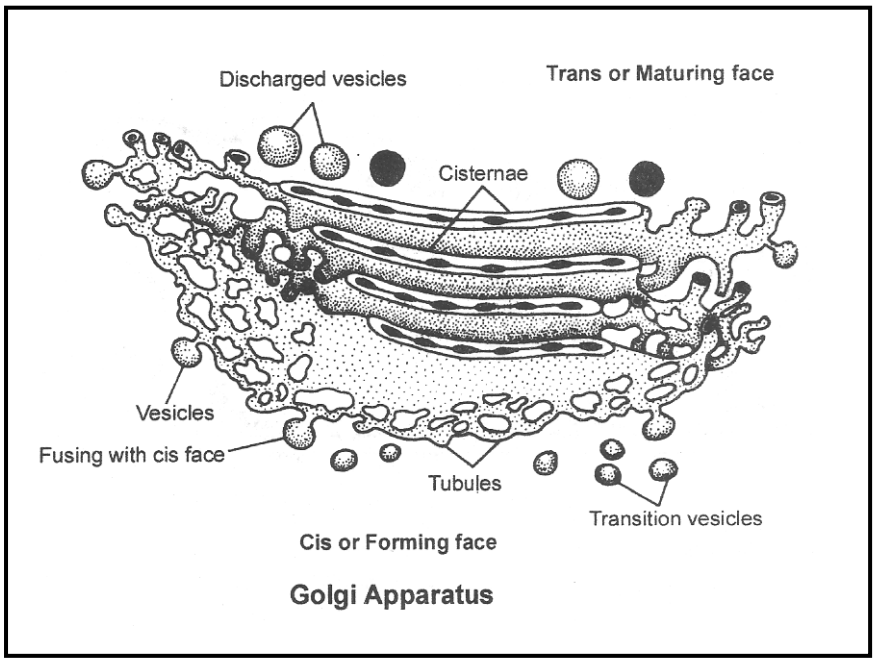
(1) **Cisternae: -**These are unbranched saccules likes smooth E. R, 4to 8 saccules are arranged on a stack. Dense opaque material inside cisternae is called Nodes. Convex surface of cisternae which is towards the nucleus is called cis-face or forming face.

☞ Concave surface of cisternae which is towards the membrane is called Transface or maturing face.

(2) **Tubules : -**These are branched and irregular tube like structures associated with cisternae.

(3) **Vacuoles: -** large spherical structures associated to tubules.

(4) **Vesicles: -** Spherical structures arise by budding form tubules. Vesicles are filled with secretory materials.



Golgi Apparatus

☞ Golgibody is single membrane bound cell organelle.

☞ About 60% proteins and 40% phospholipis occur in golgi body.

FUNCTIONS

(1) **Cell Secretion : -**Chief function of golgi body is secretion (export) of macromolecules.

Secretion involve three steps:

(a) Golgi body receives the materials from E. R. through it's cis-face.

(b) Materials are chemically modified by golgi body, (For e. g. **glycosidation** (glycosidation) of proteins and lipids takes place in golgi body and it yields **glycosidation and glycosidation)**

(c) After chemical modifications materials are packed in vesicles. These vesicles are pinched off from trans face of golgi body and discharged out side the cell **(Reverse pinocytosis)**

☞ Golgi complex involves secretion of zymogen granules from pancreas, secretion of lactoptein from mammmary Glands.

☞ The secretion of hormone by endocrine glands is mediated through golgibodies.

All the macromolecules which are to be sent out side the cell, move through the golgi body . So golgi body is terned as **" principal director of macromolecular traffic in cell"** or **middle men of cell**.

(2) **Synthesis of cell wall Material** (polysaccharide synthesis)

(3) **Cell plate formation** (phragmoplast) during cell formation.

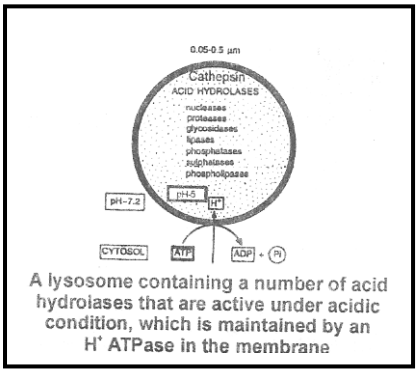
(4) **Formation of acrosome during spermiogensis,** (form of male gametes)

(5) **Vitellein membrane of egg** is secreted by golgi body.

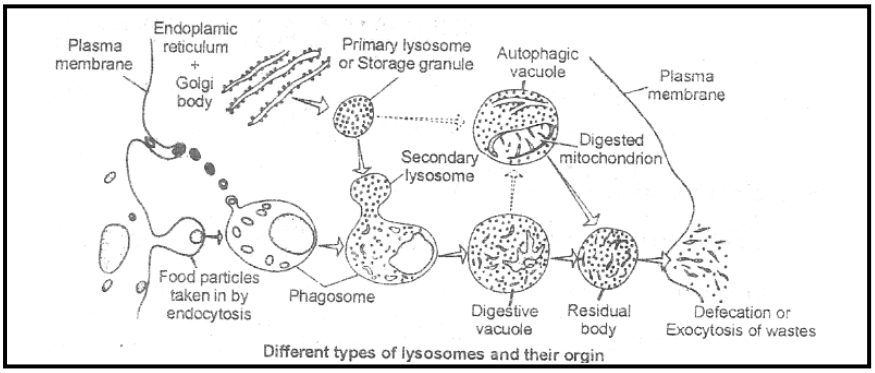
(6) **Formation of Lysosome=**It is collective function of golgi body and E. R.
(7) **Mucilage secretion** by root cells for lubrication to soil.
(8) **Secretion of hormones** by cells of glands.

LYSOSOME

- **Christion De Duve** (1955) discovered lysosome as cell organelle and also Lysosomes. (Lyososme wre first observed by novikoff)
- With the excepion of mammalian RBC they were reported from all cells.
- In plant cells large central vacuole functions as Lysosome. So in higher plants lysosomes are less frequent.
  But number of lusosomes is high in fungi.
- **Periplasmic Space: -** space between cell wall and cell membrane in bacteria, may play similar role.
- **Lysosomes** are spherical bag like structures (01-0. 8 μm) which is covered by single unit membrane, They are larger in Phagocytes (WBC) (0. 8to 2 μm) .
- Lysosomes are filled with 50 different type of digestive enzymes termed as **Acid hydrolases.** These acid hydrolases function in acidic medium . (pH = 5) Membrane of lysosome has an active H+ pump mechanism which produce acidic pH in Iumen of lysosomse.
- Lysosomes are **highly polymorphic** cell organelle. Because, during functioning, lysosomes have different morphological and physisological states.



A lysosome containing a number of acid hydrolases that are active under acidic condition, which is maintained by an H^+ ATPase in the membrane



Different types of lysosomes and their orgin

TYPES OF LYSOSOMES

(1) **Primary Lysosomes or storage granules : -**These lysosomes store enzyme Acid Hydrolases in the inactive form. (Enzymes synthesized on ribosomes in cytoplasm) these are newly formed lysosome.
(2) **Digestive vacuoles or Heterophagosomes: -** These lysosome forms by the fusion of primary lysosomes and phagosomes. These are **secondary Lysosomes**.
(3) **Residual bodies: -** Lysosomes containing undigesested material are called residual bodies, These may be eliminated by **exocytosis .** These are also called as **Telolysosomes . (Tertiary lysosomes)**
(4) **Autopagic Lysosomes or Cytolysosomes or autophagosomes: -** Lysosomes containing cell organelles to be digested are known as **Autophagosomes.**

FUNCTIONS

(1) **Heterrophagy: -**This is digestion of foreign materials receiced in cell by phagocytosis and pinocytosis.
(2) **Autophagy: -**Digestion of old or dead cell organelles. Autophagy also takes place during stsrvation of cell.
[**Ambilysosomes : -** Lysosomes which perform both heterophagy and autphagy.]
(3) **Extracellular digestion: -**
Lysosomes of osteoclast (bone eating cells) dissolve unwanted part of bones.
Extracellular digestion also occurs by fungal lysosomes.)

(4) Crinophagy: -
Excessive secretory granules of hormone in endocrine gland may be digested by lysosomes. This event is called crinophagy. Thyroglobulin stores in thyroid gland with its follicles and after crinooophagy by proteases it produces thyroxin.

(5) Cellular digestion (Autolysis) : -Sometimes all lysosomes of a cell burst to dissolve the ell completely. Old cells are removed by autolysis. Unwanted organs of embryo are destroyed by autolysis Cathepsin of lysosome digests the tail of tadpole of frog during metamorphosis.

(6) Lysosomes are helpful in digestion of egg membrane to assist fertilisation

(7) Lysosomes also trigger the cell division or mitosis.

☞ Lysosomes of Liver in some people lack the enzymes for the digestion of glycogen. In such persons excessive storage of glycogen occurs in liver . This is called Ponpe's Disease.

☞ **Membrane stabilizers** are substances, which stabilize the lysosome membrane and stop its rupture, thus prevents Autolysis. e. g. cholesterol, chloroquine etc.

☞ **Membrane labilizers** are substances which make the lysosome membrane fragile and increase the chance of aut olysis e. g. Progesterone, testosterone , Vitamin A, D, E, K, U. V. radiations , bile salts etc.

☞ Sometime Lysosomes burst it's whole cell so lysosome called as **suicidal bags** of cell.

☞ **Biogenesisof Lysosome** Lysosomes originates from GERL- (Golgi associated Endoplasmec Reticlumfrom which Lysosomes arise) .

$$E.R. \longrightarrow Golgi\ body \longrightarrow Lysosome$$

ENDOPLASMIC RETICULAM

☞ " Garnier (1897) first observed them and called Ergastoplasm. E. R. name proposed by " porter" _1967) (Credit for discovery of ER goes to porter)

Components of E. R. ;-

(1) **Cisternace –**These are long Flattened and unbranched units arranged in stacks,

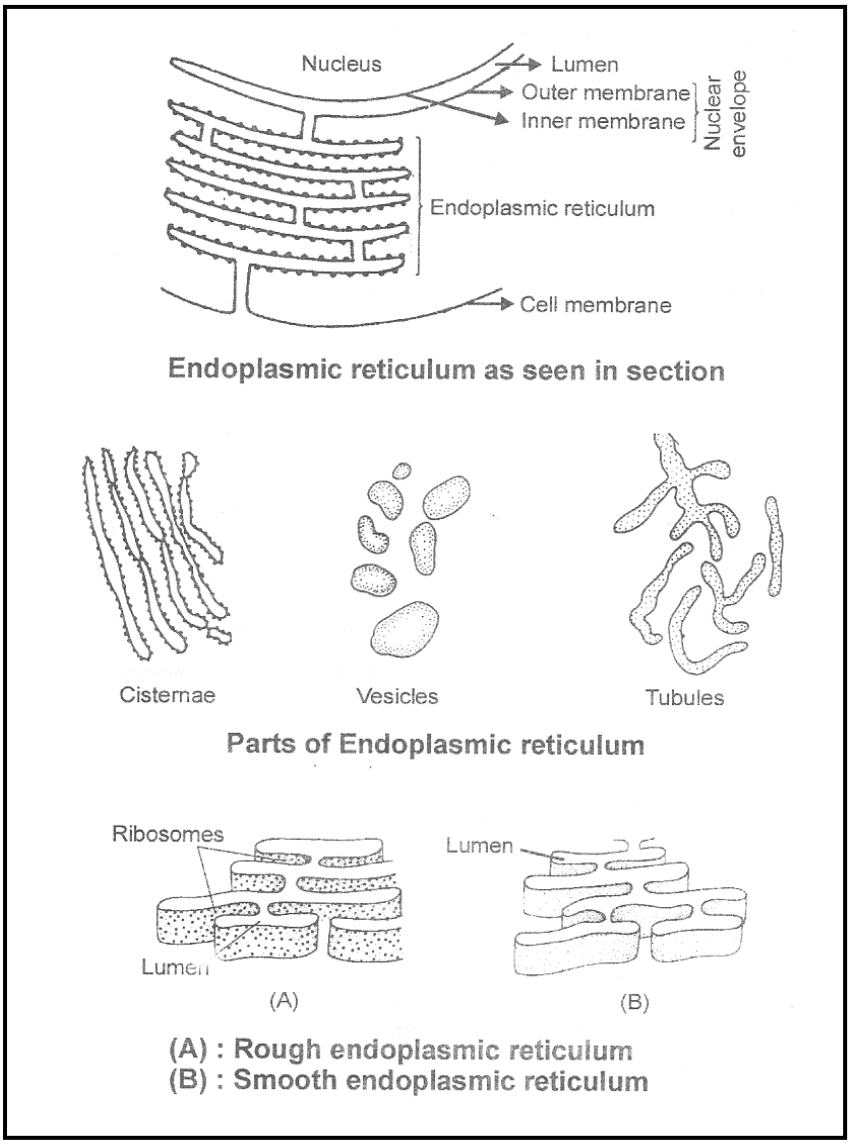
(2) **Vesicles-**These are oval membrane bond structures.

(3) **Tubules-**These are irregular, often branched tunded by membrane. Tubules may free or associated with cisternae.

☞ Structure of E. R. is like the golgi body but in E. R. cisternae, vesicles and tubules are isolated in cytoplasm and these do not form complex.

☞ Golgi body is localised cell organelle while E. R. is widespread in cyoplasm E. R. is often termed as" **System of Membranes "**

Rough E. R. (Granular)	**Smooth E.R. (Agranular**
(1) 80s ribosomes binds by their larger subunit, with the help of two glycoroteins (Ribophorin I and II) on the surface of Rough E. R.	(1) Ribososmes and Ribophorins abent
(2) More Stable structure	(2) Less Stable structure
(3) Mainly composed of cisternae and vesicles	(3) Mainly Composed of tules.
(4) Abundantly occurs in cells which are actively engaged in protein synthesis e. g. liver , pancreas, Goblet cells. Smooth E. R. (Agranular)	(4) Abundantly occurs in cells concerned with glycogen and Lipid metabolism. e. g. Adipose tissue, interstitialcells,Muscles .Glycogen storing liver cells. and adrenal cortex,



MODIFICATIONS OF E. R.

(1) **Sarcoplasmic Reticukum (S. R.) : -** These smooth E.R. occurs in skeletal and cardiac muscles. S.R. Stores Ca^{2+} and energy rich compounds required for muscle contraction.

(2) **T-tubules:-** These are transversely arranged tubules in skeletal andcardiac muscle cells. These transmits stimulus for contraction of muscles.

(3) **Ergastoplasm :** -When the ribosomes are acculated on the small parallel cisternce of E. R. then called **Ergastoplasm,** Ergastoplasm of nerve cells is called as Nissl's bodies.

(4) **Myeloid Bodies: -**
Myeloid bodies are the specialised smooth E. R. which found in pigmented epithelial cells of the retina. Myeloid body is light sensitive structure and may be involved in pigment migration.

(5) **Microsomes –**These are pieces of E. R. with associated ribosomal particles (Claude 1951) . These can be obtained by Fragmentation and high speed centrifugation of cell. They do not exist as such in the living cell.

ENZYMES OF E.R.

Sucrases, NADH diphosphatase, Gulcose-6-phosphatase, NADH-cytochrome-C-reductase, Mg+2activated ATPase, nucleotide diphosphatase, Ascorbic acid synthase are enzymes of E. R

FUNTIONS OF E. R.

(1) **Mechanical support : -**Microfilaments, Microtubules and E. R. forms **endoskeleton** of cell.

(2) **Intracellular exchange : -**E. R. forms intracellular conducting system. Transport of materials in cytoplasm form one place to another occurs through the E. R.

☞ At some places E. R. is also connected to P. M. So can secrete the materials outside the ce

(3) **Rough E. R. : -** Provides site for the protein synthesis , because Rough E. R. has ribosomes on its surface.

(4) **Lipid Synthesis: -**Lipids (cholesterol phospholipids) synthesizes by the agranular pgranular of E. R. **(Smooth E. R)** The major lipids synthesized by S. E. R. are phospholipids and Cholesterol

(5) **Release of Glucose from Glycogen: -Endoplasmic reticulum** seems to play a in breakdown of glycogen (glycogenolysis) . (The polymerisation of glucose to form glycogen probably occur in the cytosol not in the wall of S. E. R.)

(6) **Cellular metabolism: -**The membranes of the reticulum provides anincreased surface for metabolic activities with in the cytoplasm.

(7) **Formation of nuclear membrane: -**Fragmented vesicles of disintegrated nuclear membrane and ER elements arranged around the chromosomes to form a new nuclear membrane during cell division.

(8) **Formation of lysosomes , Golgi-body & Micro-bdies.** All the oganelles are form by E. R. which have membrane except chloroplast and mitochondria (semi autonomous organelles)

(9) **Detoxification –**Smooth ER concerned with detoxification of **drugs , Pollutants and steroids.**

☞ **Cytochrome P_{450}** in E. R. act as enzyme which function in detoxification of drugs and other toxins

(10) E. R. provides the precursor of secrtory material to golgi body.

BIOGENESIS OF E.R.

☞ E. R. may originates as an in foldings of the cell membrane.

☞ Origin from **Nebenkern** (Germ center) , Nebenkern is group of membranes arranged in concentric rings just out side nuclear membrane.

PLSTIDS

☞ The term" Plastid " first used by Haeckel'

☞ **Schimper** coined the term chloroplastid for green plastids Meyer called them Autoplast

☞ **Chloropast** name proposed by Erera.

TYPES OF PLASTIDS

(1) **Chromoplasts : -**These are plasties, which contain different types of pigments (carotenes, Xanthophylls etc.) Chlorophylls either absent or occur in very less amount . Chromoplasts occus mainly in **pericarp** and petals. Red colour of chillies and red tomatoes is due to the red pigment **" Lycopene "** of chromoplasts. Lycopene is a typeof carotene. Yellowish –orange colours of fruits are due to α-carotene, and β-carotene and -carotene -carotene is precursor of vitamin –A . Richest source of β-carotene are carrot roots.

☞ **Chloroplasts** also occurs in petals but colour of petals are mainly due to water soluble pigments occur in cell sap. E. g. **Anthocyanin-** (Blue or violet or red pigment) **Anthoclor** (yellow pigment) .

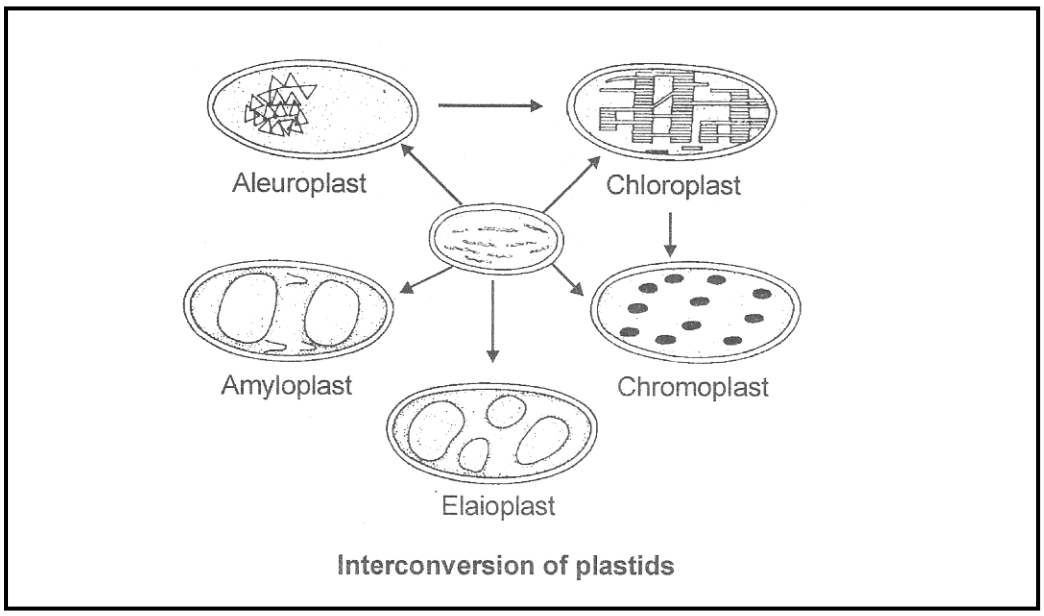
(2) **Chloroplasts-**Green plastids with chlorophylls and other photosynthetic pigment.

(3) **Lrucoplasts: -**These store food in different forms like **starch** (Amyloplasts) , **Fat and oil** (Elaioplasts) and **protein** (Amyloplasts) . Pigments and lamellar structure absents in Leucoplasts. Generally occurs in non green and underground plant cells.

☞ All types of plastids have common origin from **proplastids,** sac like ono –lamellar structures.

☞ Different types of plastids may transform one to another . Because genetic material is similar. But chromoplasts never transform to chloroplasts.

☞ **Etioplasts: -** These are plastids without pigments, stored food and lamellar structures , These occur in etiolated plants **due to the absence of light.**



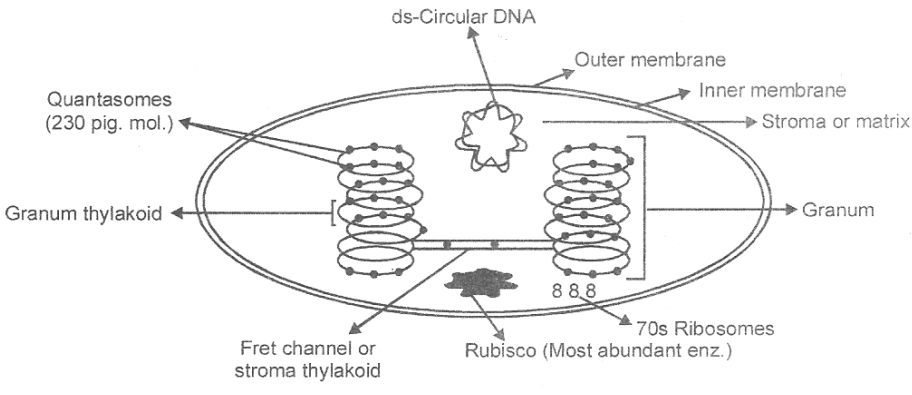
Interconversion of plastids

- **Chromatophores;-** These are clusters of pigment granules in cytoplasm of photosynthetic bacteria.
- In Blue-green algae pigments are located on membranous lamellar structures, scattered in Cytopiasm. These structures are known as **Chlorosomes** or **Lamellisones** or **Carboxysomes.**

STRUCTURE OF CHLOROPLAST

Shape of chloroplasts		Plant types
Discoidal or oval	-	Higher plants
Girdle shaped	-	Ulothrix
Cup shaped	-	Chlamydomonas
Reticulate	-	Oedogonium
Spiral	-	Spirogyra
Stellate	-	Zygnema

- Chloroplast is a **double membrane** bound cell organelle, and is the **largest organelle of cell** $(4-3\mu m \times 1-3\mu m)$ (largest component is nucleus)
- Internally chloroplast contain stroma (Matrix) and thylakoids or lamellae. Matrix part of chloroplast contains **circular** or rarely linear **DNA, RNA, 70-sRibosomes, starch grains , enzymes of calvin cycle or dark reaction.** Rubisco is the most abundant enzyme on the earth. It made 16% protein of the chloropast.



Chloroplast

- The number of chloroplast in cell of higher plants 20-40. (One in chlamydomoas)

- **Thylakoids** (Term by **Menke** 1962) are membrane lined **flattend sacs.** Whhich forms stacks called granum (plu. grana) Each chloroplast contains about 20-100 granum , Fret channel or stromal thylakoids is connection between two granum . Photosynthetic (chlorophylls) are located in the thylakoid membranes.
- A photosynthetic functional unit , which consists of about 230 to 400 molecules of various pigments (Chl-a . Chl-b, carotenes, xanthophylls etc.)
  Is called as **Quantasomes** (By park & Biggins 1964) .
- Cchloroplasts has their own genetic system & complete prorin synthesis machinary **(ds-DNA, RNA, Ribosomes, enzymes , Amino Acids) ,** thus chloroplasts are called as **semiautonomus organelle** of the cell.
- DNA of chloroplast **(Plastidome)** was discovered by **Ris** & **Plaut.** (Upto 14% DNA of cell)
- Chloroplast have more genes as compare to mitochondria (100 or more genes)

FUNCTIONS

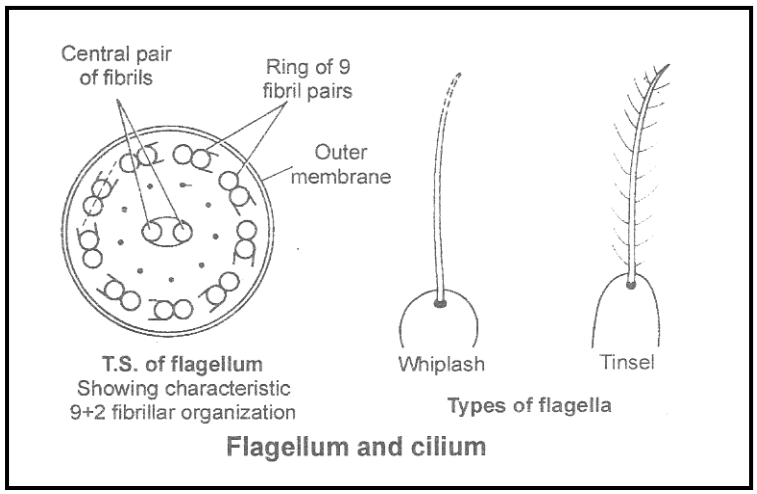
(1) **Photosynthesis:** The chloroplasis trap the light energy of sun and transform it into the chemical energy in the form glucose.
(2) Balancing of O2 & CO2 in nature.
(3) Chloroplasts can be changed into chromoplasts during ripening of fruits.
(4) Chloroplasts impart in **cytoplamic inheritance.**
(5) Chloroplasts impart the plrasing greenary to the earth.
(6) Chloroplasts store vitamin K, E, Rubisco protein and Fe etc.

BIOGNESIS

(1) From Propladted
(2) From Division of pre-existing plastids.
(3) Origin from **Endosymbiotic origin** by a cyanobacterium

CILIA AND FLAGELLA

- Cillia & Flagella are Mechanical, har hair lik cellulr appendages and locomotory structure. Flagellar apparaty is consist of following parts.
  (a) **Shaft or ciliary part:** It is projecting hair like part of ciliary apparatus. Clium is composed of 11 microubules. (9 doublet +2 singlet) .
  - Bundie of microtubules is called as **axonema.** Nine microtubules are peripheral and each composed of two small tubules I, e. A tubule with two atms and **B-Tubules** without arms.
  - Microtubules is consists of a contractile protein **tubulin** similar to actin of muscles.
  - Arms of A tubules consist of an enzmatic proein **dyninen** similar to muscle cells. **Dynien** have ability of hydrolysis of ATP & liberates energy for ciliary movement.



Flagellum and cilium