# CYTOPLASMIC ORGANELLES

The cytoplasmic organelles include:

1. Endoplasmic Reticulum
2. Ribosomes
3. Golgi Apparatus
4. Lysosomes
5. Peroxisomes and Glyoxysomes
6. Cytoskeleton
7. Centrioles
8. Mitochondria
9. Plastids
10. Nucleus

## TYPES OF ORGANELLES

* Non membranous organeller are present in both prokaryotes and eukaryotes. e.g Ribosome.

* Membranous organelles are present only in eukaryotes.

# 1. ENDOPLASMIC RETICULUM

Endo → inside
Plasmic → Cytoplasm
Reticulum → Network

## DISCOVERY

It was discovered by Porter in 1945.

## DEFINITION

Endoplasmic Reticulum is a membrane bounded network of tubules inside the cytoplasm extending from plasma membrane to nuclear membrane. It can be seen only with an electron microscope.

OR

It is an elaborated system of membranes found throughout the cell, forming a cytoplasmic skeleton.

## CISTERNAE

The channels are separated from the cytoplasmic materials by the spherical or tubular membranes one above the other, called cisternae.

## FUNCTIONS

The main functions of endoplasmic Reticulum include circulation, synthesis, detoxification, mechanical support and communication.

## MORPHOLOGICAL FORMS

ER has two morphological forms:

1. Rough Endoplasmic Reticulum
2. Smooth Endoplasmic Reticulum

# 1. ROUGH ENDOPLASMIC RETICULUM

RER appear rough due to the presence of attached ribosomes.

## PRESENCE

Rough endoplasmic Reticulum are mostly found outside the nuclear membrane.

## FUNCTION

RER is involved in protein synthesis. Proteins are synthesized at ribosomes. Inside the ER short chains of sugars are then linked to the polypeptide making the molecule a glycoprotein. The ER packages the glycoprotein into a tiny sac called **transport vesicle**. Then the vesicle buds from the ER membrane and will make its way to plasma membrane. After synthesis the proteins are either stored in the cytoplasm or exported out of the cell through these channels.

## 2. SMOOTH ENDOPLASMIC RETICULUM

Smooth ER is continuous with the RER and is a network of interconnected tubules. Ribosomes are not attached to it.

### SARCOPLASMIC RETICULUM

In muscle cells a specialized form of smooth ER called sarcoplasmic Reticulum is present.

# FUNCTIONS OF SER

### 1. LIPID SYNTHESIS

The SER helps in metabolism of different types of molecules particularly lipid synthesis. SER makes lipids from fatty acids and glycerol absorbed in the gut and passes them to Golgi bodies for export.

### 2. DETOXIFICATION

SER helps to detoxify the harmful drugs.

## 3. Transmission Of Impulses

In some cells SER is responsible for the transmission of impulses, for example, in muscle cells, nerve cells etc.

## 4. Transportation

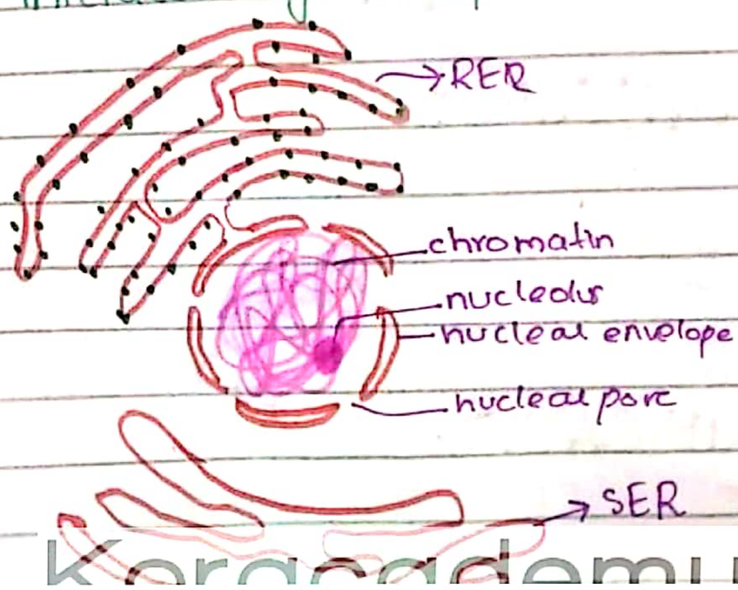
SER plays an important role in the transport of materials from one part of cell to the other.

## 5. Mechanical Support

It provides mechanical support to the cell so that its shape is maintained.

## 6. Initiation Of Hormones

Hormones corticosteroids made in adrenal gland (adrenal cortex) and sex hormones testosterone, estrogen are also initiated by endoplasmic Reticulum.



# RIBOSOMES

## DISCOVERY

Ribosomes were first studied by Palade in 1955.

## DEFINITION

Ribosomes are tiny non-membranous granular cytoplasmic organelles present in both prokaryotic and eukaryotic cells.

## DIAMETER

Diameter of Ribosome is about 20nm.

## COMPOSITION

Eukaryotic Ribosomes are composed of almost equal amount of RNA and protein, hence they are ribonucleoprotein particles.

## RIBOSOMAL RNA

The RNA present in ribosomes is Ribosomal-RNA (rRNA)

## FUNCTION

The ribosomes are the sites for protein synthesis. An example of protein synthesized by free ribosomes is Haemoglobin in young RBCs.

## SYNTHESIS

Ribosomes are synthesized in nucleolus of the nucleus. These r then transported to cytoplasm through nuclear pore.

## TYPES

There are two types of ribosomes:

1. Free Ribosomes
2. Bound Ribosomes

## 1. FREE RIBOSOMES

Those ribosomes which are freely dispersed in cytoplasm.

## 2. BOUND RIBOSOMES

Those ribosomes which are attached to the RER are known as bound Ribosomes.

## STRUCTURE SUB UNITS

All ribosomes in eukaryotes are composed of two subunits of different sizes, the large and the small. The larger one is 60S particles and the smaller one is 40S particles. The two subunits on attachment form 80S particles. The attachment is controlled by presence of magnesium ions concentration of forming salt bonds between phosphate group of RNA and amino acid or both by magnesium ions and salt bonds.

## UNIT

The unit for the size of ribosomes is Svedsberg (S) named after Svedberg.

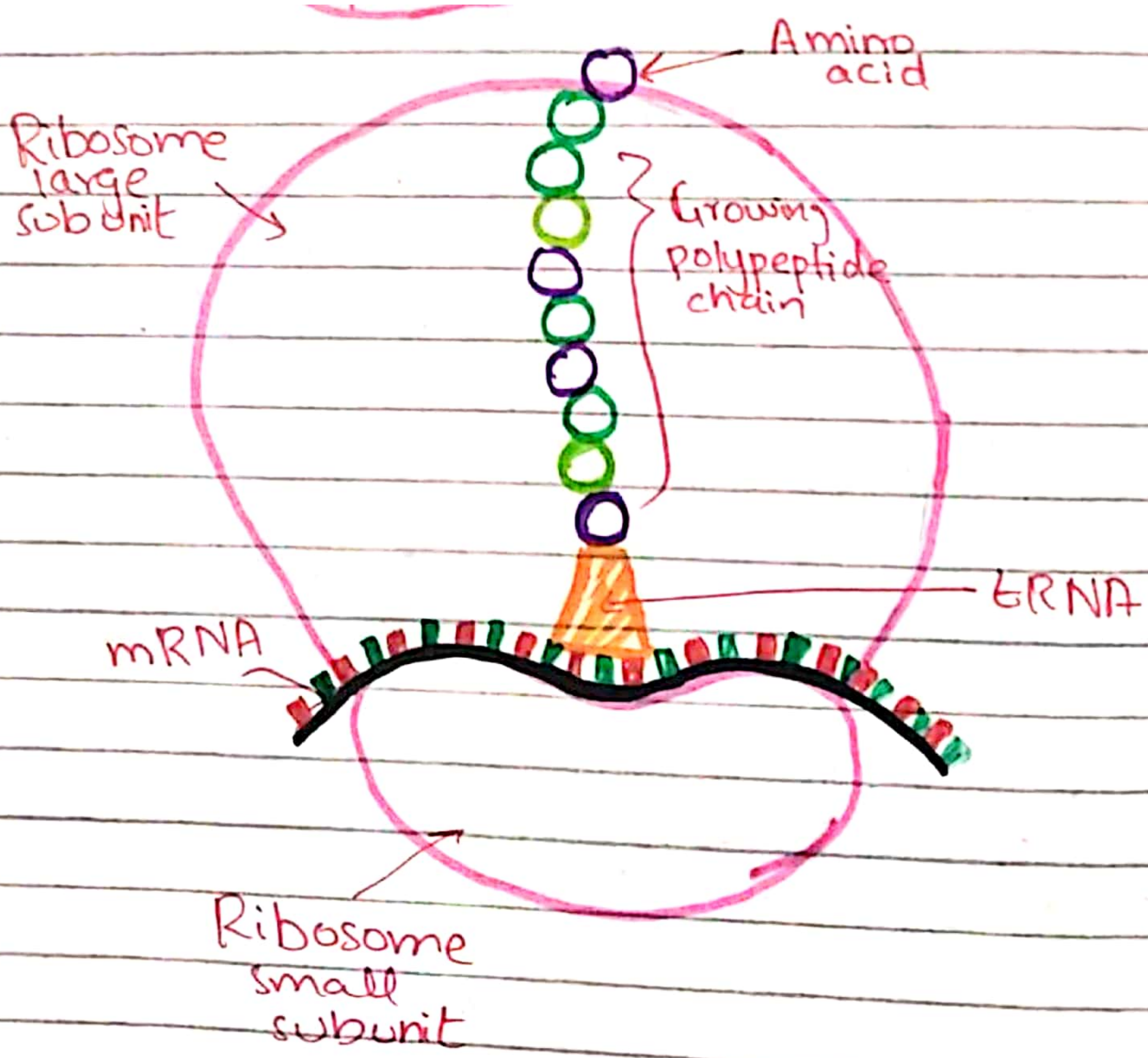
## POLYSOME

When several ribosomes are attached to one mRNA strip it is called polysome or polyribosomes.

## DIFFERENCE BETWEEN PROKARYOTIC AND EUKARYOTIC RIBOSOMES

| | Eukaryotic Ribosome | Prokaryotic Ribosome |
|---|---|---|
| Small subunit | 40S | 30S |
| Large subunit | 60S | 50S |
| Total size | 80S | 70S |

The total size is less than the expected bcz when the two subunits


Amino acid
Ribosome large subunit
Growing polypeptide chain
tRNA
mRNA
Ribosome small subunit

# Golgi Apparatus

## Discovery

The Golgi apparatus was discovered by Camillo Golgi in 1898, using special staining techniques.

## Cisternae

Golgi Apparatus consists of stacks of flattened, membrane bounded sacs called cisternae.

## Golgi Complex

The cisternae together with associated vesicles are called Golgi-complex.

## Dictyosomes

The Golgi complex consists of units called dictyosomes. Each dictyosome is formed of bundles of curved and flattened cisternae, associated tubules and secretary vesicles.

## Faces

Dictyosomes is formed of two distinct faces.

i) Cis Face ii) Trans face

## i) CIS FACE

The proximal (cis) or forming face present close to the nucleus is known as cis face.

Vesicles and tubules pinched off from RER flow, converge, and fuse with the forming face to form new cisterna.

## ii) TRANS FACE

The distal (trans) or maturing face is located towards the cell membrane

# FUNCTIONS

## 1. STORAGE AND PACKAGING

Golgi apparatus helps in the storage of secretory products and in the modification and packaging of secretory products.

## 2. SYNTHESIS OF POLYSACHARIDES

In some cases polysaccharides may be synthesized from simple sugars in the Golgi Apparatus. These polysaccharides may then be attached to proteins and lipids to form glycoproteins and glycolipids.

## 3. INCREASE SURFACE AREA OF CELL MEMBRANE

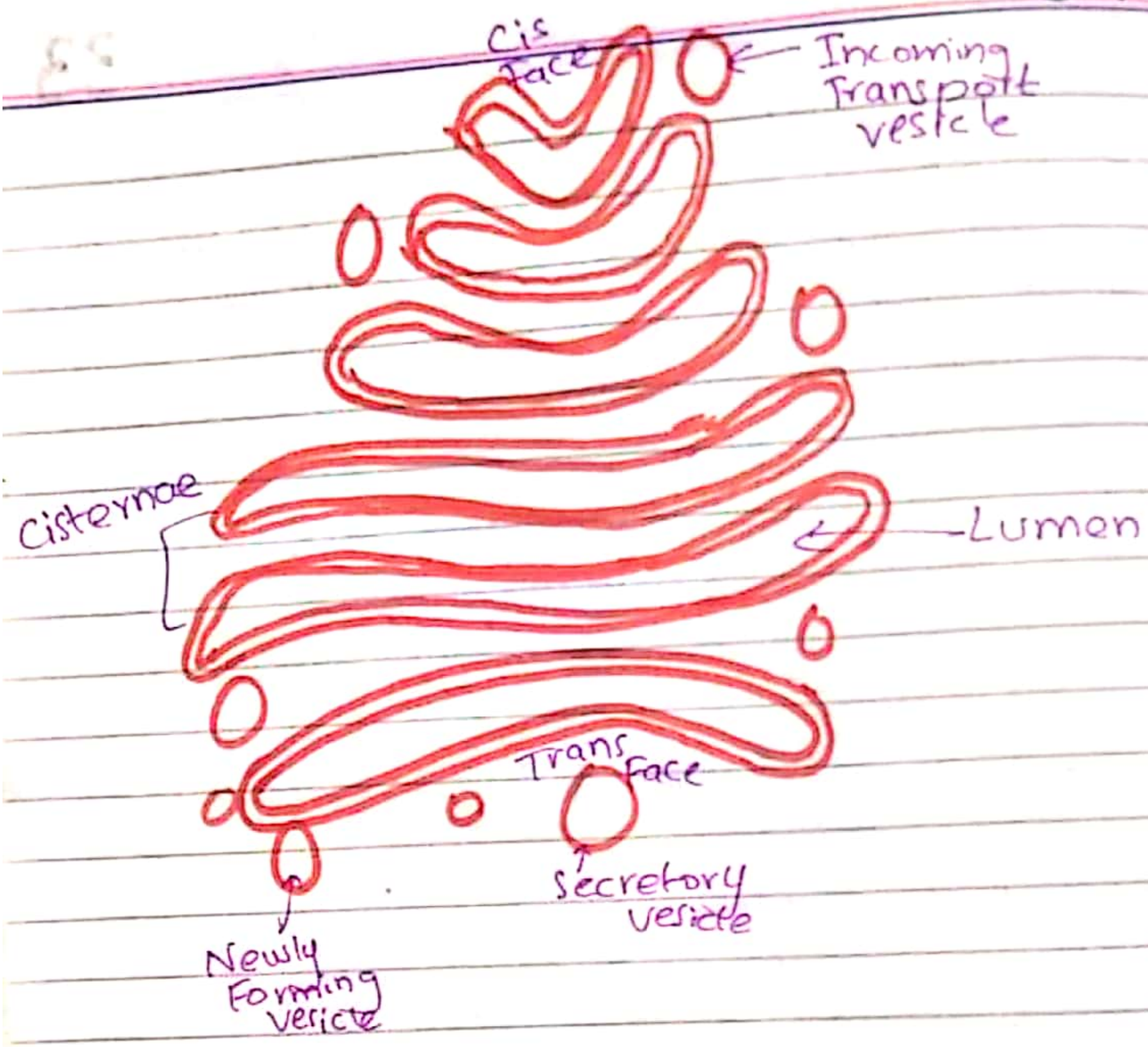
Secretory vesicles produced by Golgi apparatus may play an important role in adding surface area to plasma membrane.

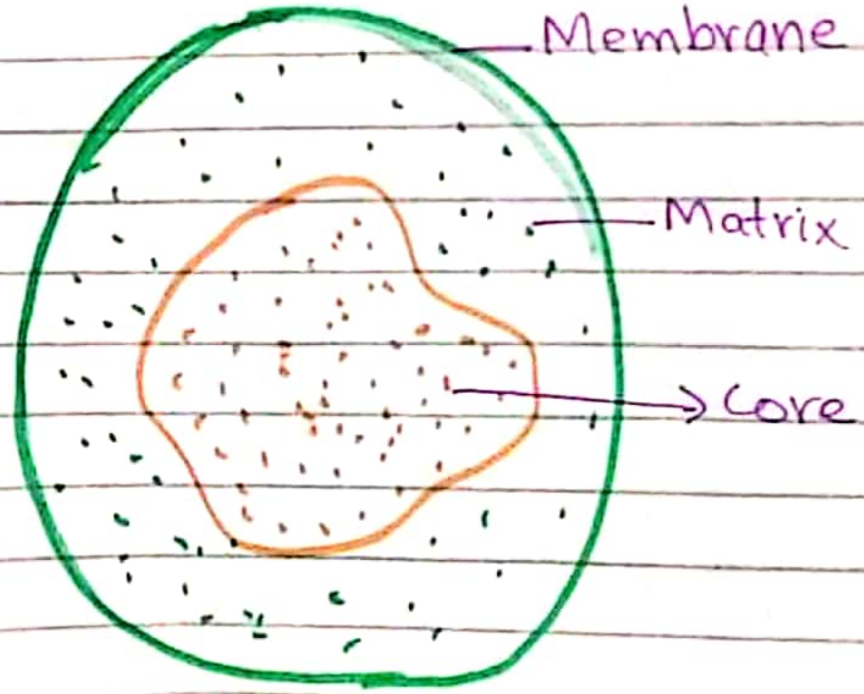
## 4. LYSOSOMES

An important function of the Golgi apparatus is the production of lysosomes.

## 5. TRANSPORT

It helps in transport of material. Many substances travel through Golgi bodies to their destination.




Structure of Glyoxysome

# LYSOSOMES

Lyso → splitting
soma → body

## DISCOVERY

Lysosomes were discovered by De Duve in 1949.

## OCCURANCE

Lysosomes are cytoplasmic organelles found in most eukaryotes and are different from other cytoplasmic organelles due to their morphology.

## COMPOSITION

Lysosomes are simple sacs that contain very large variety of food digesting enzymes called hydrolases. They contain numerous hydrolytic and acid phosphatase enzymes.

## FORMATION OF PRIMARY LYSOSOMES

The lysosomal enzymes are manufactured on RER. Then these enzymes are transported to Golgi apparatus. Here the enzymes are enclosed in membrane. The enclosed enzymes are pinched off as golgi vesicles. These vesicles are called primary lysosomes.

## SECONDARY LYSOSOME

Once a lysosome has fused with a vesicle containing material to be digested, the structure is called secondary lysosome.

## SHAPE

Lysosomes are roughly spherical structures bounded by single membrane.

## SIZE

Lysosomes vary in size, and usually 0.2 - 0.5 $\mu m$ in diameter.

# FUNCTIONS

## 1. PHAGOCYTOSIS

Phagein → to eat
Kytos → cell

Any foreign objects that gain entry within the cell are immediately engulfed by the lysosomes and are completely broken down into digestible pieces. This process is known as phagocytosis.

They are very abundant in those animal cells which exhibit phagocytic activity e.g neutrophils.

## 2. AUTOPHAGY

The process by which unwanted structures within the cell are engulfed and digested within the lysosomes is called autophagy. With the help of lysosomes, the cell continually renews itself. For example, a human liver cell recycles half its macro molecules every week.

## 3. AUTOLYSIS

Autolysis is the self digestion of a cell by releasing the contents of lysosomes within the cell. In such circumstances lysosomes have been named as suicidal bags. Autolysis may occur throughout the tissue e.g reabsorption of tadpole tail during metamorphosis.

## 4. EXOCYTOSIS

Sometimes the enzymes of lysosomes are released from the cell by exocytosis. This occurs during the replacement of cartilage by bone during development

## 5. METAMORPHOSIS

Metamorphosis of animals (removal of tadpole tail) is an example of lysosomal activity.

# MALFUNCTIONING OF LYSOSOMES

Several congenital diseases have been found to be due to accumulation of substances such as glycogen or various lipids within the cell. These are also called lysosomal storage diseases and are produced by a mutation that affects one of the lysosomal enzymes involved in the catabolism of certain substances.

Some of the diseases caused due to lysosomal storage diseases are:

## i) GLYCOGENESIS TYPE II

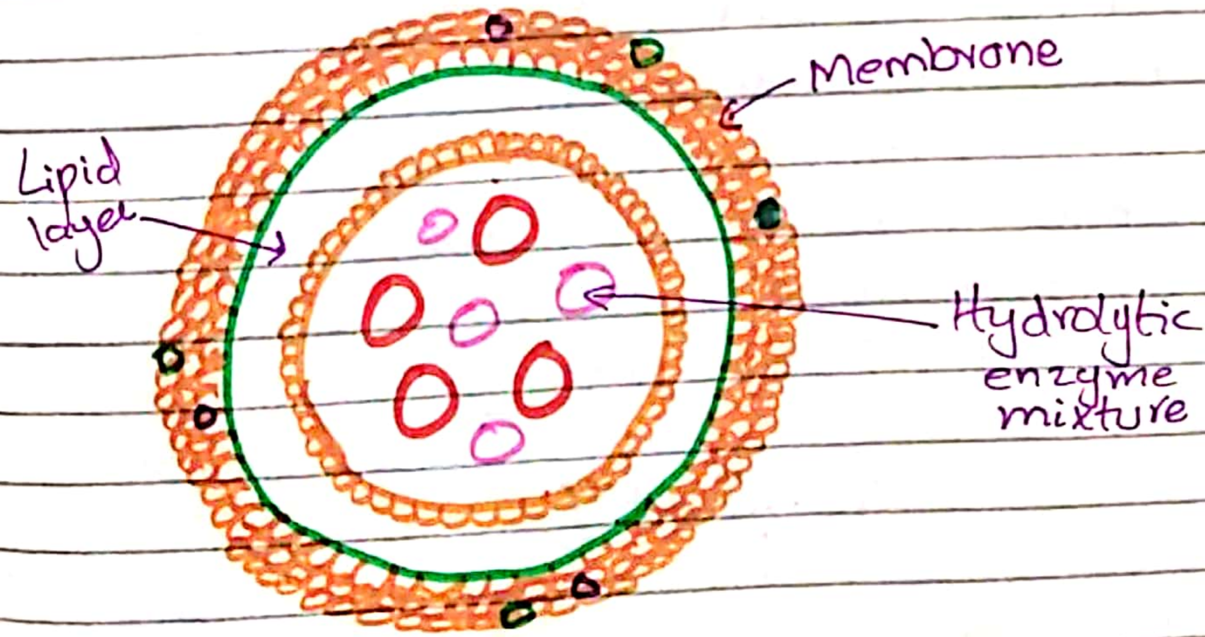
In this disease, the liver and muscles appear to be filled with glycogen within membrane bound organelles. In this disease, an enzyme that converts
(α - glucosidase)

glycogen to glucose, is absent.

## ii) TAY-SACH'S DISEASE

In the Tay-Sach's disease a lipid digesting enzyme is missing or inactive and accumulation of lipids in brain cells lead to mental retardation and even death.

Ganglioside is a group of lipids present in brain. Enzyme hexodiamylase is responsible for breakdown of gangliosides and this disease occurs when these enzymes are absent



# MICROBODIES

Microbodies are similar to lysosomes and are a single membrane enclosed cytoplasmic organelles. Microbodies include:

i) Peroxiosomes
ii) Glyoxiosomes

## i) PEROXIOSOMES

### DISCOVERY

In 1965, De Duve and his coworkers isolated particles from liver cells. These particles were enriched with some oxidative enzymes. As this organelle is specifically involved in the formation and decomposition of hydrogen peroxide so they were named peroxiosomes.

### OCCURANCE

Peroxiosomes are present abundantly in animal cells while rarely in plant cells.

In animals they are most common in liver and kidney cells.

In plants they are found in leaf.

## SIZE

Peroxiosomes are approximately 0.5 to 1 micrometer in diameter.

## COMPOSITION

Peroxiosomes consist of certain enzymes which include peroxidases and catalase. Urate Oxidase (one enzyme is also present which acts on uric acid.

# FUNCTIONS

## 1. DECOMPOSITION OF HYDROGEN PEROXIDE

$H_2O_2$ Hydrogen Peroxide is produced in different metabollic processes. Hydrogen peroxide is a toxic molecule which is immediately broken down to water and oxygen by enzyme called catalase.

$$H_2O_2 \longrightarrow H_2O + O_2$$

## 2. DETOXIFICATION

Peroxiosomes help to detoxify alcohal, and convert fats to carbohydrates.

## 3. PHOTORESPIRATION

In the leaves of green plants, photorespiration may occur in peroxiosomes.

# 2) GLYOXYSOMES

## PRESENCE

Glyoxysomes are present in plant cells and are abundant in germinating seeds.

## COMPOSITION

It contains a number of enzymes including glycolic acid oxidase and catalase.

## FUNCTION.

### 1. GLYOXYLATE CYCLE

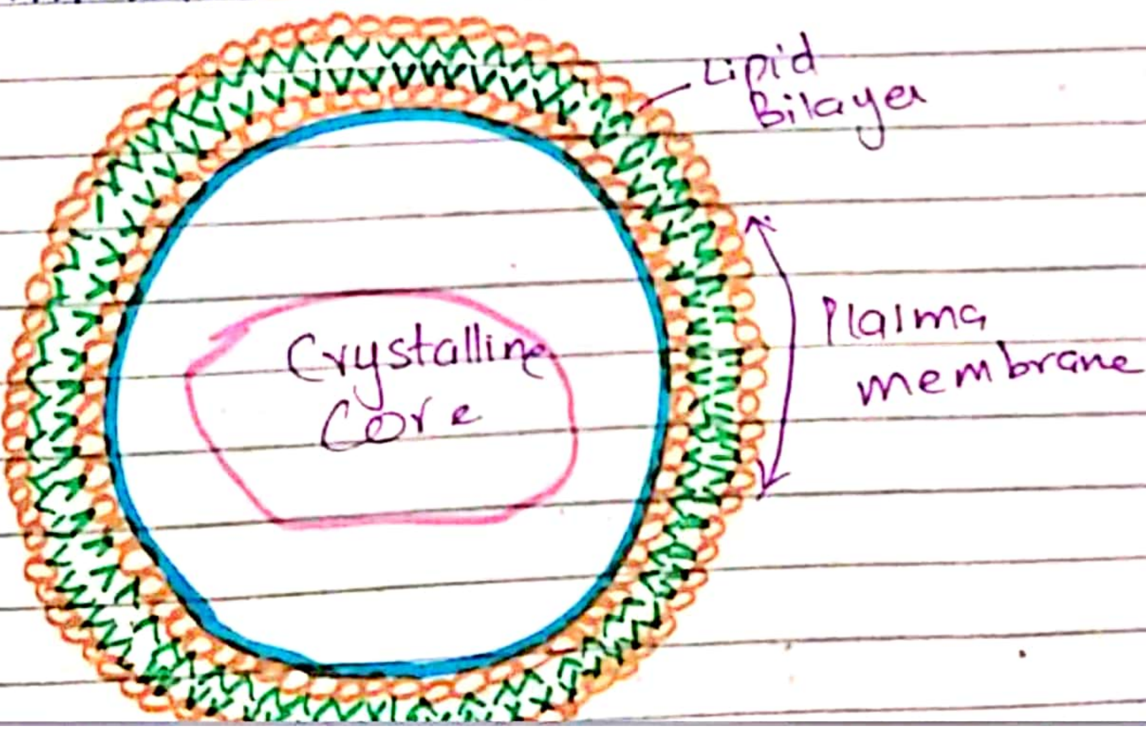
The primary activity of the glyoxisomes is the conversion of fatty acids to carbohydrates. This is achieved through a cycle called glyoxilate cycle.

### 2. BREAKDOWN OF LIPIDS

In lipid rich seeds such as soyabeans, glyoxisomes provide sites for the breakdown of lipids. These organelles are absent in seeds poor in lipid.

# 3. GERMINATION OF SEED

For a seed to germinate, the first step is that seed coat must rupture. But as lipids are insoluble in water, potential difference doesnot develop and the seed coat doesnot burst. For the seed coat to burst lipids are converted into ~~sugar.~~ fatty acids by catalase. Fatty acids are then converted into sugar by glycolic acid oxidase. As sugars are soluble in water, the seed coat ruptures and the seed germinates.



# CYTOSKELETON

## DISCOVERY

Koltzoff in 1928, by his microscopic studies suggested the existence of an organized fibrous network of skeleton in the cytoplasm of eukaryotic cells. Later on, Cohen in 1977 confirmed the views of Koltzoff by his electron microscope studies.

## DEFINITION

Kytos → cell
skeleton → dried body

The cytoskeleton is a network of interconnected filaments and tubules that extends from the nucleus to the plasma membrane in eukaryotic cells.

## FUNCTION

The cytoskeleton maintains cell shape and causes the cell and its organelles to move.

## COMPOSITION

According to Cohen, the

cytoplasm of eukaryotic cells contains a cytoskeletal network of different types of microtubules, microfilaments and intermediate filaments.

## PROTEINS

The main proteins that are present in the cytoskeleton are tubulin (in microtubules), actin, myosin, tropomyosin and others which are also found in muscles.

## a. MICROTUBULES

These are long, unbranched slender tubulin protein structures.

### DIAMETER

They are the thickest among the cytoskeleton, about 25nm in diameter.

### ORIGIN

They radiate from cell membrane and goes to nuclear membrane.

### FUNCTION

## 1. SUPPORT

Microtubules provide support to the cell.

## 2. SPINDLE FORMATION

One very important function of microtubules is spindle formation during cell division through which chromosomes move towards the opposite pole.

## 3. TRACK FOR MOTOR PROTEINS

Microtubules provide track for motor proteins along which organelles can move to their destination. The motor proteins are myosin and dynion. Their function is to anchor various cell organelle.

## 4. DERIVATION OF CELL ORGANELLES

Several cell organelles are derived from special assemblies of microtubules e.g cilia, flagella, basal bodies and centrioles.

## b) MICROFILAMENTS

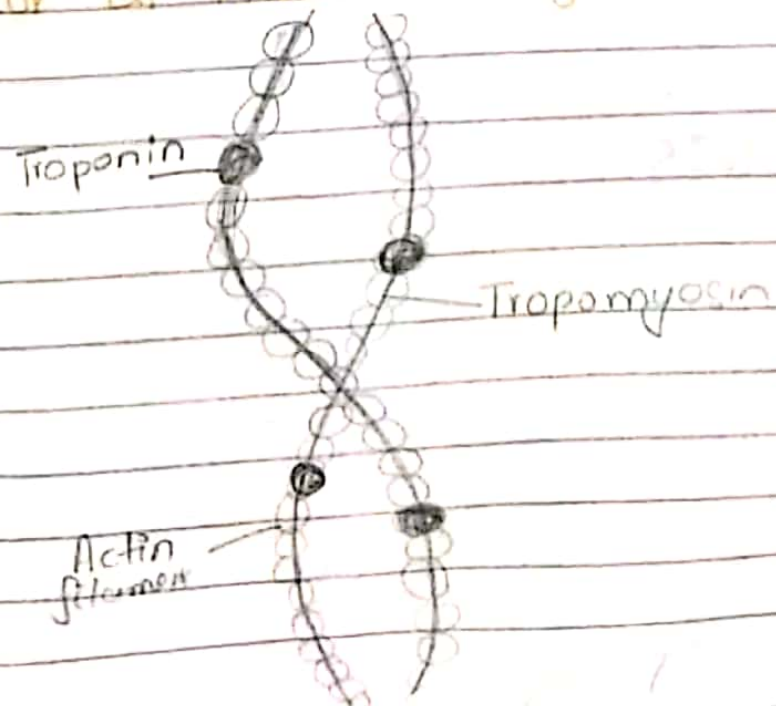
Microfilaments are the thread like structures which are also known as actin filaments.

### SIZE

They are the thinnest among the cytoskeleton. These are extremely thin fibres about 7nm in diameter that occur in bundles or mesh like networks.

### STRUCTURE

The actin filament contains two chains of globular actin monomers twisted about one another in a helical manner. Threads of tropomeyosin wind around an actin filament and troponin occur at intervals along the thread.



# FUNCTIONS

## 1. CYCLOSIS

Cyclosis and amoeboid movements are because of microfilaments. Cyclosis is streaming movement of cytoplasm.

## 2. MOVEMENT

They help in contraction of muscles thus involved in movement.

They are also involved in Pseudopodia formation thus helps in locomotion. Amoeboid movement

## 3. ENDOCYTOSIS

Microfilaments help in endocytosis. Endocytosis is the process in which any molecule comes inside the cell.

## 4. EXOCYTOSIS

They are also involved in exocytosis. Exocytosis is a process in which any molecule goes outside the cell.

# c) Intermediate Filaments

In intermediate filaments the protein fibers are wrapped around one another.

## Size

They are 8 to 10 nm in diameter, intermediate in size between actin filaments and microtubules, this is why they are called intermediate filaments.

## Vimentin

The basic protein subunit of the filament is vimentin.

## Function

They help in maintaining cell shape. Some intermediate filaments support nuclear envelope, and others support plasma membrane.

# CENTRIOLES

Centrioles are non-membranous cell organelles found mainly in animal cells. and unicellular organisms

## PRESENCE

They are found in animal cells, cells of some microscopic organisms and lower plants.

They are absent in higher plants i.e Angiosperms and Gymnosperms

## SIZE

These are small hollow cylinders that occur in pairs. ~~Their diameter~~ They are about 0.3–0.5 μm long and about 0.2 μm in diameter.

## STRUCTURE

Centrioles commonly occur in pairs. These occur at right angle to each other near one pole of the nucleus.

## CENTROSPHERE

The centrioles lie in a distinctly staining region of the cytoplasm known as centrosphere.

# CENTROSOME

The centrioles and centrosphere are together referred to as centrosome.

# STRUCTURE OF CENTRIOLE

A centriole consists of 9 triplets of microtubules. Each triplet is composed of 3 microtubules. These triplets are arranged in a circle. The microtubules are connected with eachother with intermediate filaments. The triplets are also connected to eachother through intermediate filament.

# FUNCTIONS

## 1. SPINDLE FORMATION

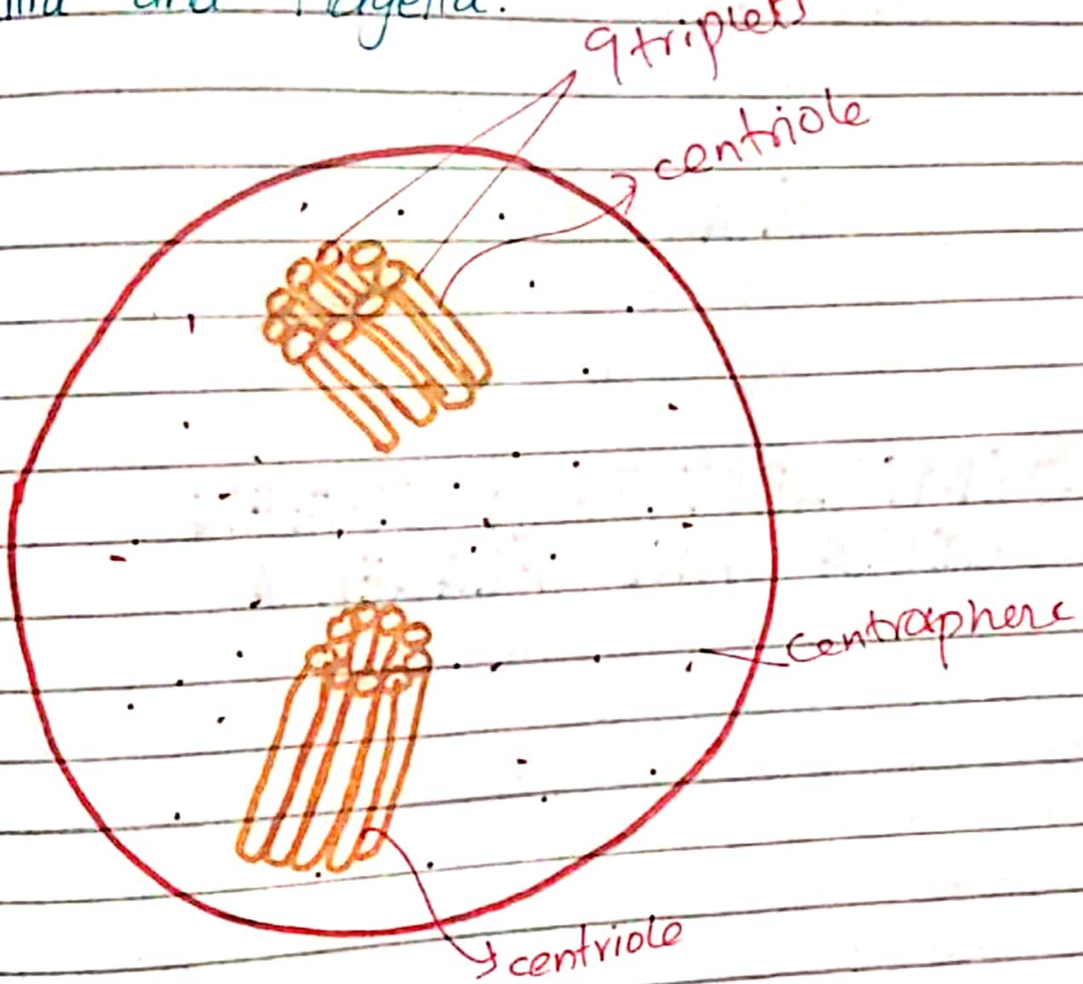
Just before the cell division, the centrioles duplicates and the pairs migrate to the opposite of the nucleus. The spindle fibres are then formed between the two pairs of centrioles.

## 2. CELL DIVISION

The centrioles play an important role in cell division by forming spindle and providing a mechanism for the allignment and dragging of chromatids.

## 3. FORMATION OF CILIA AND FLAGELLA

Centrioles give rise to basal bodies ~~of~~ or kinetosome of cilia and flagella.



# CILIA AND FLAGELLA

## CILIA

[Cilia is derived from Latin word Cilium which means eyelash or hair]

## FLAGELLA

[Flagella is a latin word which means whip]

## SIMILARITIES BETWEEN CILIA AND FLAGELLA

Cilia and flagella are hair like projections on the surface of the cells. These are cytoplasmic processes and act as sensory organs and also perform several other functions of the cell.

## DIFFERENCE

There is no clear morphological or physiological difference between cilia and flagella except that of size.

**FLAGELLA** are few in number ranging

from 1 to 9 and are longer. e.g the Chlamydomonas has two flagella, the mammalian sperma tozoan has a single flagellum.

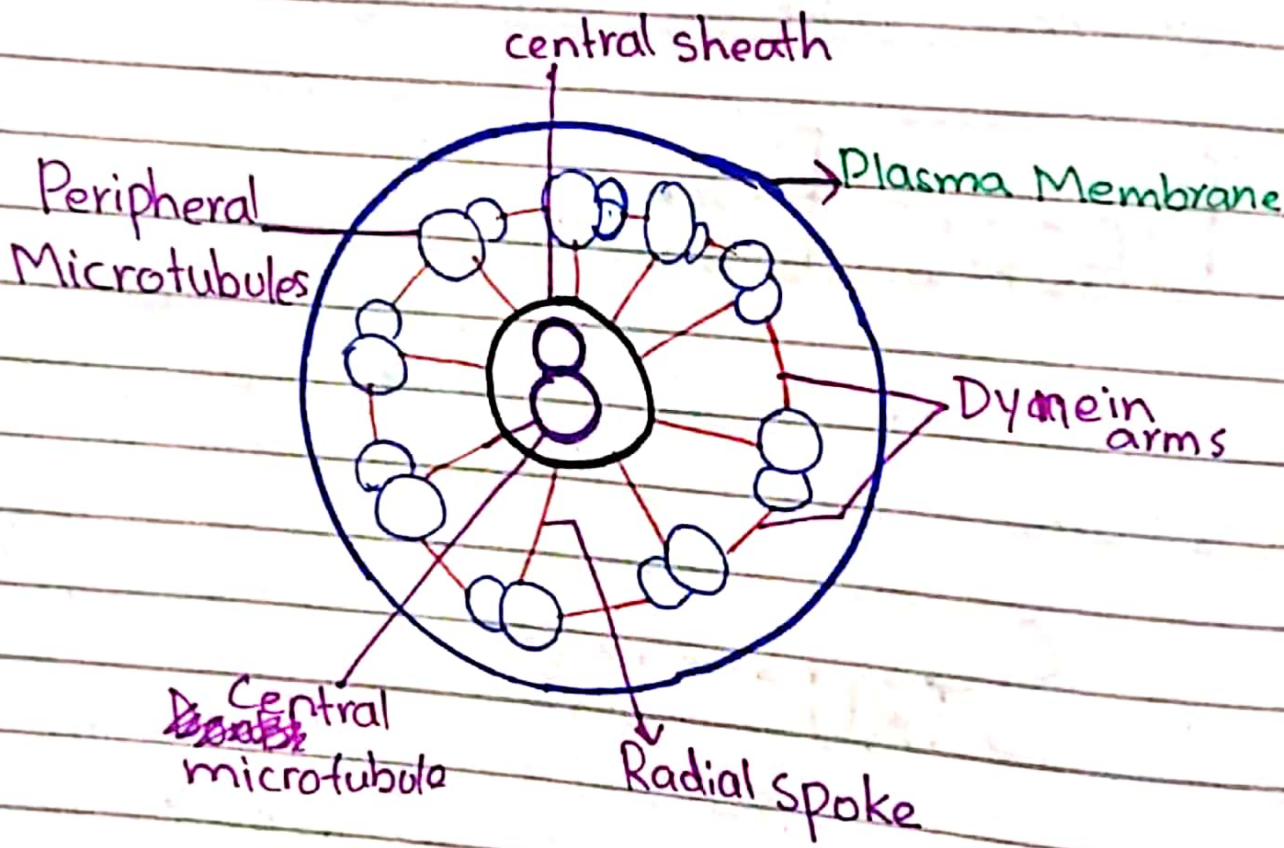
**CILIA** are numerous and relatively short e.g the unicellular protozoan Parameclum is covered with a few thousand cilia.

# BASAL BODIES

Cilia and flagella originate from their basal bodies embedded in the cytoplasm.

# STRUCTURE

Each cilium and Flagellum consists of longitudenal **AXONEME** enclosed in spiral sheath of cytoplasm and a plasma membrane surrounding the axoneme. Axoneme is made up of eleven longitudenal fibrils or **MICROTUBULES**. Of them 9 are peripheral microfibrils and 2 are central microfibrils. These are arranged in 9+2 pattern. The central fibrils are enclosed in a central sheath. The 9 peripheral microfibrils forms a ring around the central sheath. Each peripheral microfibrils is composed of two SUBFIBRES forming a doublet. The inner surface of the double is complete and the outer surface is C-shaped. Each inner subfibre has two arms composed of DYNEIN PROTEIN and a RADIAL SPOKE which ~~it~~ extends from it to the central sheath.



# MITOCHONDRIA

Mitos → Thread
Chondrion → Body

## PRESENCE

Mitochondria are found within the cytoplasm of all eukaryotic cells, although in highly specialized cells such as mature RBCs, they may be absent.

## DISCOVERY

They were first seen as granules in muscle cells in 1850.

## SHAPE / MORPHOLOGY

Under electron microscope, mitochondria appear to be vesicles, rods or filaments and also show complex morphology.

## MEMBRANE

Mitochondria is a double membrane structure, the outer membrane and the inner membrane. Mitochondrial membranes are composed of lipids and proteins. It has same chemical nature as that of cell membrane.

## INTERMEMBRANAL SPACE

The two membranes are

separated by a narrow space the intermembranal space.

## OUTER MEMBRANE

The outer membrane is smooth and somewhat like a sieve.

## INNER MEMBRANE

The inner membrane is selectively permeable and folded inwards.

## CRISTAE

The folds are called cristae which serve to increase the surface area.

## MATRIX

The region of mitochondria enclosed by membrane is called matrix. Mitochondrial matrix is jelly like material that contains DNA, RNA, Ribosomes and enzymes [The matrix contains a large number of oxidative enzymes, co-enzymes, organic and inorgani salts, vital for aerobic respiration (Krebs cycle, fatty acid metabolism etc)

# FUNCTIONS

## 1. POWER HOUSE OF CELL

It is also known as power house of cell due to storage of high energy (ATP) during cellular respiration.

## 2. MAINTENANCE OF $Ca^{++}$

Mitochondria maintains proper concentration of calcium ions.

## 3. BREAKDOWN OF FOOD

The enzymes present in mitochondrial matrix break down carbohydrate products, releasing energy that is used for ATP production on the cristae.

## 4. PROTEIN SYNTHESIS

The presence of ribosomes and DNA inside mitochondria indicate that some proteins are synthesized in it, so it is a self replicating organelle.

## 5. TANK OF CALCIUM

Mitochondria is also known as tank of calcium as it helps in storage of calcium.

## * SELF REPLICATING ORGANELLE

The presence of ribosomes and DNA inside mitochondria indicate that some proteins are synthesized in it, so it is a self replicating organelle.

## * ELEMENTARY PARTICLES

The inner surface of cristae in the mitochondrial matrix has small knob like structures known as elementary particles ($F_1$ particles)

# PLASTIDS

Plastids are mostly pigment containing membrane bounded organelles present in plant cell and some protozoans and flagellates.

## TYPES

There are three types of plastids:

1. Chloroplast
2. Chromoplast
3. Leucoplast.

## 1. CHLOROPLAST

In photosynthetic plant cells, these are membrane bounded structures containing a green pigment, chlorophyll.

### SHAPE

Chloroplasts vary in their shape. They may be round, star shaped, cup shaped, prismatic etc.

### DIAMETER

Their diameter ranges from about 4-6 µm.

# CHLOROPHYLL

Chlorophyll is an organic molecule which helps the cell to absorb sunlight and utilize it to manufacture food.

Chlorophyll molecule resembles haemoglobin. The only and main difference between the two molecules is that chlorophyll has $Mg^{++}$ while haemoglobin has $Fe^{++}$ as the central atom.

# COMPONENTS

Chloroplast show three components:

1. Envelope
2. Stroma
3. Thylakoid

## 1. ENVELOPE

Each chloroplast is bounded by a smooth double membrane known as envelope.

### OUTER MEMBRANE

The outer membrane is smooth and permeable to small molecules.

### INNER MEMBRANE

The inner membrane is semipermeable and rich in protein.

# 2. STROMA

Stroma is the colourless proteinaceous ground substance that fills the chloroplast.

## COMPOSITION

The stroma contains proteins, lipids, small (70S) ribosomes, DNA, RNA, ions and enzymes.

## FUNCTION

In the stroma, the $CO_2$ is fixed to manufacture sugars.

The stroma is the main site for dark Reaction of Photosynthesis.

# 3. THYLAKOID

Thylakoids are flattened vesicles which arrange themselves to form grana.

## GRANUM

A granum appears to be a pile of thylakoids stacked on eachother like coins. On average there are 50 or more thylakoids piled to form one granum. Granum appears to be green due to presence of chlorophyll on thylakoid membranes.

## INTERGRANUM

Each granum is interconnected

by the non green part called intergranum

### FUNCTION

All the necessary pigments are attached to the grana so light reaction takes place in the grana of chloroplast.

## b) CHROMOPLAST

Chromoplasts imparts colour to the plant part other than green.

### PRESENCE

They are present in the petals of the flower and in the ripened fruits.

### FUNCTION

They help in pollination by attracting insects for dispersal of seeds.

## c) LEUCOPLAST

Leucoplasts are colourless. They are triangular, tubular or of any other shape. They are found in endosperm, ubers, roots and other non-photosynthetic issues of plants.

## FUNCTION

Leucoplasts are mostly found in the underground parts of the plant and store food. The leucoplasts are involved in the storage of various materials (carbohydrates, fats, oils and proteins), especially starch.

If leucoplasts are exposed to light they can develop into chloroplasts and vice versa.

## TYPES OF LEUCOPLASTS

### i) AMYLOPLASTS

Plastids storing carbohydrates are called amyloplasts.

### ii) ELAIOPLASTS

Plastids storing fats and oils are called elaioplasts.

### iii) PROTEINOPLASTS

Plastids storing proteins are called proteinoplasts.

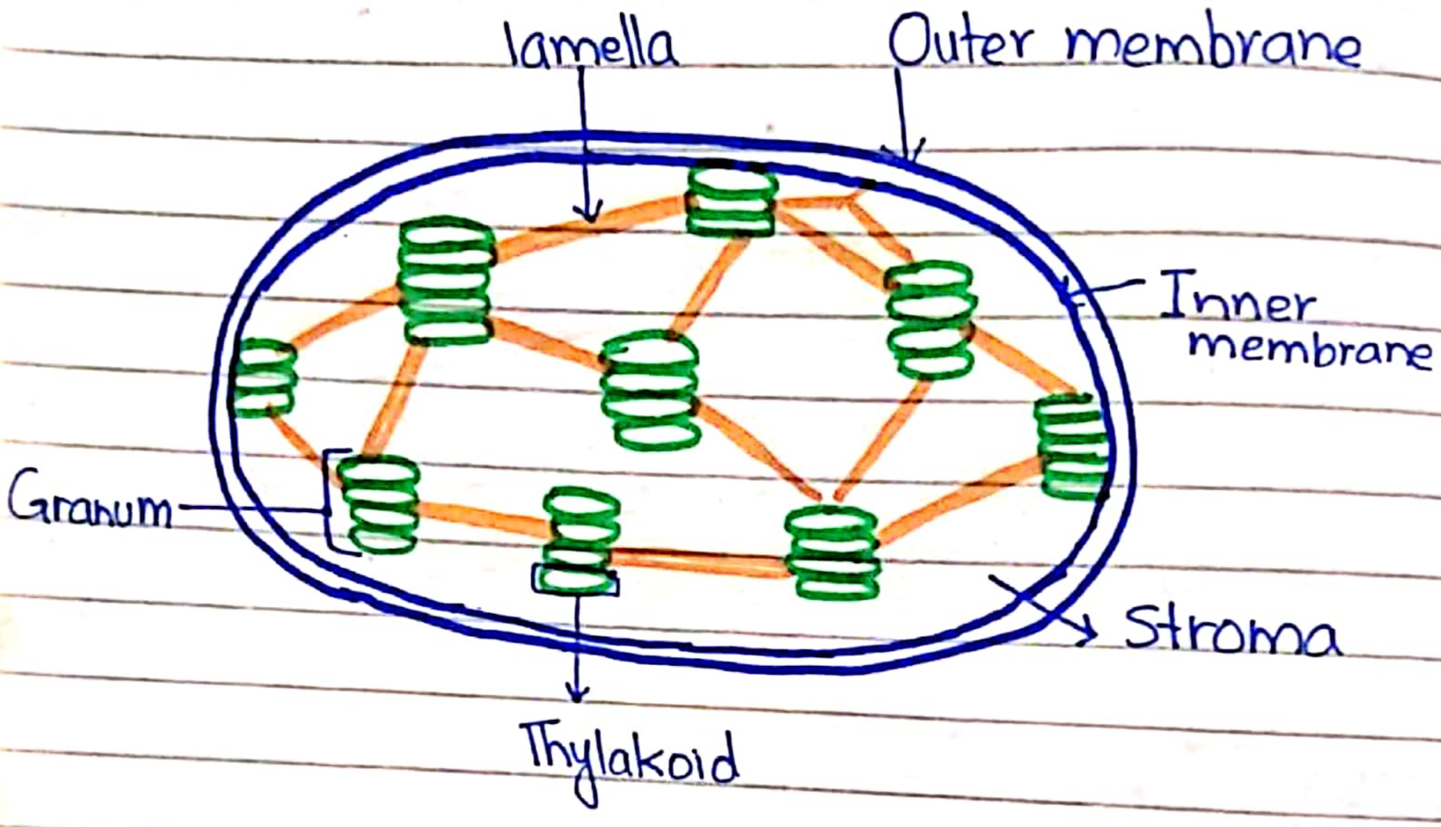



Fig: Chloroplast

# NUCLEUS

Nucleus is also known as the mastermind of the cell. It is present in the centre of an animal cell while in plant cell it is pushed aside due to the presence of large central vacuole.

## DISCOVERY

Presence of cell nucleus was reported in 1838 by Robert Brown. Its early discovery was due to its prominence in many cells, where it stands out as slightly darker than the surrounding cytoplasm.

## SIZE

They are about 10µm in diameter.

## SHAPE

They may be irregular or spherical in shape

## MONO-NUCLEATE CELLS

The cells having one nucleus are called mono-nucleate cells

## BI-NUCLEATE CELLS

The cells having two nuclei are called bi-nucleate cells.

# MULTI- NUCLEATE CELLS

The cells with more than two nuclei are said to multi-nucleate cells.

# FUNCTION OF NUCLEUS

Nucleus is one of the most important organelle because it controls all the metabollic activities and has the genetic information in the form of chromosomes and DNA.

# PARTS OF NUCLEUS

Nucleus consists of:

1- Nuclear Membrane
2. Nucleolus
3. Nucleoplasm
4. Chromosomes.

# 1. NUCLEAR MEMBRANE

NUCLEAR ENVELOPE

The outer membrane of the nucleus is the double membrane which is called the nuclear membrane which separates the nucleus from the cytoplasm. The nuclear membrane is actually the nuclear envelope, composed of two membranes.

## OUTER MEMBRANE

The outer membrane is continuous with endoplasmic Reticulum (RER).

## INNER MEMBRANE

The inner membrane encloses the nuclear contents.

## NUCLEAR PORES

These membranes are not continuous, leaving certain pores at points known as nuclear pores. These pores allow the exchange of materials between the nucleus and the cytoplasm.

# 2. NUCLEOLUS

It is darkly stained body within the nucleus and is without any membranous boundary to separate it from the rest of nuclear material.

Nucleolus appears during interphase and disappears during cell division.

## NUMBER

There may be one or more nucleoli in the nucleus.

A diploid cell contains two nucleolus while a haploid cell contains only one nucleolus.

## FUNCTION

The rRNA (ribosomal RNA) is synthesized and stored in the nucleolus. Nucleolus is the factory of ribosomes while ribosomes is the factory of proteins.

## REGIONS

Nucleolus is composed of two regions:

1. Peripheral granular area
2. Central fibrillar area.

## i. PERIPHERAL AREA

The peripheral granular area is composed of ribosomal subunits. Here rRNA and proteins are present.

## ii. CENTRAL AREA

The central fibrillar area consist of large molecular weight RNA and rDNA.

# 3) NUCLEOPLASM

Nucleoplasm is a colloidal mixture of organic and inorganic salts and ions.

## COMPOSITION

Nucleoplasm is a transparent semifluid ground substance formed of a mixture of proteins, enzymes (DNA and RNA polymerase), phosphorus, nucleotide, some nucleic acids and metal ions (Mg) for the synthesis of DNA and RNAs. It also contains histone and non-histone proteins.

## FUNCTION

* It serves as a matrix in nucleoprotein complex (chromatin) is suspended.
* It also serves as storage place for enzymes, raw material needed for DNA replication and synthesis of RNA.

# 4) CHROMOSOMES

During cell division chromatin material is stained as dark thread like structures known as chromosomes.

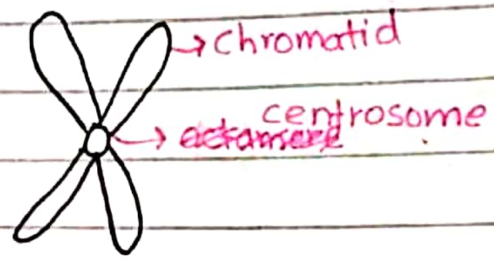
## COMPOSITION

Chromosomes are composed of chromatin material. Chromatin is the combination of DNA, RNA and protein (histone proteins). Histones are the primary protein components of chromatin that compact the DNA.

# PARTS

There are three parts of chromosomes:

1. Chromatids
2. Centrosome mere
3. Kinetochore




# 1. CHROMATIDS

During nuclear division, when each chromosome splits, each part of the chromosomes is called a chromatid.

OR

Each arm of the chromosome is known as chromatid.

# 2. CENTROSOME

The common point of attachment of the chromatids is the centrosome

Centromere is the place on the chromosome where spindle fibres are attached during cell division.

# 3. KINETOCHORE

~~Each centromere~~ Kinetochore is the plaque of protein that helps in the attachment of chromatids with centromere.

# NO. OF CHROMOSOMES

The number of chromosomes are constant throughout its somatic cells of the body e.g human has 46 chromosomes in each somatic cell, potato has 48, fruit fly Drosophila has 8 etc.

Each of these chromosome numbers is the so-called diploid number i-e the number found in the somatic body.