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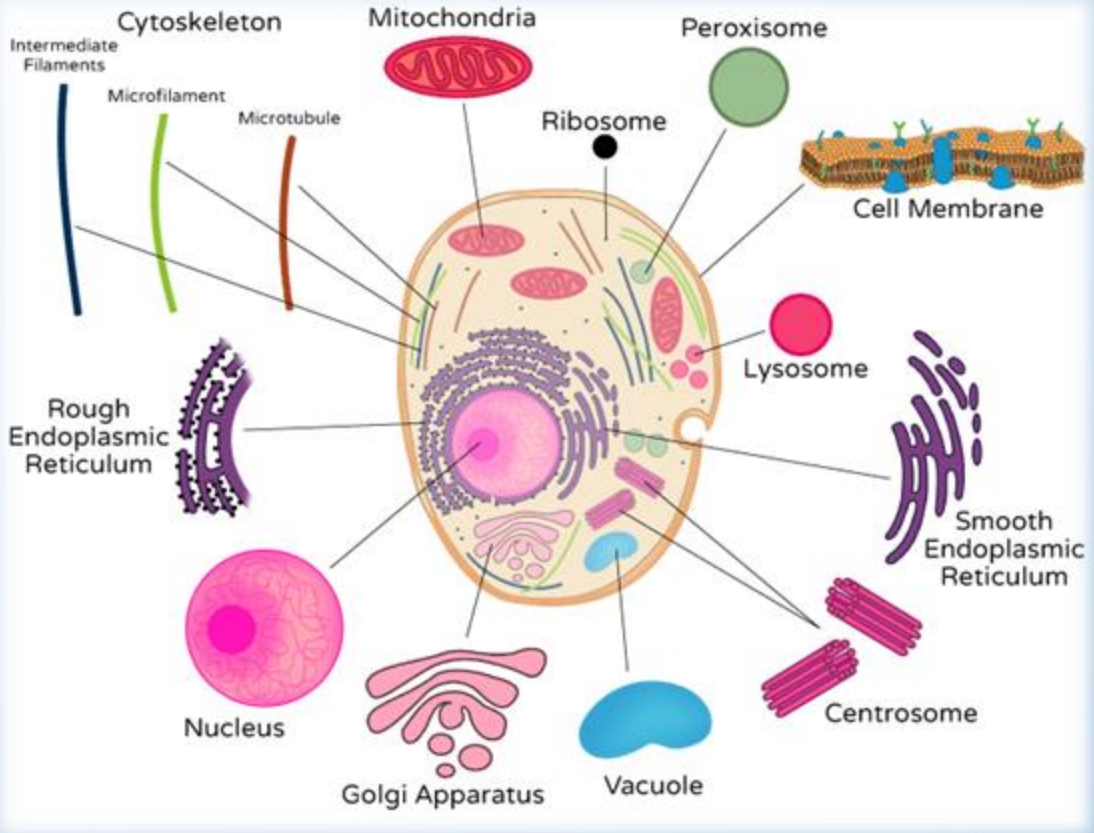
Biological Science

Module 1 Class 1

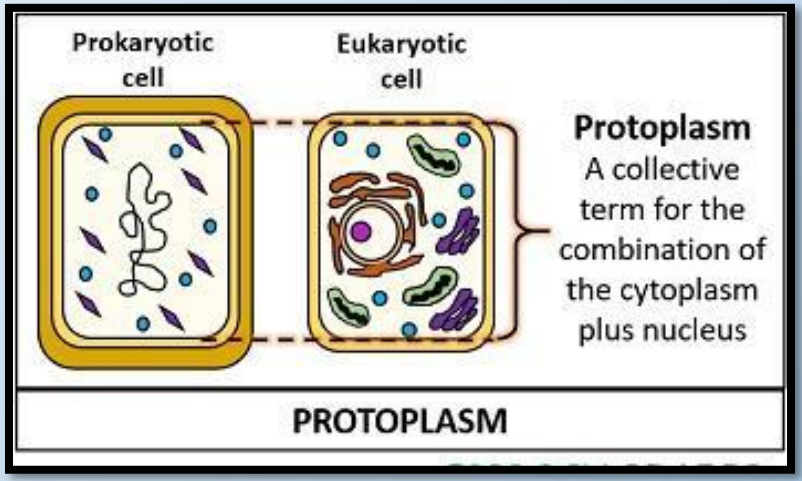
Cell & Cell Organelles

GEN COM COE

Department of Bio Sc. & Environment



- **What is cell**?- The smallest structural and functional unit of an organism, which is typically microscopic and consists of cytoplasm and a nucleus enclosed in a membrane.
- **Types of cell-**
  - **Prokaryotic cell** (‘**Pro**’- Primitive, ‘**Karyon**’- Nucleus)
  - **Mesokaryotic cell** (‘**Meso**’- Intermediate; ‘**Karyon**’- Nucleus)
  - **Eukaryotic cell** (‘**Eu**’- Modern; ‘**Karyon**’- Nucleus)



- ***POINTS TO REMEMBER***

Protoplasm = cytoplasm + nucleus

Protoplasm is called “**Physical basis of life”.**

Dujardin in 1835 discovered protoplasm but in 1839 it was J.E.Purkinje who coined the word protoplasm.

KEY POINTS

- Study of cell is called **cytology.**
- Robert Hooke first discovered cell in the year 1665 from a section of Cork. On 1665 in Micrographia, Robert Hooke coined the term "cell". But the cell that he discovered was dead in nature.
- Leeuwenhoek first discovered living animal cell.
- In 1839, botanist Matthias Schleiden and zoologist Theodor Schwann proposed cell theory.
- **Key points of cell theory are as follows-**

- *Organisms are made up of either single cell or multiple cell.*
- *Cell is a structural and functional unit of life.*

- Scientist Rudolf Virchow told that cell arise from pre-existing cell. (Modern cell theory)

Exception of cell theory is **Virus.**

Why are Viruses Nonliving

-Nonliving characteristics of viruses:

1. are not made of **cells**
2. do not use their own **energy**
3. do not **grow** or **respond**
4. can not make **food**, take in **food** or **produce wastes**.

-Living characteristics of viruses:

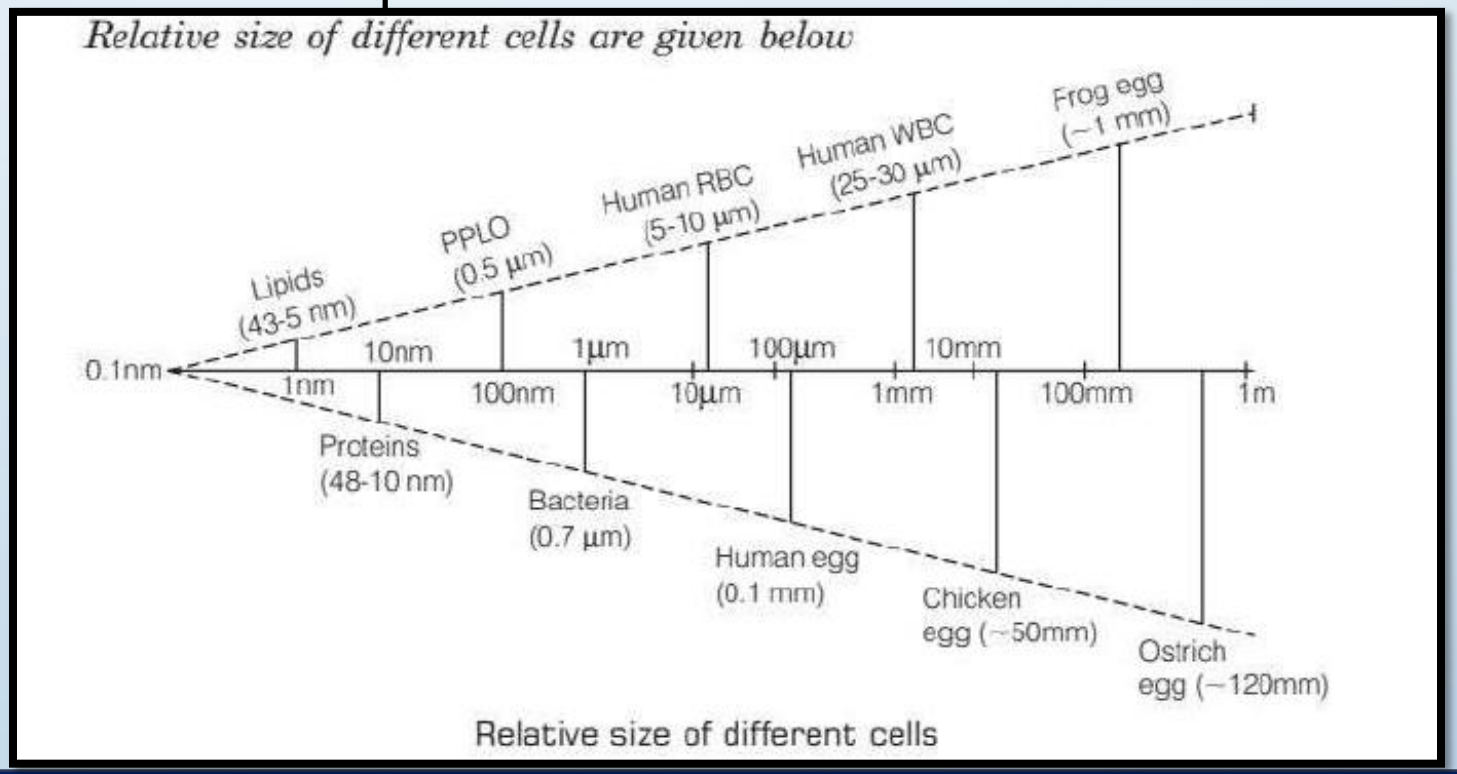
1. contain **DNA** or **RNA**
2. contain **proteins**
3. can multiply---but **NOT** on their own

Cell observing instrument-Microscope

S. No	Characteristics	Light Microscope	Electron Microscope
1.	Magnification	2,000x	Up to 10,000,000x
2.	Resolution	200 nm	0.5 nm
3.	Image produced by	Visible light rays	Electron beam
4.	Image focused by	Glass objective lens	Electromagnetic objective lenses
5.	Image viewed through	Glass ocular lens	Fluorescent screen
6.	Specimen placed on	Glass slide	Copper mesh
7.	Organisms may be	Live	Always dead
8.	Specimen requires special stain or treatment	Not always	yes
9.	Colored Image produced	Yes	No i.e. Black and white

Discovery

- Simple microscope- Leeuwenhoek (Father- microscopy/microbiology)
- Compound microscope- Hans janssen & Zacharias janssen
- Electron microscope- Knoll & Ruska



Relative size of different cells

❑ **Prokaryotic cell (Examples-** Bacteria , Blue green algae**)**

❑ <u>Characters</u>

1. It is primitive type of cell.
2. Absence of membrane bound cell organelles.
3. Nucleus is not well organised.
4. Ribosome is 70 S type.

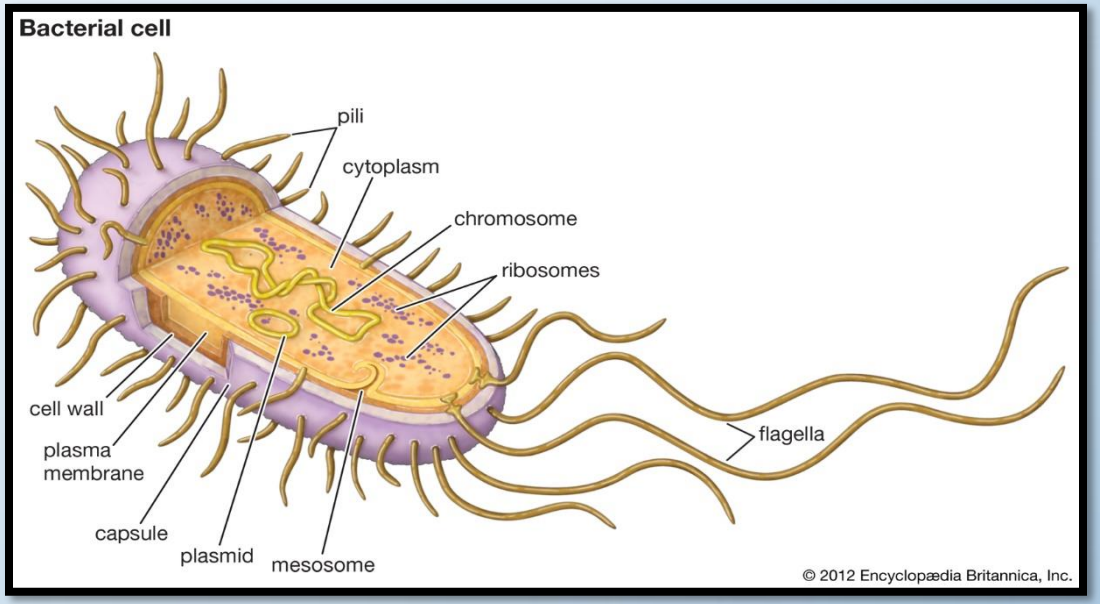


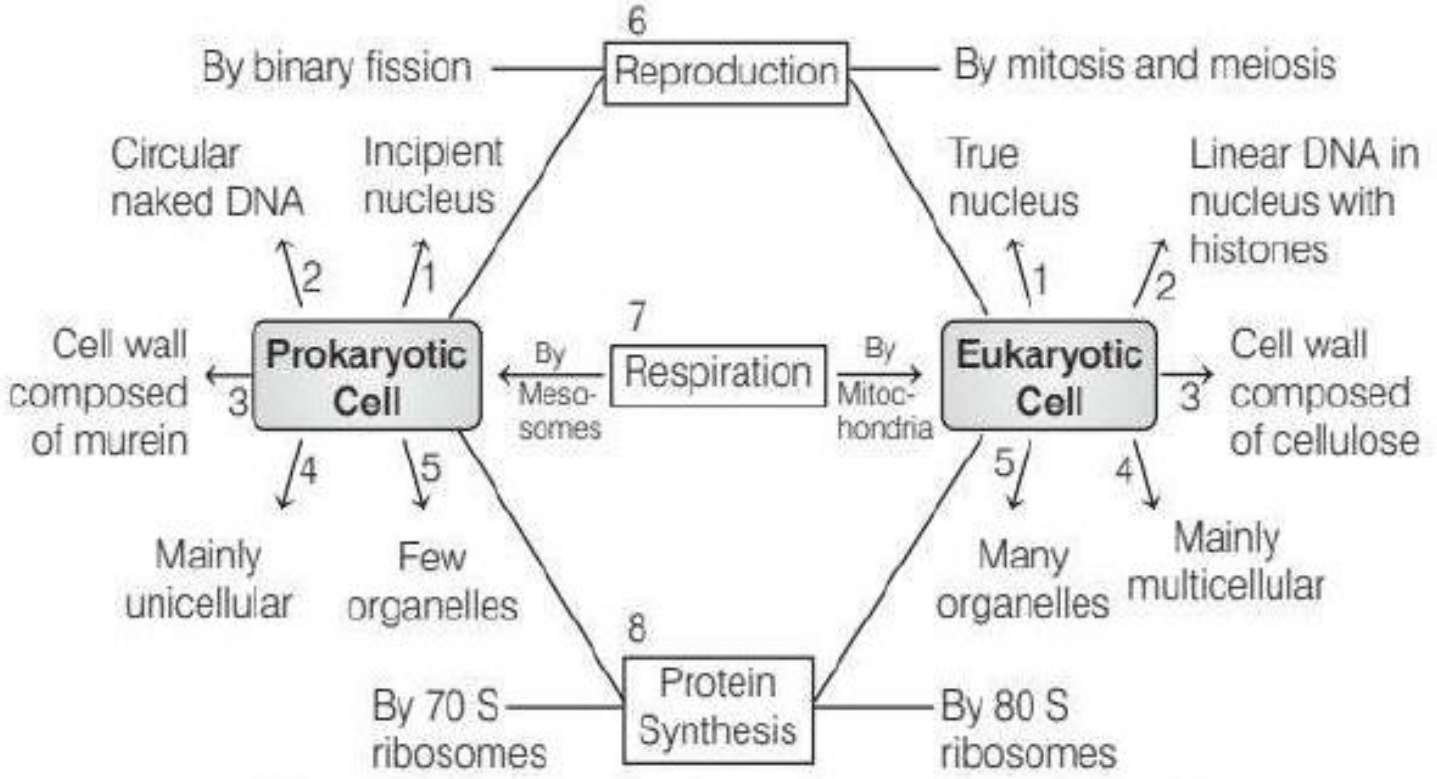
Figure- Prokaryotic cell

FACTS

1. **Major component of bacterial cell wall-** Peptidoglycan
2. **Major component of cell membrane-** Lipoprotein
3. **Nucleus is known as –** Genophore/Nucleoid/Pro-chromosome
4. **Locomotory organ-** Flagella
5. **Reproductive organ-** Pilli
6. **Ribosome-** 70S
7. **Respiratory organ-** Mesosome
8. **Photosynthetic organ** – Chromatophore
9. Plasmid DNA is used as gene vector
10. "S" in ribosome means Svedberg Unit

Types of Cells

Cells are classified into two types, *i.e.*, prokaryotic and eukaryotic cells. Prokaryotic cells have incipient nucleus and lack double membrane bound cellular organelles, whereas eukaryotic cells have true or advanced nucleus and possess many organelles.

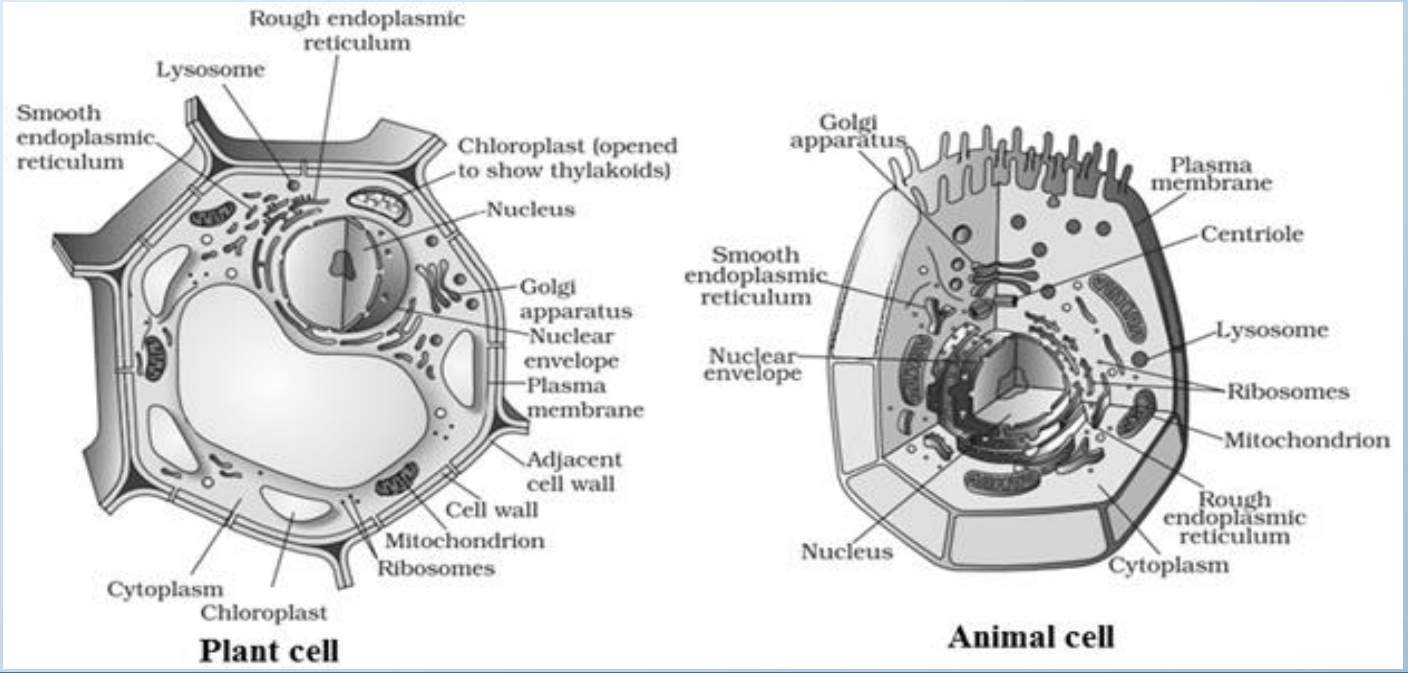


Differences between prokaryotic and eukaryotic cell

❑ **Eukaryotic cell (Examples-** Higher Group of plant & animal cell)

❑ <u>Characters</u>

- It is advanced.
- Presence of membrane bound cell organelles
- Nucleus is well organised.
- Ribosome is 80 S type.



Difference between plant & animal cell

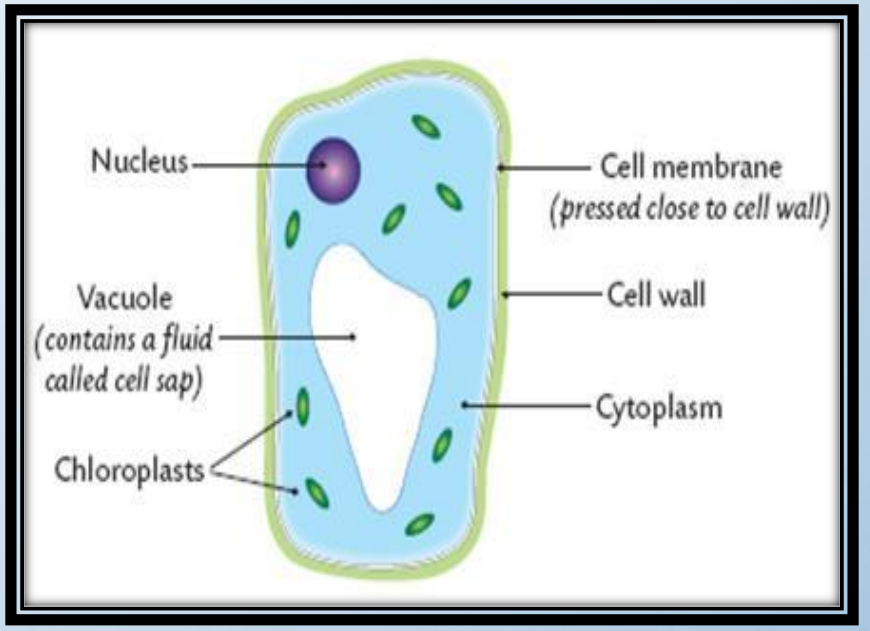
Sl. No	Characters	Plant cell	Animal cell
1	Cell Wall	Present	Absent
2	Plastid	Present	Absent
3	Plasmodesmata	Present	Absent
4	Desmosome	Absent	Present
5	Vacuole	Large	Small
6	Lysosome	Rare	Present
7	Reserve food	Starch	Glycogen
8	Cytokinesis	By cell plate formation	By furrowing/cleavage.

❑ Cell wall

1. Present in plant and bacteria.
2. Plant cell wall is mainly composed of cellulose.
3. Fungal cell wall is composed of chitin.
4. Bacterial cell wall is composed of peptidoglycan.

❑ Cell membrane

1. It is made up of lipid & protein.
2. It is present both in plant & animal cell.



Detail Structure of Cell Wall

It was first discovered by **Robert Hooke** (1665). It is a rigid and non-living structure. It is present just below the glycocalyx (outermost glycoprotein covering) or murein in all eubacteria and cyanobacteria. It is absent in animal cell.

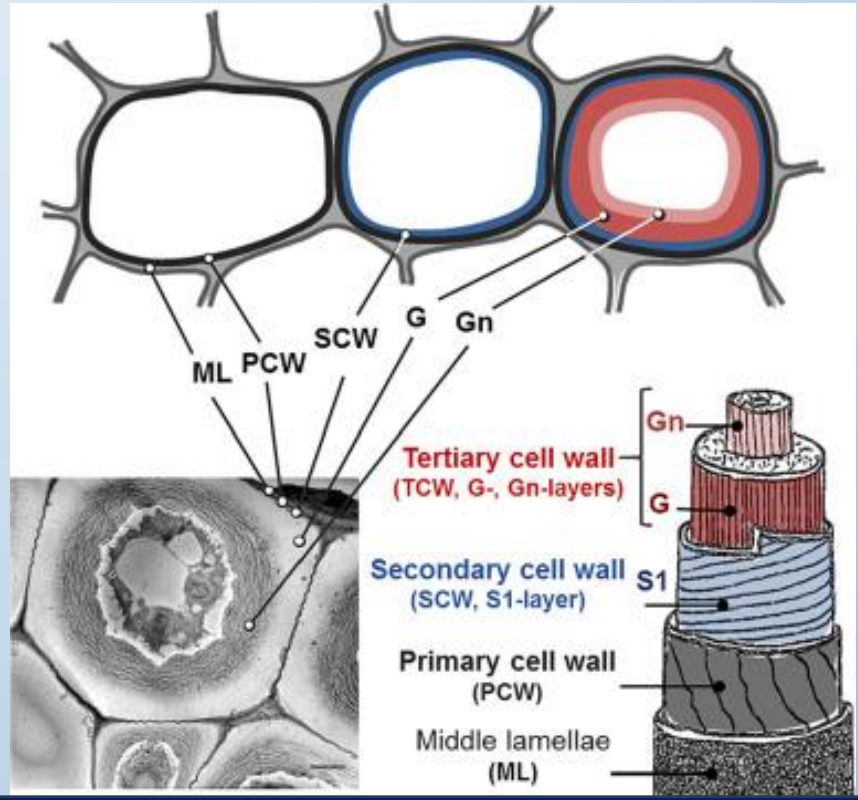
A typical cell wall consists of four layers namely

(i) **Middle lamella** Outermost cementing layer between the cells, made up of Ca and Mg pectates, absent in outer free spaces and ruptures to create intercellular spaces.

(ii) **Primary cell wall** Thin, elastic, capable of growing cells and diminishes as the cells mature possesses more hemicellulose and less cellulose in their cell wall, only cell wall in meristematic and parenchymatous cells.

(iii) **Secondary cell wall** Formed by accreration, they have more cellulose, found in collenchyma, sclerenchyma and xylem vessels; it is rigid and non-elastic, contains pits at intervals.

(iv) **Tertiary cell wall** It is present occasionally, purely cellulosic and sometimes contains xylem found in the tracheids of gymnosperms.



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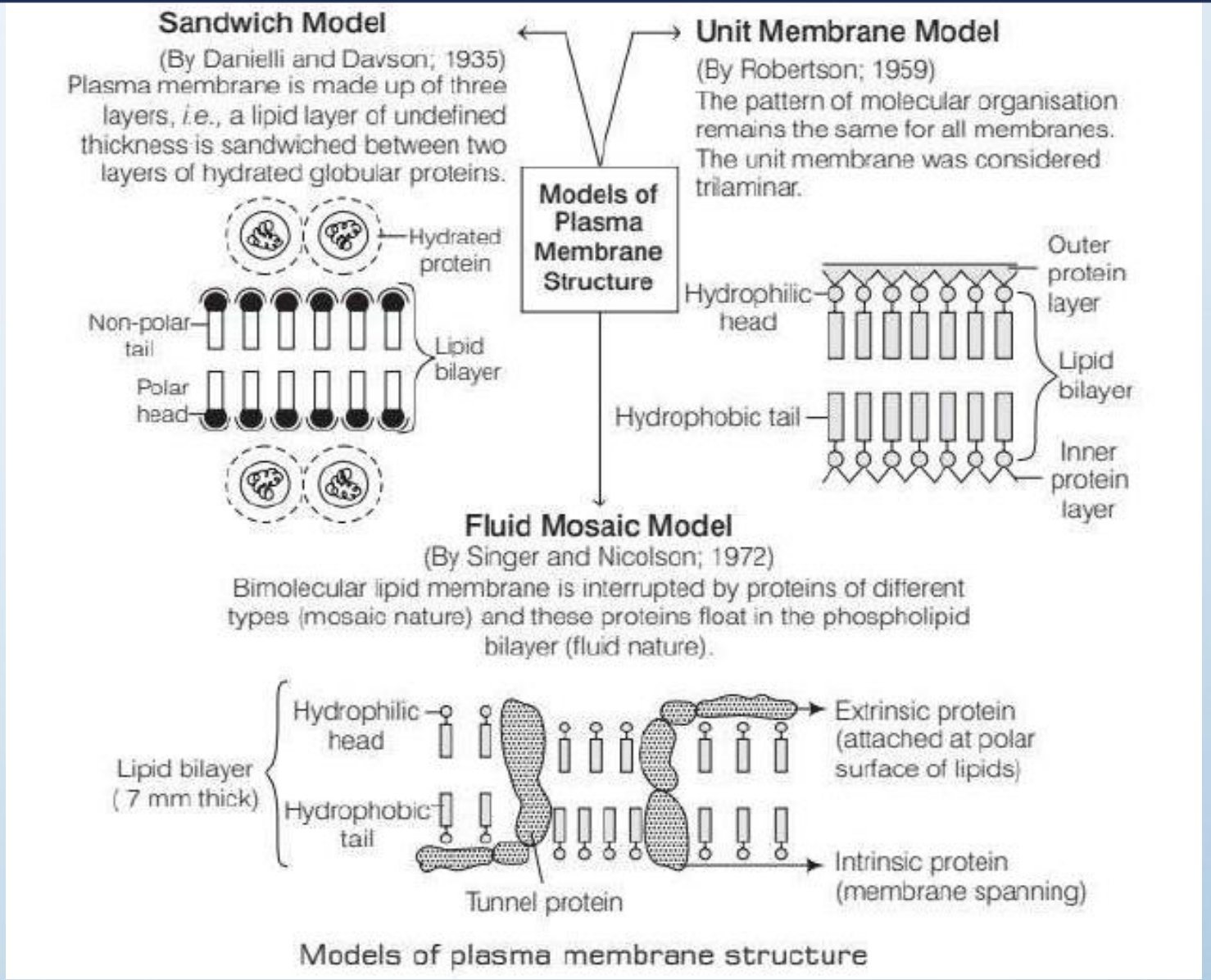
Various Models of Plasma Membrane



Models of plasma membrane structure

Double membrane bound cellular organelles

❑ Nucleus

1. Discovered by Robert Brown.
2. It is called **"Brain of a cell"**.
3. It composed of nuclear membrane, nucleolus , nuclear reticulum and nucleoplasm.

Nucleus

Nucleus or **karyon** was first discovered by **Robert Brown** (1831) in the cells of orchids roots. It is darkly stained, spherical and the largest cell organelle whose composition is as follows : 9-12% DNA, 15% histones (basic proteins), 15% enzymes, 5% RNA, 3% lipids, 65% acid and neutral proteins.

Nucleus has an outer double layered nuclear membrane with nuclear pores, a transparent granular matrix (nucleoplasm/karyolymph), chromatin network composed of DNA and histones and a directly stainable spherical body called **nucleolus**.

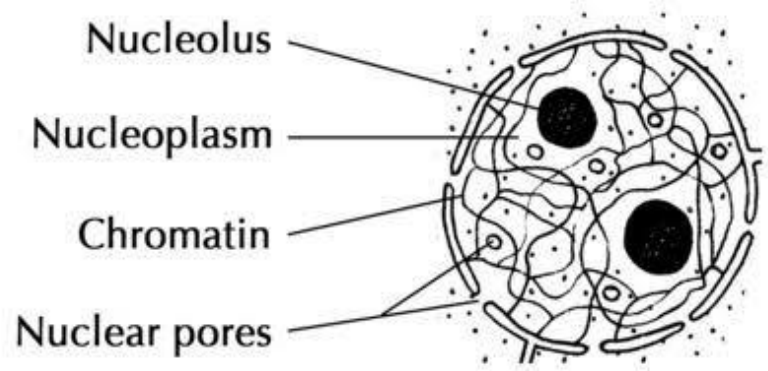


Figure. Eukaryotic Nucleus

❑ Mitochondria

1. The term mitochondria was coined by Benda.
2. It is called "**Power house of cell**".
3. Inner membrane is folded to form Cristae.
4. Oxysomes are present on inner membrane.

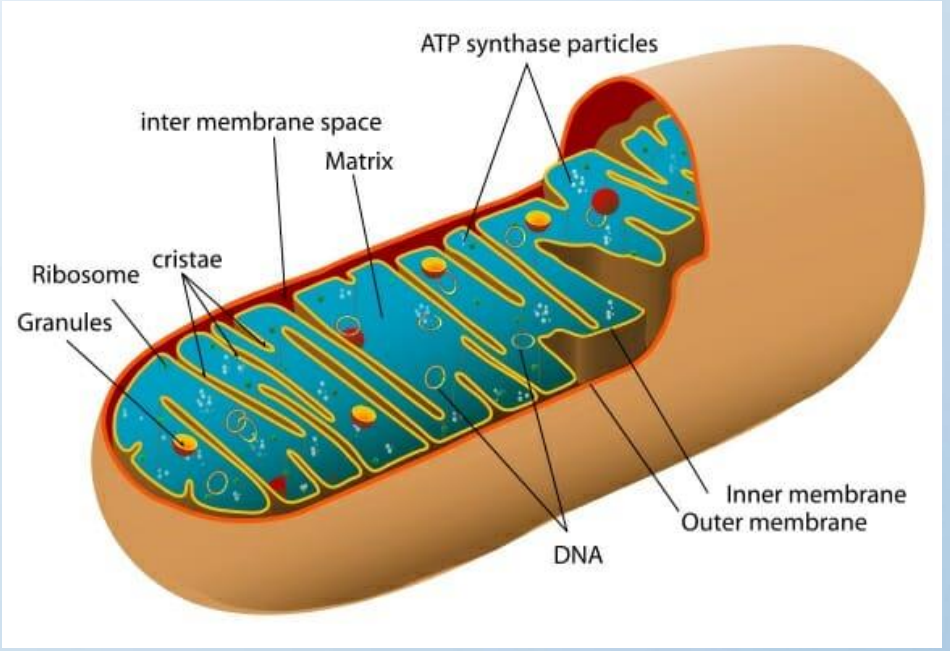
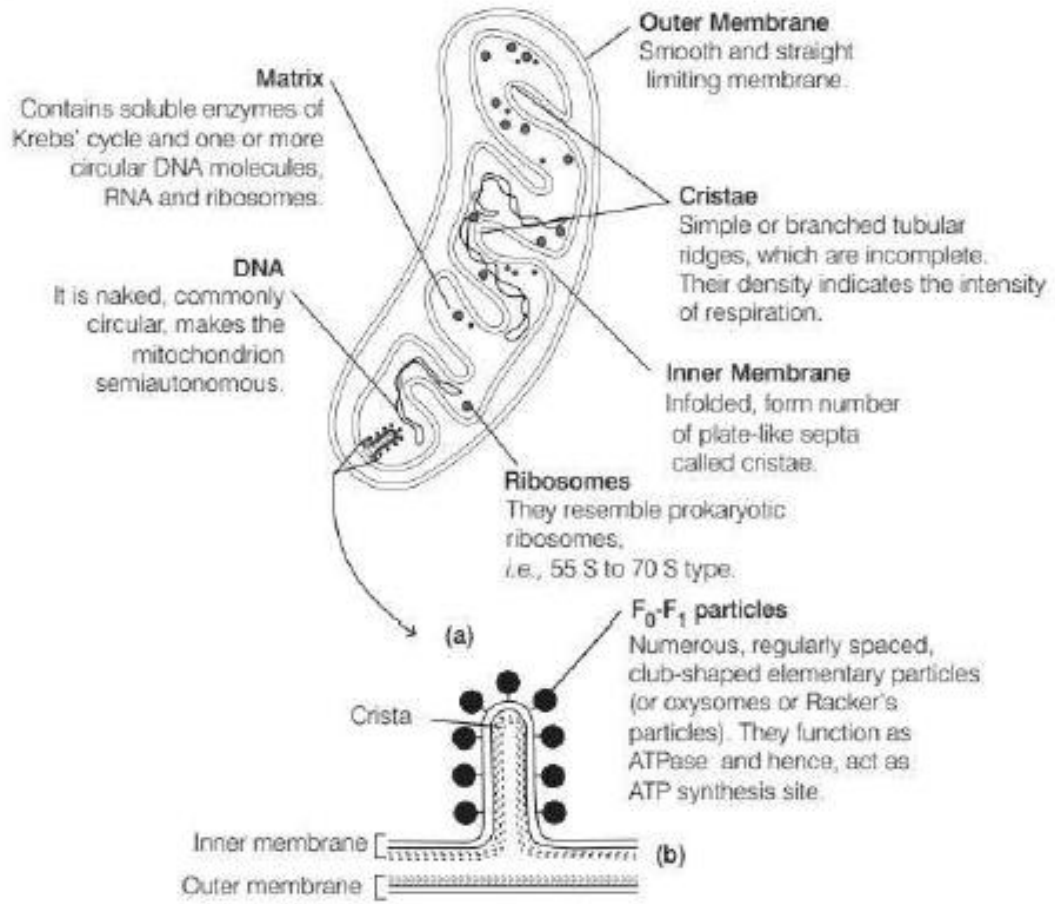


Figure- Mitochondria

Detail of Mitochondria

Mitochondrion

It is a spherical or rod-shaped, two-layered granular structure. It was first seen by **Kolliker** (1850) in the striated muscles and called **sarcosome**. Because of the formation of ATP, they are also called as powerhouses of the cell.



Mitochondria (a) Internal structure of a mitochondria (b) One crista magnified

❑ **Plastid(Present in plant only)**

It is three types.

1. **Chloroplast**

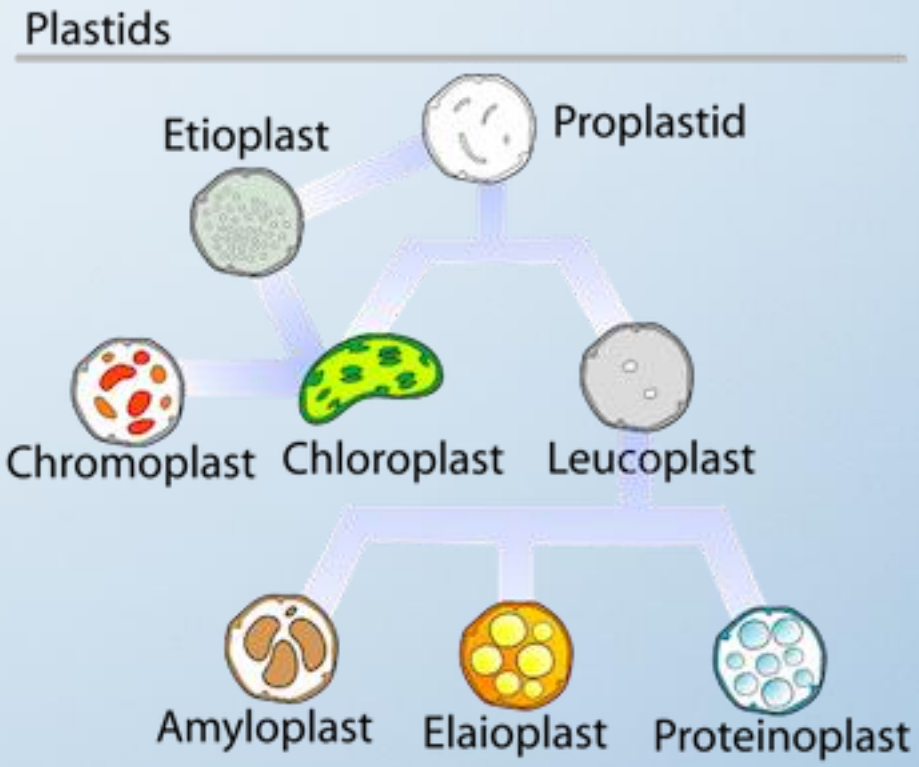
a) Chlorophyll containing plastid.
b) Photosynthetic cell organelle.
c) It is called **sugar factory**.

2. **Chromoplast**

a) Colour pigment containing plastid.
b) Responsible for fruit & flower colour

3. **Leucoplast**

a) Colourless plastid.
b) Storage plastid.



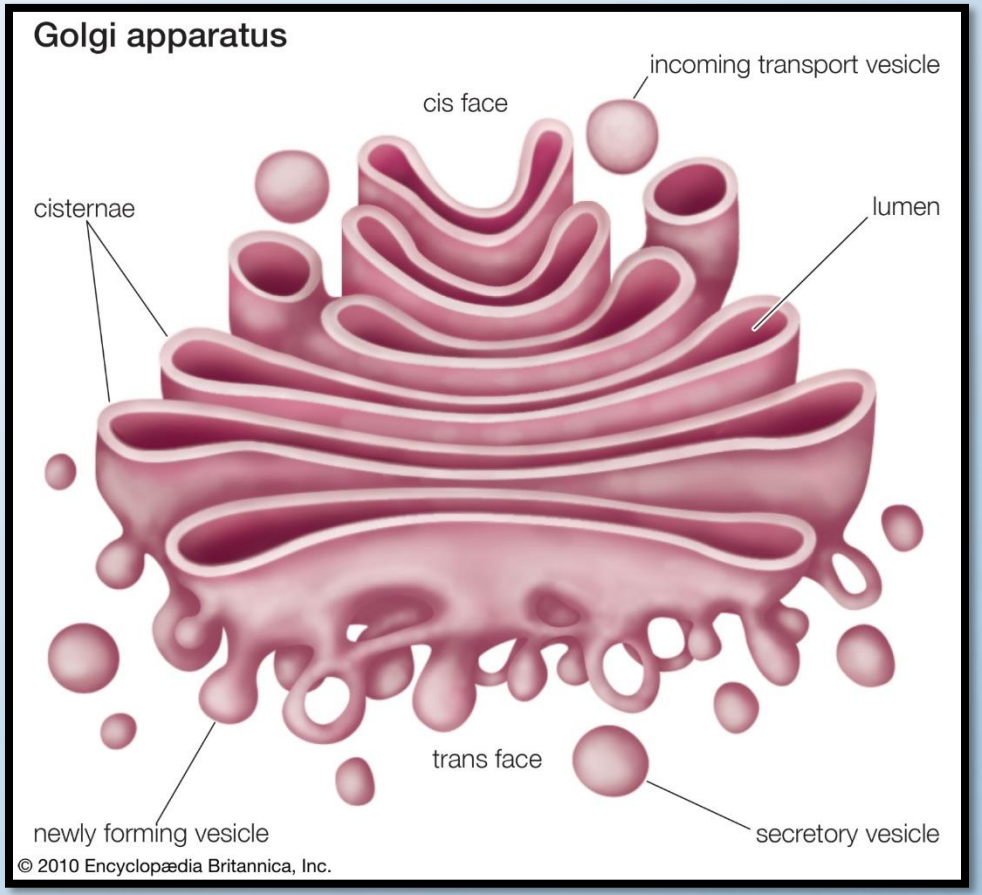
Facts

1. *Apart from the nucleus, mitochondria and chloroplast also contain DNA. Therefore, they are called cell inside cell.*
2. *Amyloplast stores carbohydrates.*
3. *Elaioplast stores fat.*
4. *Proteinoplast stores protein.*

Single membrane bound cell organelle

❑ Golgibody

1. Present both in plant and animal.
2. Golgibody of plant is called **dictyosome**.
3. Acrosome of sperm is produced from golgibody.
4. It is called "**traffic police**"
5. It acts as **"secretory organelle".**



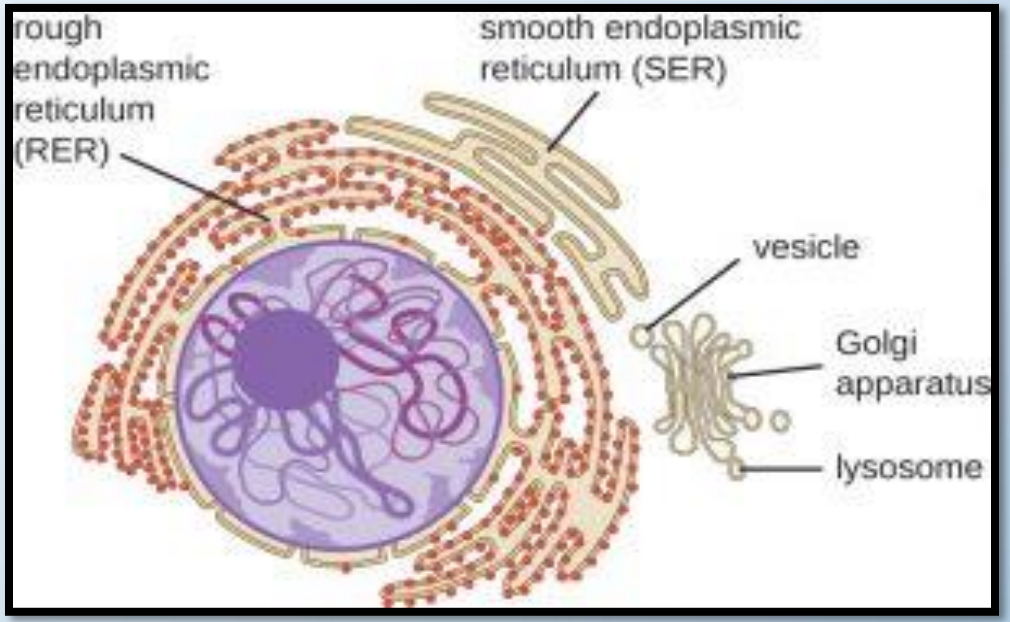
❑ **Lysosome**

1. It contain lot of hydrolytic enzyme.
2. It is called "**Suicidal Bag**" or "**Atom Bomb of cell**".
3. Spherosome is "**Plant lysosome**".
4. It actually promotes intracellular digestion.

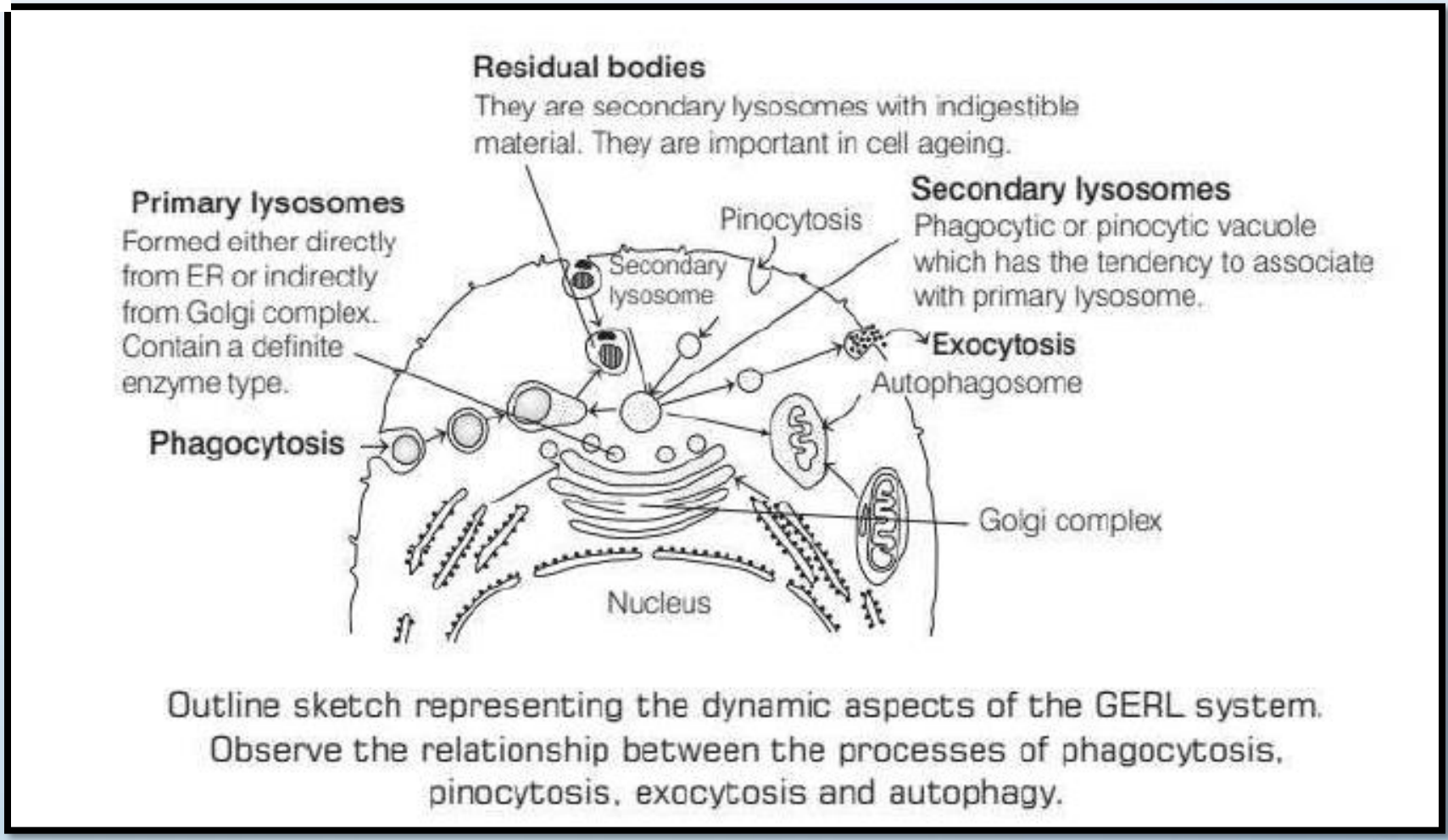
❑ **Endoplasmic Reticulum**

1. It actually divides the cell into many compartment.
2. It is two types 1. **RER** 2. **SER**
3. **Functions:**

RER – Protein synthesis. **SER** - Lipid synthesis.



Work method of lysosome



Outline sketch representing the dynamic aspects of the GERL system. Observe the relationship between the processes of phagocytosis, pinocytosis, exocytosis and autophagy.

Lysosome in detail

Lysosomes

They are single membrane bound structures, supposed to contain hydrolytic enzymes in them. Therefore, they are known as **suicidal bags of the cell**. They were first observed by **C de Duve** (1949) in the liver cells. They were reported in plant cells by **P Matile**.

There are two basic types of lysosomes namely **primary lysosomes** and **secondary lysosomes**. Primary lysosomes are further categorised to phagosomes, autophagic vacuoles and residual bodies.

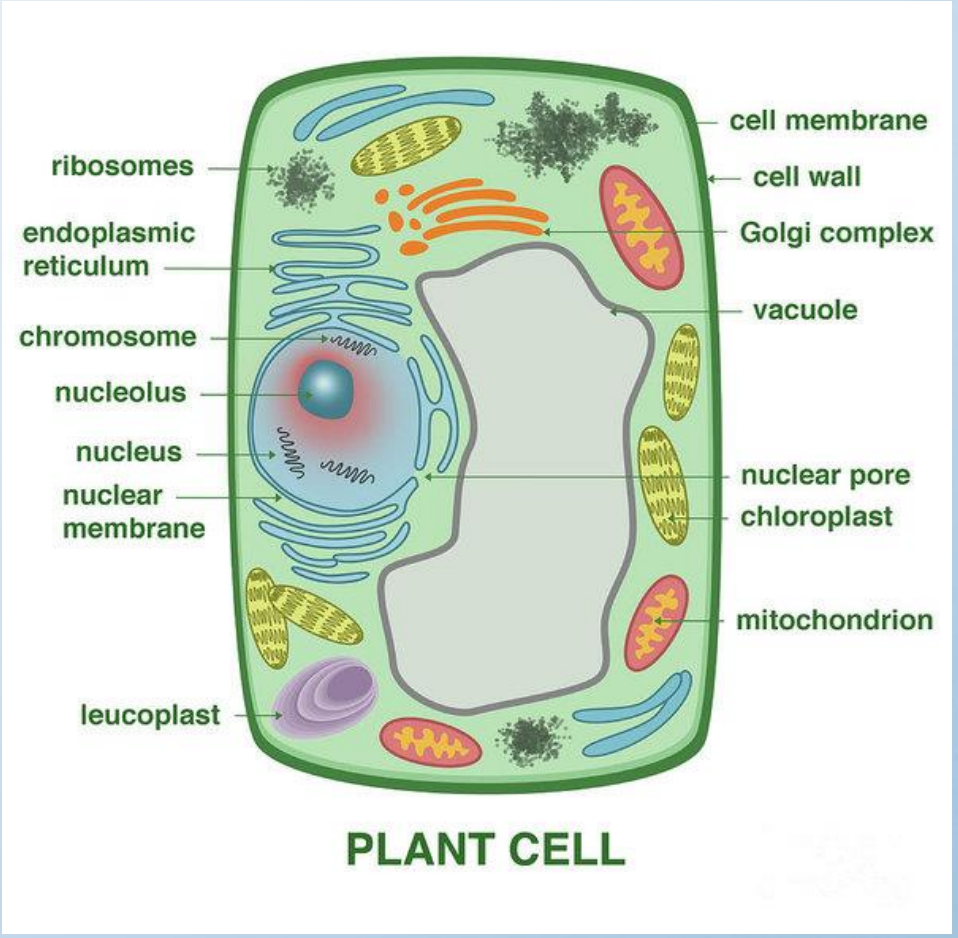
Autolysis is the phenomenon of self destruction of a cell with the help of lysosomes. Because of close relationship between Golgi complex, ER and lysosomes, **Novikoff** *et al.* (1961-64) denoted endomembrane system as **GERL system**, *i.e.*, Golgi complex, ER and lysosome system.

❑ **Peroxisome**

1. It is called "**Safety Valve**" of a cell.
2. Function – Oxidation, H_20_2 metabolism.

❑ **Vacuole**

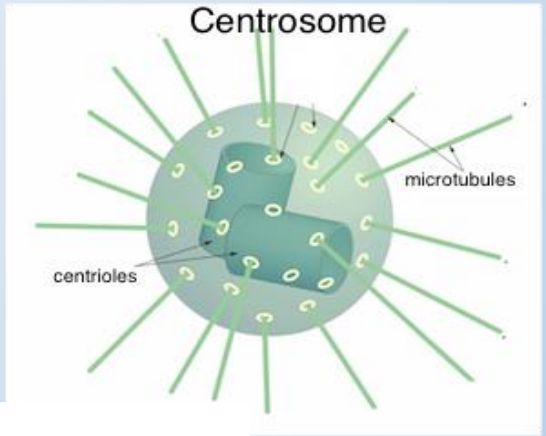
1. It is a cavity within a cell containing cell sap.
2. It is called "**Storehouse of cell**".
3. Large vacuole is present in plant cell.
4. Animal cell either contain very small vacuole or do not contain any vacuole.
5. Membrane of vacuole is called **tonoplast**.



Membrane less cellular organelle

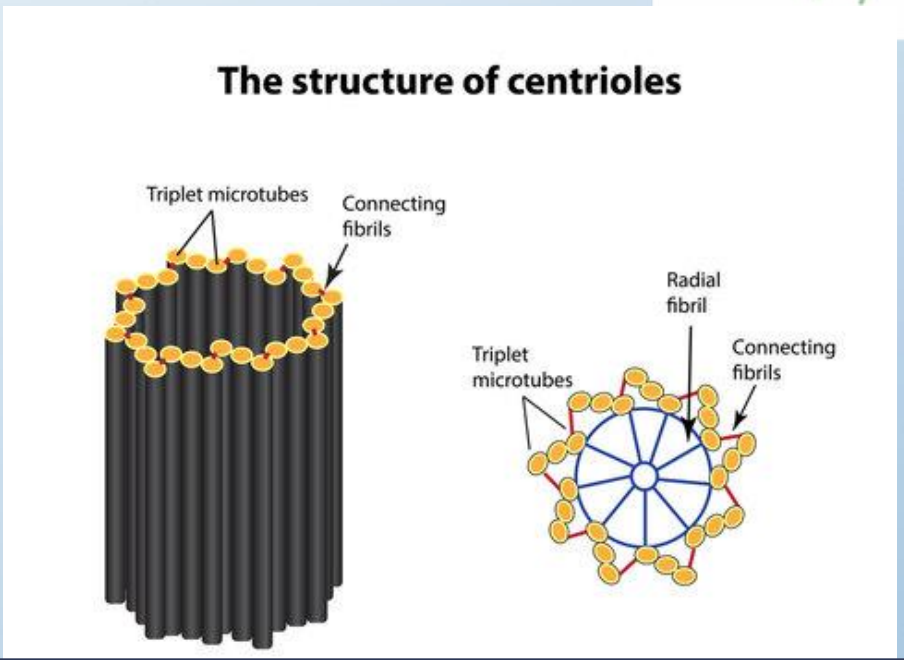
❑ Ribosome

1. It is smallest cell organelle.
2. Present both in prokaryotic and eukaryotic cell.
3. **Function:** Protein synthesis



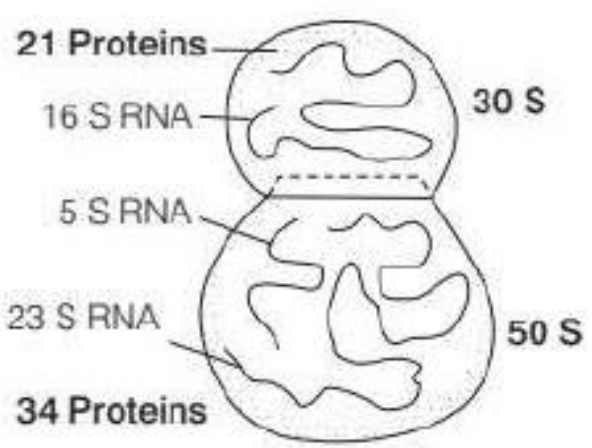
❑ Centrosome (Present in animal cell only)

1. Within centrosome two centrioles are present.
2. It helps in animal cell division.

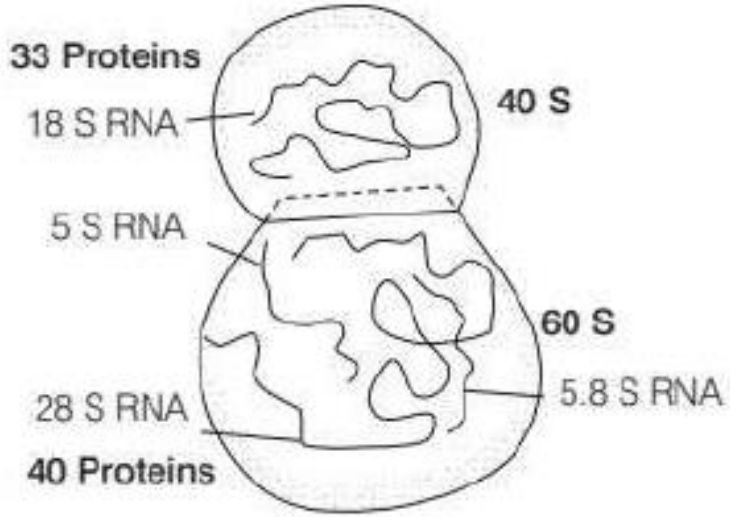


Types of Ribosomes

Ribosomes are of two basic types, *i.e.*, **70 S** and **80 S**, where 'S' refers to **Svedberg** unit of sedimentation coefficient.



(a)



(b)

Ribosomes : (a) 70 S (in prokaryotes) (b) 80 S (in eukaryotes)

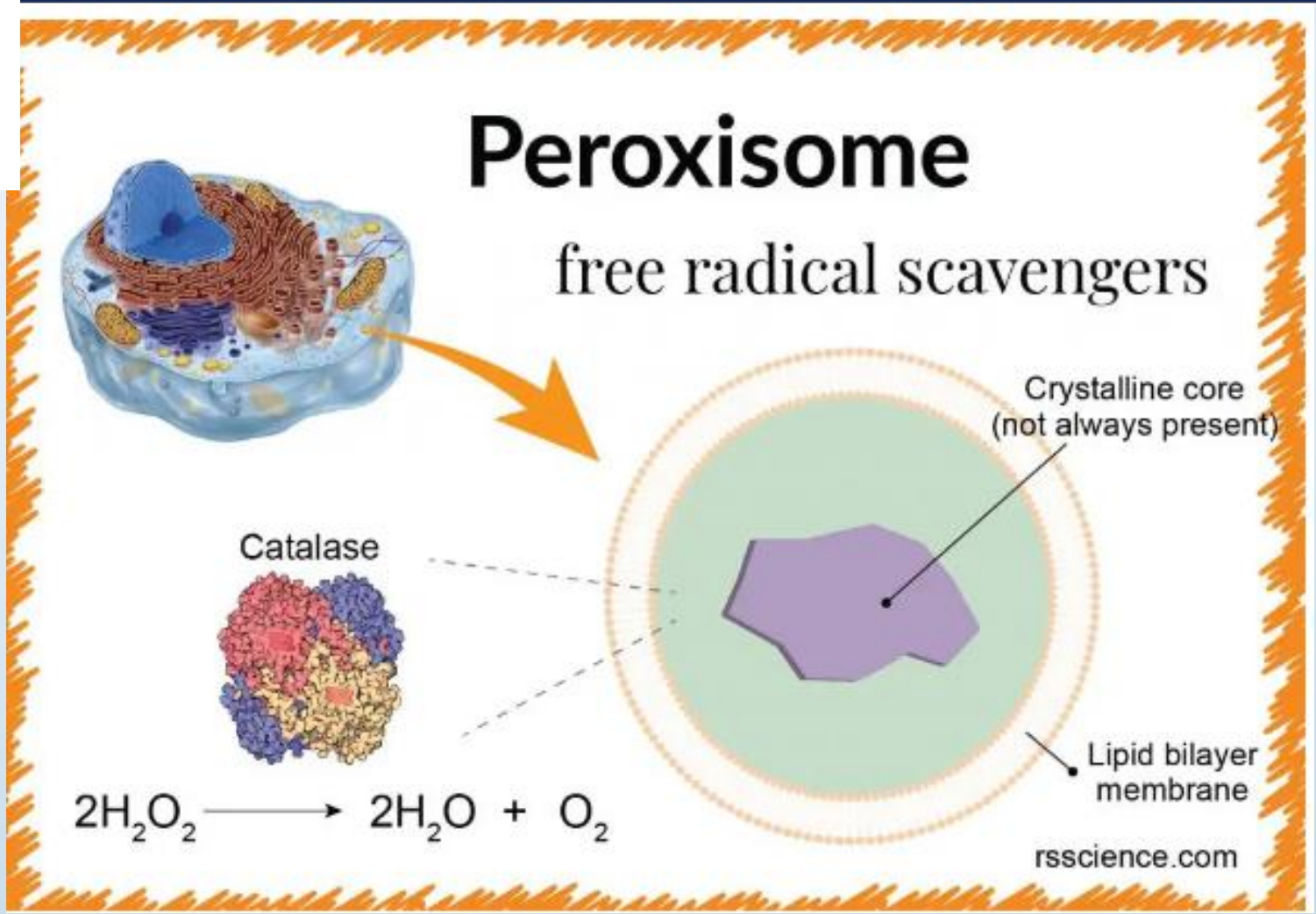
Microbodies

They are small, single membrane bound cell organelles which absorb molecular oxygen and take part in oxidation. They were first seen by **Rhodin** (1954) in mouse kidney tubule cells.

They are of two types

(i) **Peroxisomes** They contain enzymes for peroxide biosynthesis. They are found in both plant and animal cells in close association with ER, mitochondria and chloroplasts. Despite the absence of DNA, they are believed to be able to replicate like plastids and mitochondria.

(ii) **Glyoxysomes** They contain enzymes for β-oxidation of fatty acids and glyoxylate pathway. They usually occur in fat rich plant cells. They are more prominent in plant seedlings and generally found in yeast and *Neurospora* cells. They are considered to be special peroxisomes. They were first reported by **Beevers** in 1969 in the endosperm of germinating seeds.



Cytoskeletal Elements

These consist of following types

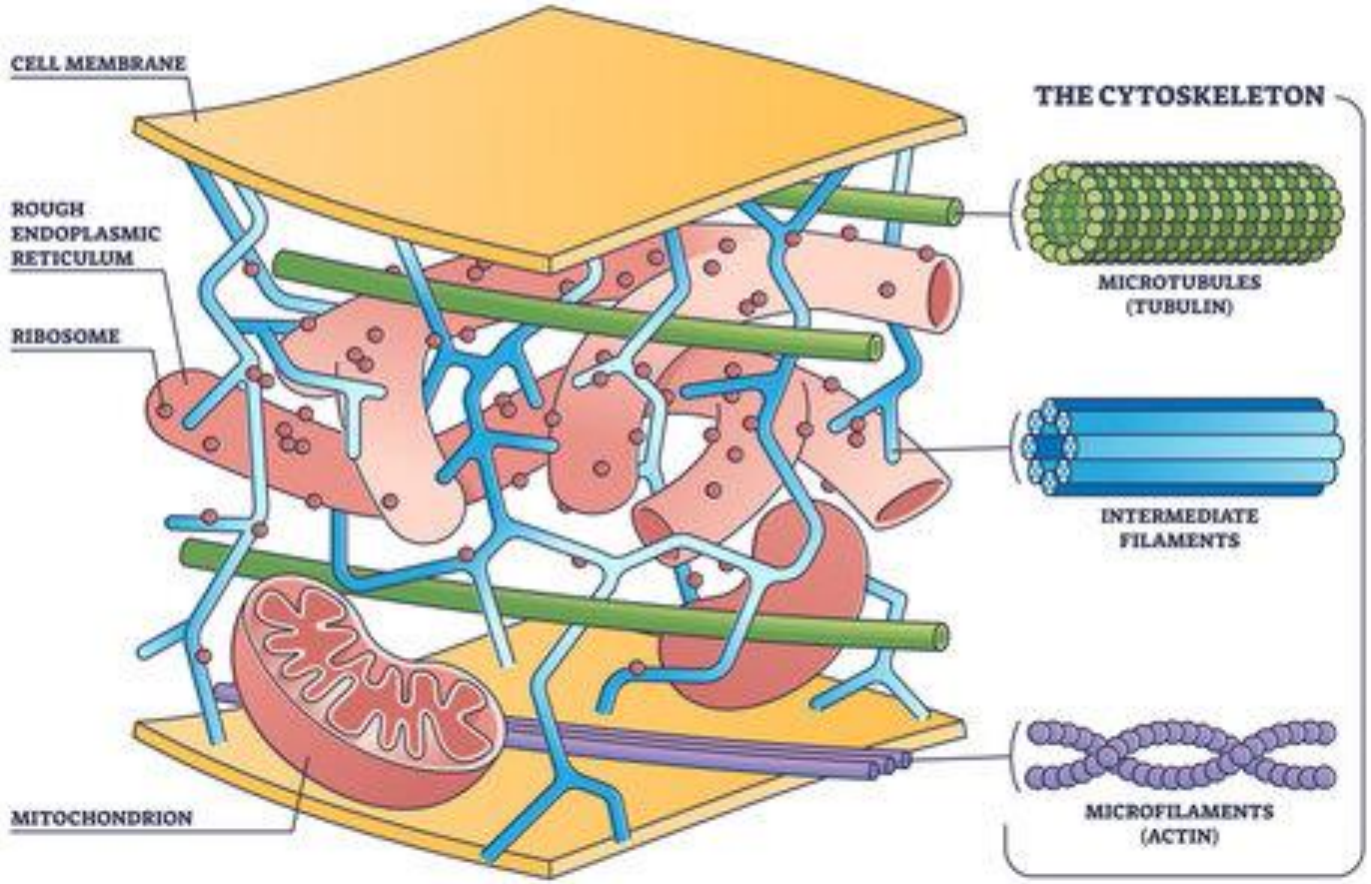
(i) **Microtubules** They are unbranched, hollow tubules made up of tubulin protein. They contain 13 protofilaments and are 25nm in diameter (**Roberts** and **Franchi**). They occur in centrioles, basal bodies, cilia/flagella, astral rays, spindle fibres, etc. They are non-contractile in nature.

(ii) **Microfilaments** They are long, narrow, cylindrical rods made up of actin protein. They are contractile, solid structures having diameter of about 7nm. They occur below cell membrane and at the interphase of plasmagel-plasmasol.

Functions of Cytoskeletal Elements

- Microtubules help in the movement of nuclei during division.
- Microfilaments are responsible for cellular movements like contraction, crawling, pinching during division and formation of cellular extensions.

CYTOSKELETON



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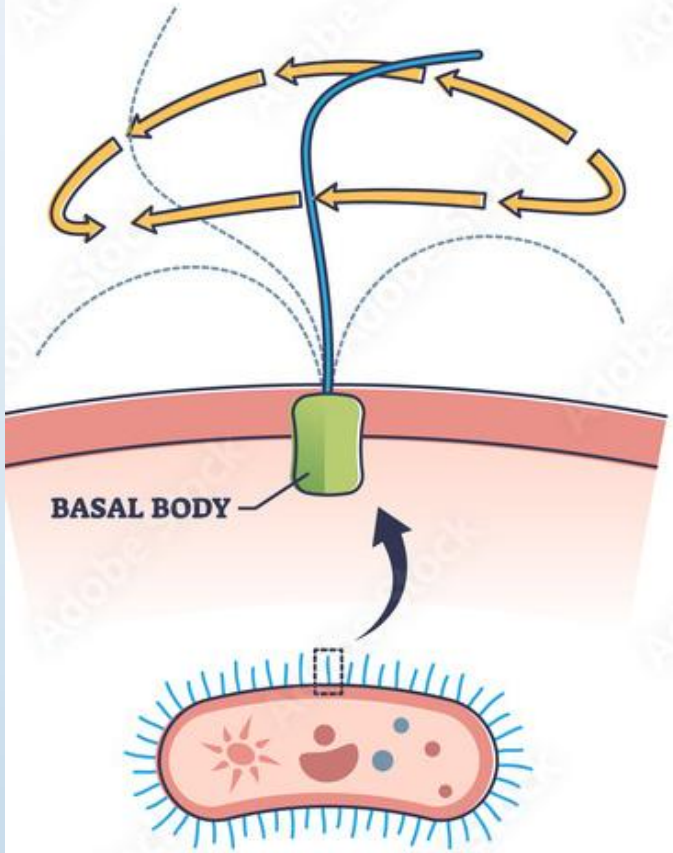
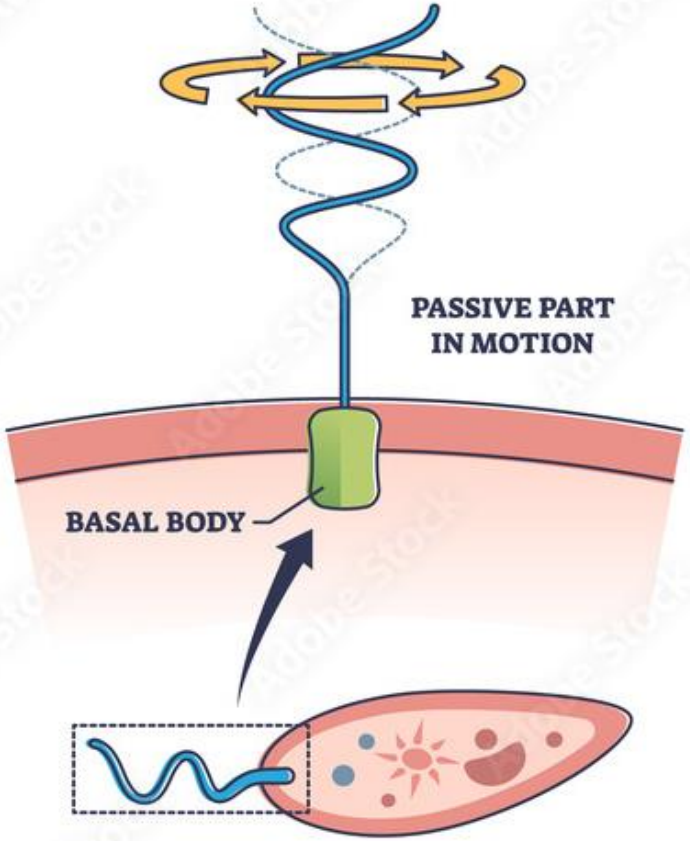
CILIA

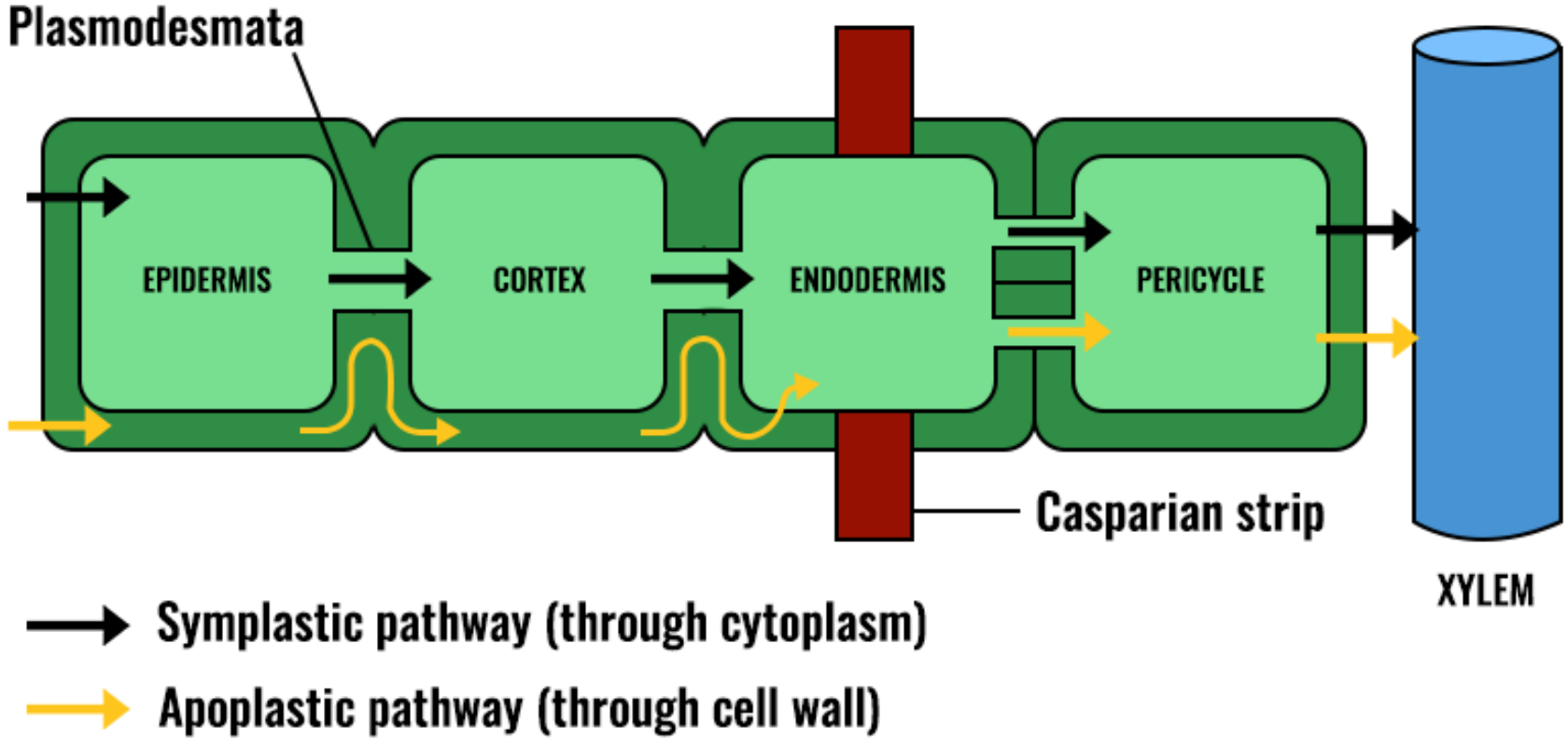
BACK AND FRONT BEATING



FLAGELLA

PROPELLER LIKE MOTION



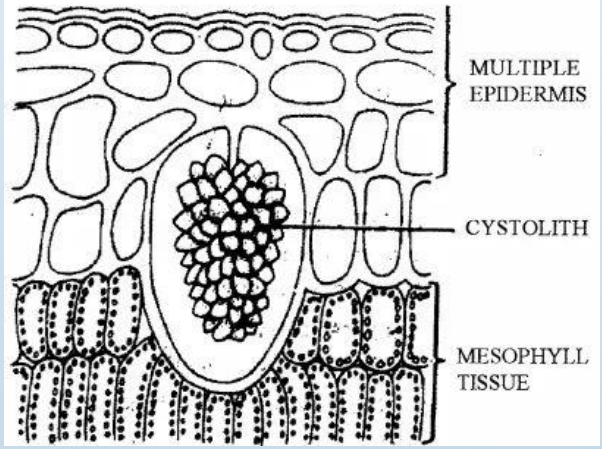

Plasmodesmata
EPIDERMIS
CORTEX
ENDODERMIS
PERICYCLE
Casparian strip
XYLEM
Symplastic pathway (through cytoplasm)
Apoplastic pathway (through cell wall)

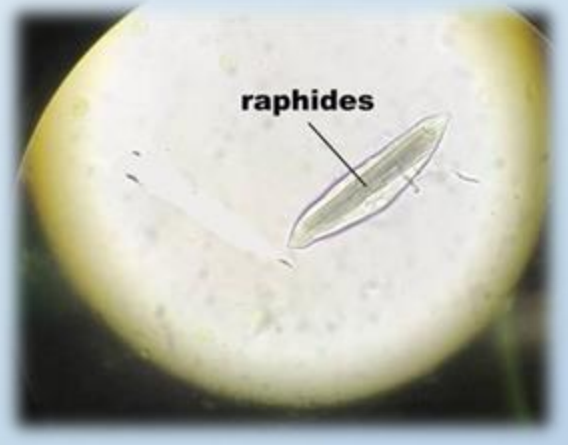
Organelle & Discoverer

Organelle	Discoverer
Cell wall	Robert Hooke
Cell membrane	Nageli & Cramer, Naming-Plowe
Nucleus	Robert Brown
Mitochondria	Kolliler, named by Benda
Plastid	Haeckel
Golgi Body	Camilo Golgi
Endoplasmic Reticulum	Porter and Thomson
Lysosome	C.D.Duve
Peroxisome	Christian de Duve and Pierre Baudhuin
Vacuole	A.V.Leeuwenhoek
Ribosome	G.E.Palade
Centrosome	Walther Flemming and Edouard Van Beneden

Ergastic Substances

Parts of Cell	Structural feature	Function
. Cell inclusions	• Non living components. • 3 types–Reserve Food materials, Secretory materials & Excretory materials.	• Storage, excretion & Secretion • Cystolith-Calcium Carbonate Crystal. • Raphide-Calcium oxalate Crystal.





Some important PYQ from this chapter

1. The bacterial cell wall consists of – (Tripura PCS Prelims)

a. Cellulose
b. Lignin
c. Mucopeptide
d. Pectose

Answer: C (Mucopeptide)

Explanation: *The bacterial cell wall consists of mucopeptide which is known as murein or peptidoglycan.*

2. What is the typical size of a prokaryotic cell? [WBCS Mains]

a) 1-10 metre

b) 1-10 millimetres

c) 1-10 micrometres

d) 1-10 nanometres

Correct answer: c) 1-10 micrometre

Explanation: *Prokaryotic cells are typically 1–10 micrometres in diameter because larger cells would become less efficient at acquiring materials and removing waste.*

3. Cell inclusions are- (BPSC Prelims)

a. Living Substances

b. Cell organelles

c. Non-living substances

d. Both a & c

Answer: c (Non–living substances)

Explanation: *Cell inclusions are non living substances present in the cells. They are called ergastic bodies.*

4. Which of the following cell organelle is not bounded by cell membrane? (MPPSC Preli)

a. Chloroplast
b. Ribosome
c. Mitochondria
d. Lysosome

Answer: b (Ribosome)

Explanation: *Ribosome is membrane less cellular organelle.*

5. The non-cytoplasmic areas present inside the cytoplasm are (JPSC Preli)-

a. Nucleus
b. Vacuoles
c. Lysosomes
d. None of these

Answer: b (Vacuoles)

Explanation: *The non-cytoplasmic areas present inside the cytoplasm are vacuoles. These remain separated from the cytoplasm by specific membrane known as tonoplast.*

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Some important book references

1. Encyclopedia of General Sciences by Arihant Publication
2. Encyclopedia of General Sciences by Disha Publication
3. NCERT Notes 6-12 by Arihant/Mcgrawhill Publication
4. Competitive Bigyan by Santra Publications (For Bengali Medium)
5. Class 9-10 Biology Text Book Bengali version (Santra/Prantik)
6. WBCS General Studies Manual- Mcgrawhill (Good for other PSC exams also)

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Thank You

In the next module, we will learn about the concepts of Cell Division and Chromosome Structures

☺☺