CELL – The Unit of Life

Biologist	Contribution
Anton Van Leeuwenhoek	• Described cell
Robert Brown	• Discovered nucleus
Matthias Schleiden (1838)	• Different kinds of cells which form the tissues of the plant
Theodor Schwann (1839)	• Reported Plasma Membrane • Cell wall is a unique character of the plant cells.
Schleiden and Schwann	• Formulated Cell Theory
Rudolf Virchow (1855) (Modified Cell theory)	• New cells are formed from pre-existing cells (*Omnis cellula-e cellula*)

Cell Theory

Given by M.J Schleiden and Theodor Schwann in 1839.

1. All living organisms composed of cells and their product
2. All cells arise from pre-existing cells.

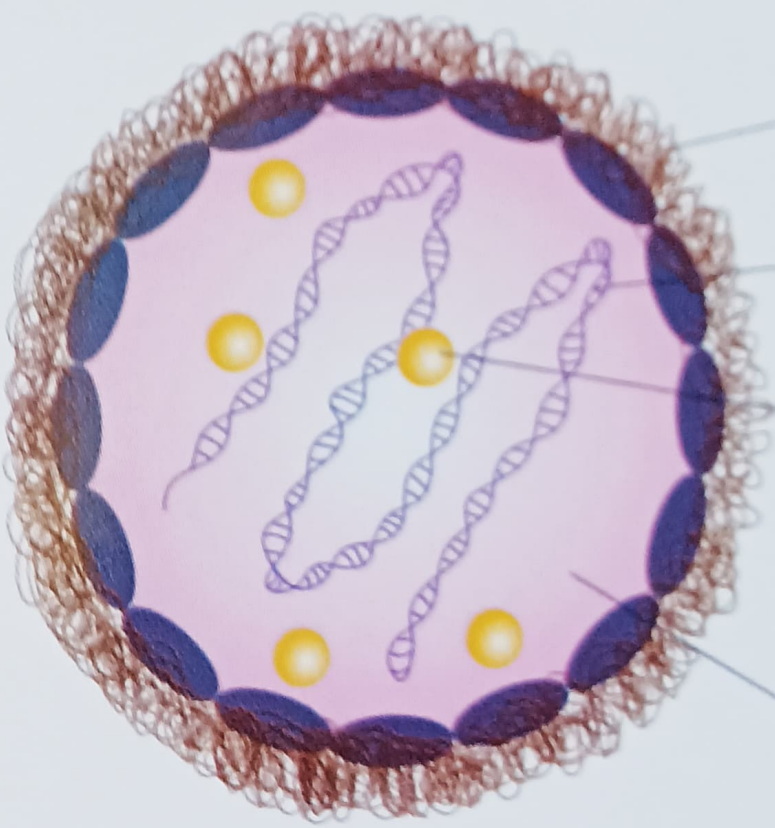
BASICS

- Plant cell-cell wall (+), animal cell-cell wall (-)
- Nucleus (contains genetic material -DNA); is Membrane bound (Eukaryotes).
- Semi-fluid matrix (cytoplasm)
- Organelles (+); ribosomes (not membrane bound)
- Smallest cell- Mycoplasma (0.3 µm-Length)
- Bacterial cell-3 to5 µm, Blood cell- 5 µm (diameter)
- Largest cell- Ostrich egg

PROKARYOTIC CELL

- Represented by bacteria, bluegreen algae, mycoplasma, PPLO-Pleuro pneumonia like organism

- Cell Wall (+) (except Mycoplasma)
- Nucleus (not defined);Unenveloped DNA
- Additional DNA than genomic DNA (in bacteria)-Plasmid
- Confers resistance to antibiotic
- Mesosome (infolding of cell membrane) (characteristic of Prokaryotes)



Cell Envelope

3 layered structure

Glycocalyx	Cell wall (shape & structural support)	Plasma membrane

Bacteria (difference in cell envelope) →
- Gram +ve (take up gram stain)
- Gram -ve (does not take up stain)

- Glycocalyx (slime like, or capsule like)
- Plasma membrane is selectively permeable

Mesosome (in form of vesicles, tubules, Lamellae)

Functions of Mesosomes

Cell wall Formation	DNA replication	Respiration
Secretion	Increases surface area (enzyme action)	

Bacteria flagellum

Basal Body	Filament-longest portion	Hook

*Pilli & Fimbriae also help in locomotion in bacteria

elongated tubular (protein) — small bristle-like

Ribosomes in Prokaryotic Cell

- Size - 15-20nm.
- 70S = 50S + 30S
- Site of protein synthesis.
- Polyribosome/polysome - chain of ribosome + mRNA

↓

Function -Translation (mRNA → Proteins)

Inclusion bodies in Prokaryotic Cell

- Storage of reserve food materials
- Membrane (-)
- Eg-phosphate granules, cyanophycea granules, glycogen granules, Gas vacuoles.

EUKARYOTIC CELL

Protists, plants, animals, fungi
Membrane bound organelles
Plastids (absent in animal cells)
Centriole (absent in plant cells)

Cell Membrane — formed by → protein

↓ lipid

Phospholipids (arranged as bilayer)

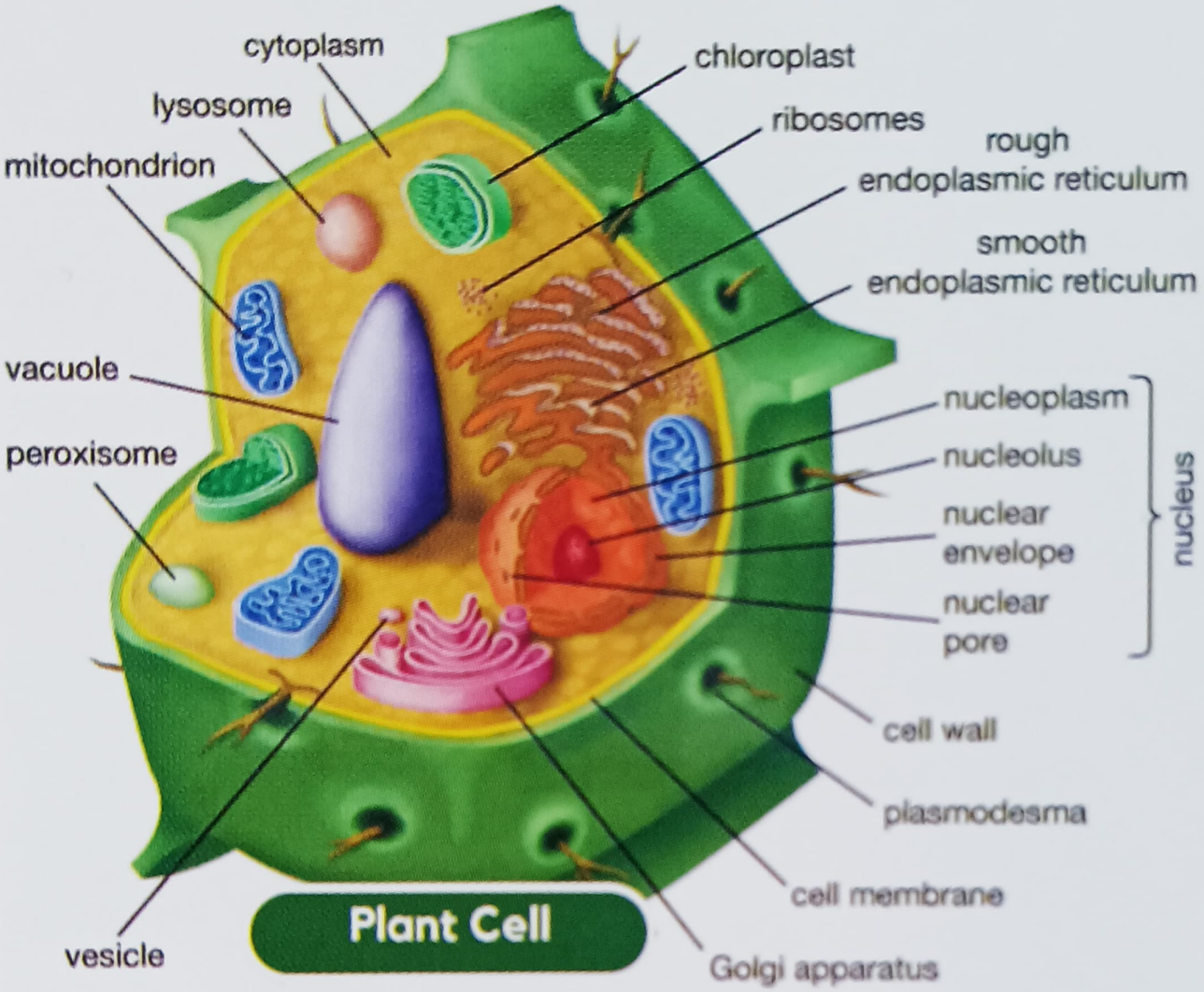
- inner (hydrophobic tails)
- outer (polar head)

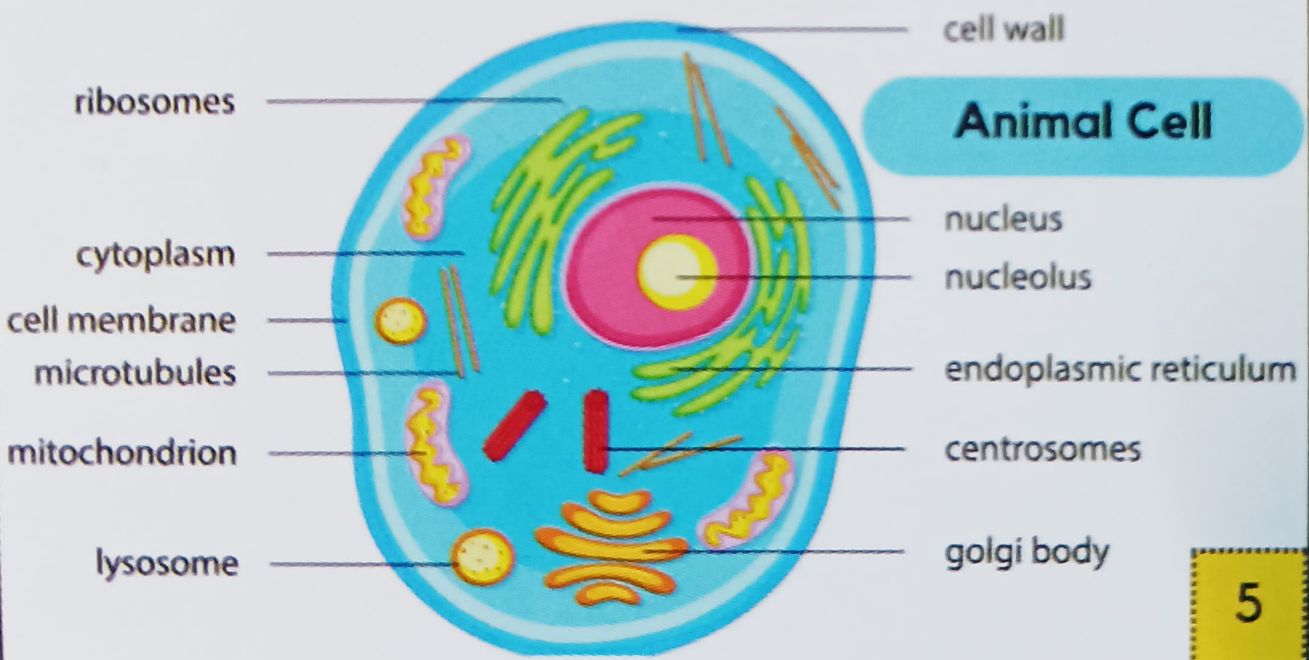
Membrane proteins

- Peripheral (lie on the surface)
- Integral (completely buried)

*Phospholipids membrane also contain cholesterol (sometimes carbs also)
→ humans - 52% : 40% (protein:lipids)

Plant cell

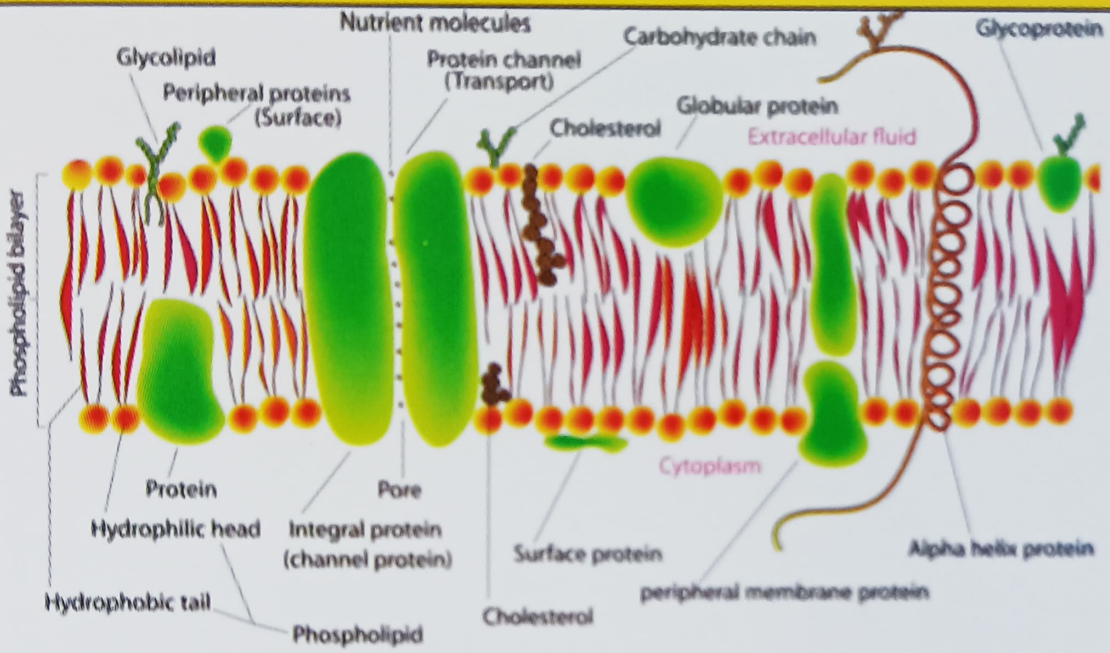




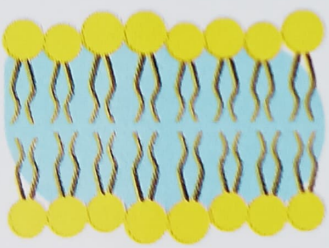
- Sausage/cylindrical (shape)
- Not visible under microscope
- 0.2-1 μm (diameter); 1-4.1 μm (length)
- Double membrane (divides Lumen)
  - → Outer membrane

- DNA (single, circular)

FLUID MOSAIC MODEL (Singler & Nicolson, 1972)



- Lipid (quasi- fluid) enables protein movement (fluidity)
- Fluidity helps in - 1. Cell growth



2. Forming intercellular junctions
3. Secretion
4. Endocytosis
5. Cell division

- Plasma membrane is selectively permeable
- Passive transport - energy (-)
- Diffusion- along conc. gradient.
- Osmosis - H_2O transport via diffusion.

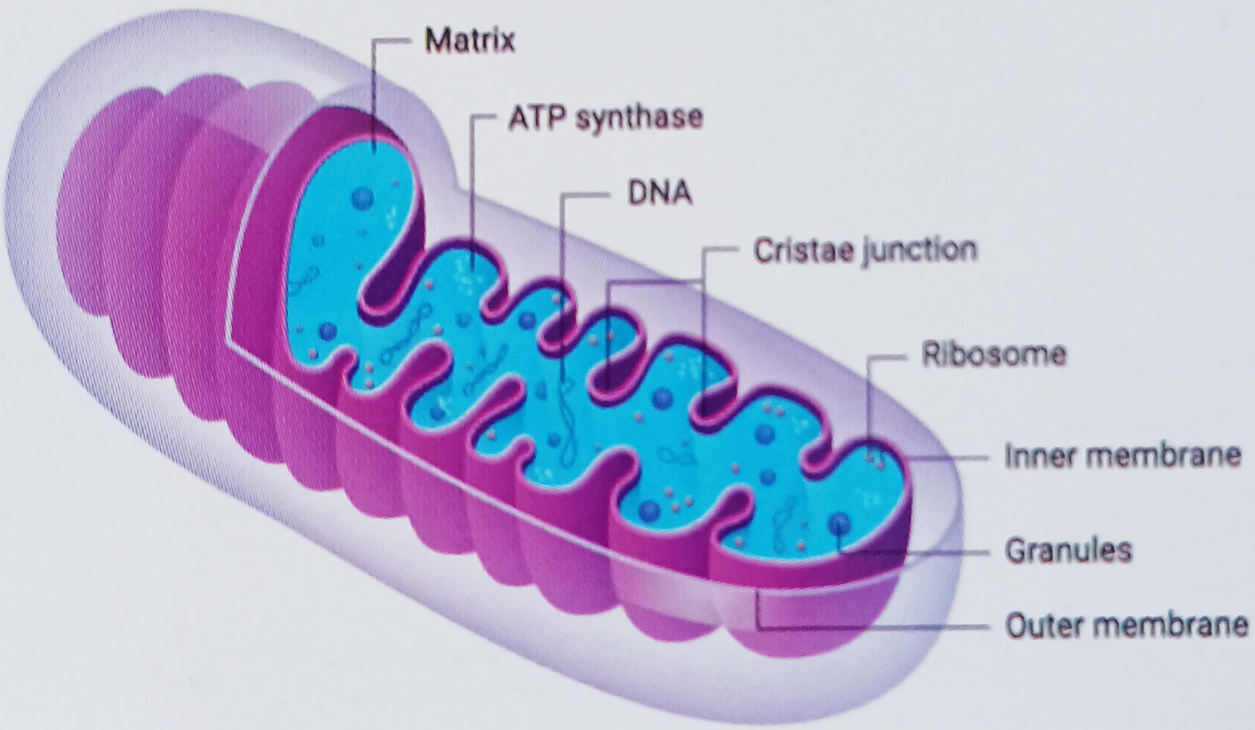
Active Transport

- ATP required
- Against conc gradient (sometimes)
- Carrier protein (+); eg - Na^+/K^+ pump

Mitochondria

- Sausage/cylindrical (shape)
- Not visible under microscope
- 0.2-1 μm (diameter); 1-4.1 μm (length)
- Double membrane (divides Lumen)
  - → Outer membrane
  - → Inner membrane

- Lumen(inner) → filled with matrix
  - DNA (single, circular)
  - RNA
  - Ribosome (70S)
- Cristae - foldings of inner membrane in Lumen



Functions

- Site of aerobic respiration
- Power house of cell (produces ATP)
- Protein synthesis (in matrix)

*Mitochondria divides by fission.

Cell Wall

- Non-living; rigid
- Fungi(+), plants (+), Algae (+)
- gives shape, provides protection.
- Algae→ cellulose, galactans, mannans, minerals ($CaCO_3$)
- Plants→ cellulose, hemicellulose, pectin, proteins
  - 1° cell wall - growth (+)
  - 2° cell wall- cells mature towards the membrane
- Middle lamella (Calcium Pectate) - holds cells via Plasmodesamta

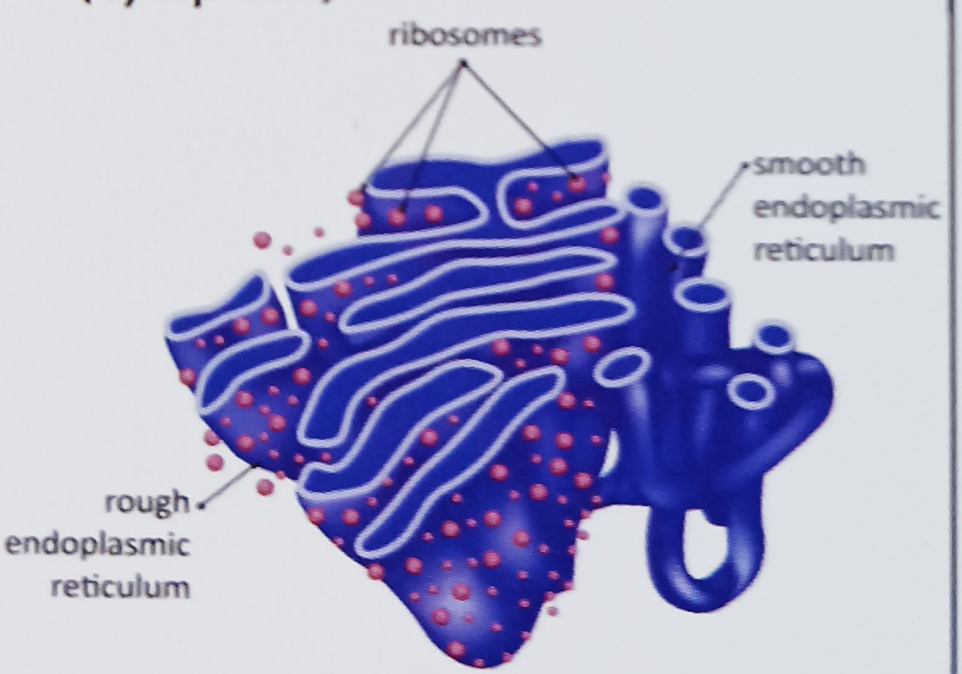
Endomembrane system

Endoplasmic reticulum	Golgi complex	Lysosomes	Vacuoles

Endoplasmic reticulum

- Network of tubular structures
- Intracellular space division as luminal & extra luminal (cytoplasm)

TYPES



Rough endoplasmic reticulum (RER)

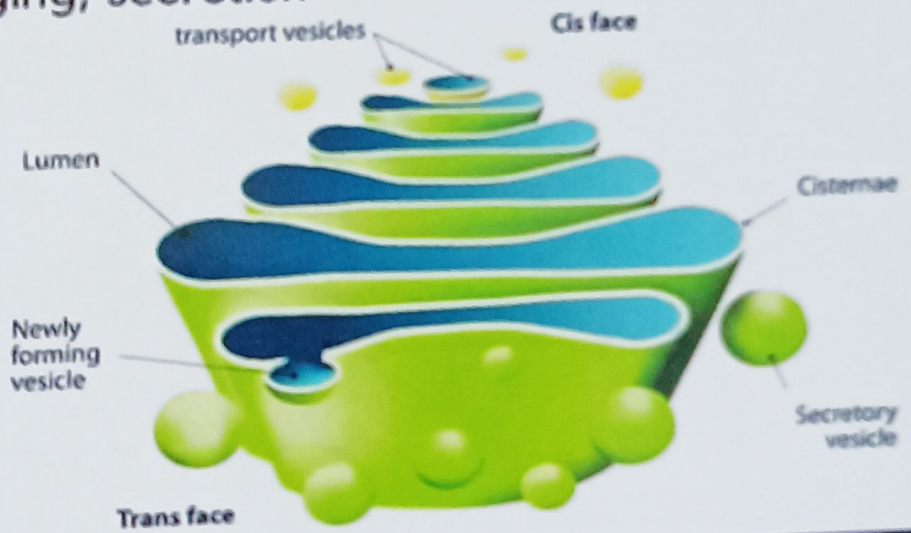
- Ribosome (+)
- protein synthesis
- continuous with nucleus

Smooth endoplasmic reticulum (SER)

- Ribosomes (-)
- Lipid synthesis (steroidal hormones in animals)

Golgi complex

- 1st observed by Camillo Golgi (1898)
- Cisternae - flat, disc shaped sacs (stacked)
- Diameter (0.5-1μm)
- Cis face(convex) - forming face
- Trans face(concave) - maturing face
- Function - formation of Glycolipid, Glycoprotein.
- Packaging, secretion



Lysosomes

- Membrane bound vesicles
- Formed by golgi apparatus
- Contain hydrolytic enzymes (lipases, proteases, carbohydrates, etc)
- Get active at optimal at pH

Note

- Tonoplast facilitates ion movement against conc gradient

Vacuoles

- Membrane bound spaces (Tonoplast)
- Contain water, sap, excretory products
- Occupy 90% volume of cell (plants)
- eg- Contractile vacuole *(Amoeba)* - osmoregulation, excretion
- Food vacuole (Protists)

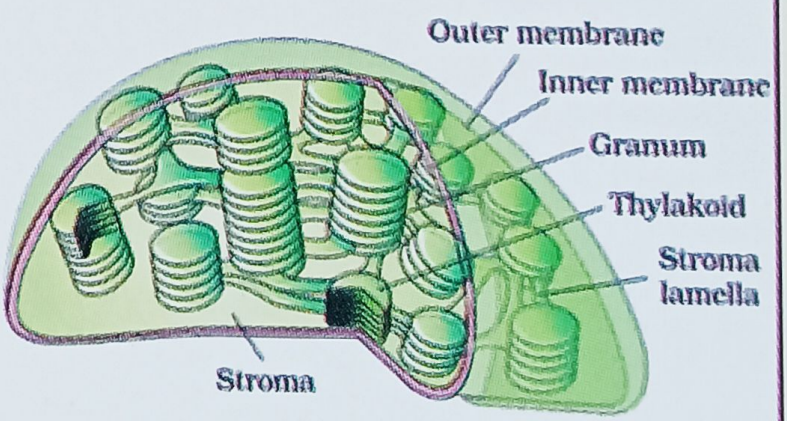
Plastids

(plant cells (+), euglenoid(+) - contain pigments)

Chloroplasts	Chromoplast	Leucoplasts (colourless)
• Photosynthesis • Chlorophyll • Carotenoid	• Fat soluble carotenoid pigment Carotene, xanthophyll	Store nutrients •Amyloplasts (starch) •Elaioplasts (fats, oils) •Aleuroplasts (proteins)

Chloroplasts

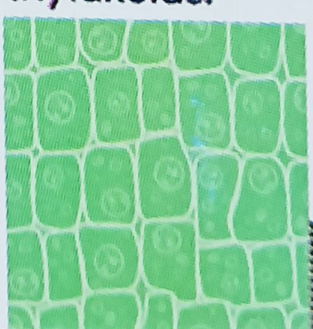
- Found in mesophyll (leaf)
- Lens shaped, oval, spherical
- Length (5-10 μm), width (2-4μm)
- Number- (1) in *Chlamydomonas*
  20 -40 in green alga.
- Double membrane
  - outer
  - inner
- Less permeable
- Stroma (space-bound).
  ↓
  Contains thylakoids



- Thylakoids arranged in sacs (grana)
- Stroma lamellae - flat tubules connecting thylakoids.

↓ contains

- Enzyme for formation of Protein, Carbohydrates.
- Circular DNA
- Ribosomes (70S & 80S)



Ribosomes

- Observed by George Palade (1953)
- Granular structure under microscope
- Formed of RNA & proteins
- 80S = 40S + 60S (eukaryotes)
- 70S = 50S + 30S (in prokaryotes)
- 'S' (Svedberg's unit) - Sedimentation coefficient measures density & size

Cytoskeleton

- Network of protein (microtubules, microfilament)
- Provide support, shape, helps in motility

Centrosome

Contains 2 cylindrical structures (Centrioles) → perpendicular to each other (cartwell)

↓ covered by Pericentriolar material

(each) formed of ↓

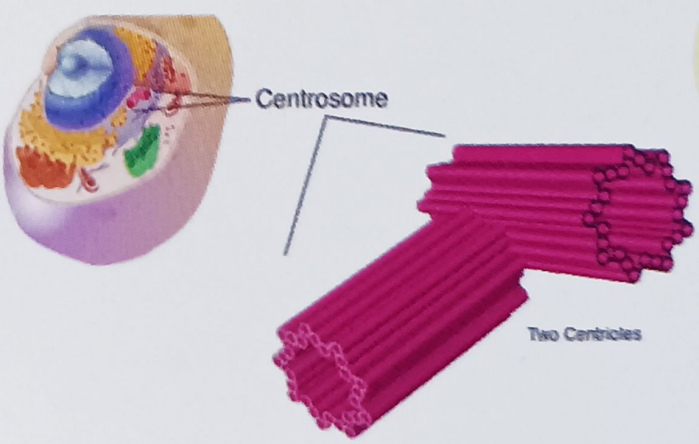
9 Fibrils (Tubulin proteins)

↓ (each)

triplet → Central part → Hub, Radial spokes

triplet → Linkage

*Centrioles form basal body of Cilia, Flagella, spindle fibres

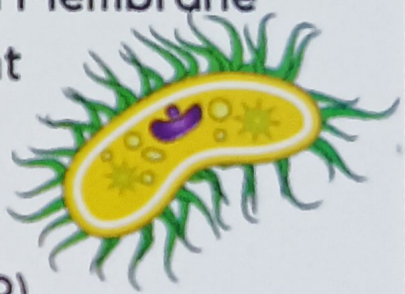


Cilia & Flagella - cell-memberane out growths

Cilia	Flagella
• Small (Many)	• Longer (less in number)
• Fluid and Cell Movement	• Cell movement

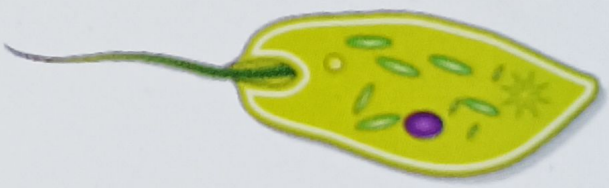
Structure

- Core → axoneme ; Covering → Plasma Membrane
- Microtubules → 9+2 array arrangement
- Bridges - connect central tubules



Central tubules
→ connection-Radial spokes (9)

Peripheral doubles
↓
interconnection
(linkers)



Originate from Centriole - like structure → basal bodies

Nucleus

- 1st described by Robert Brown (1831)
- Named Chromatin (by Flemming)
- Interphase nucleus- (2 memberanes)
  ↓
  Perinuclear space
  → Nucleoprotein fibres
  → Nuclear matrix
  → Nucleoli

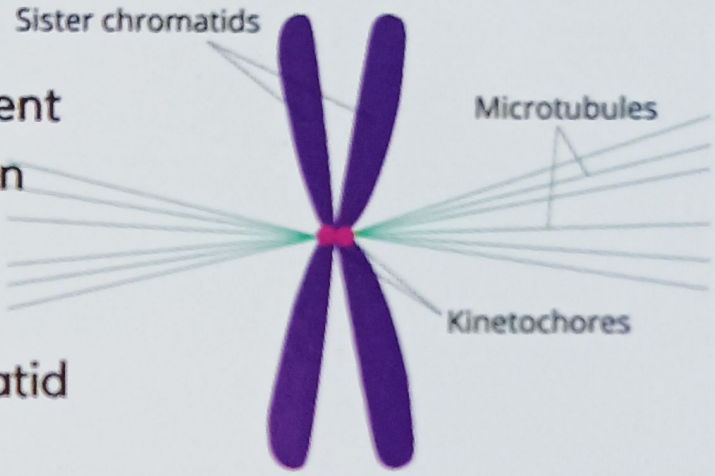
- Outer Membrane -connected to Endoplasmic Reticulum (bears Ribosomes)
- Nuclear pores - passage of RNA, proteins.
- Erythrocytes lack, Nucleus & Sieve tubes (Mammals)

Nuclear matrix (Nucleoplasm) → Nucleolus → membrane (-)
→ Chromatin → site of rRNA synthesis

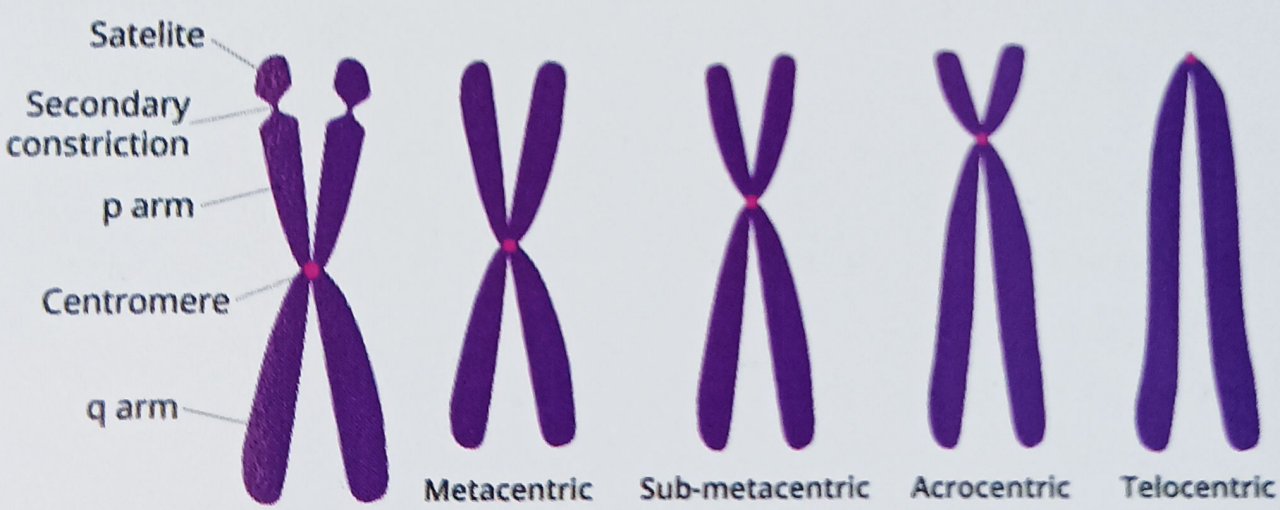
DNA	Histone	Non Histone (some)	RNA

*During cell division, Chromosomes are also present

- Centromere - 1° constriction
- Kinetochores-disc shaped structure
- Centromere hold 2 Chromatid



Types of Chromosomes



- Sometimes, there is another small constriction
  ↓ giving rise to
  small fragment (satellite)
- Microbodies - membrane bound vesicles containing enzymes.