

INTRODUCTION TO BIOLOGY

BIO-101

Cell Structure & Function

Lecture 03

Early Discoveries

- Mid 1600s - **Robert Hooke** observed and described cells in cork
- Late 1600s - **Antonie van Leeuwenhoek** observed microorganisms
- 1820s - **Robert Brown** observed and named nucleus in plant cells



Developing Cell Theory

Matthias Schleiden

Theodor Schwann

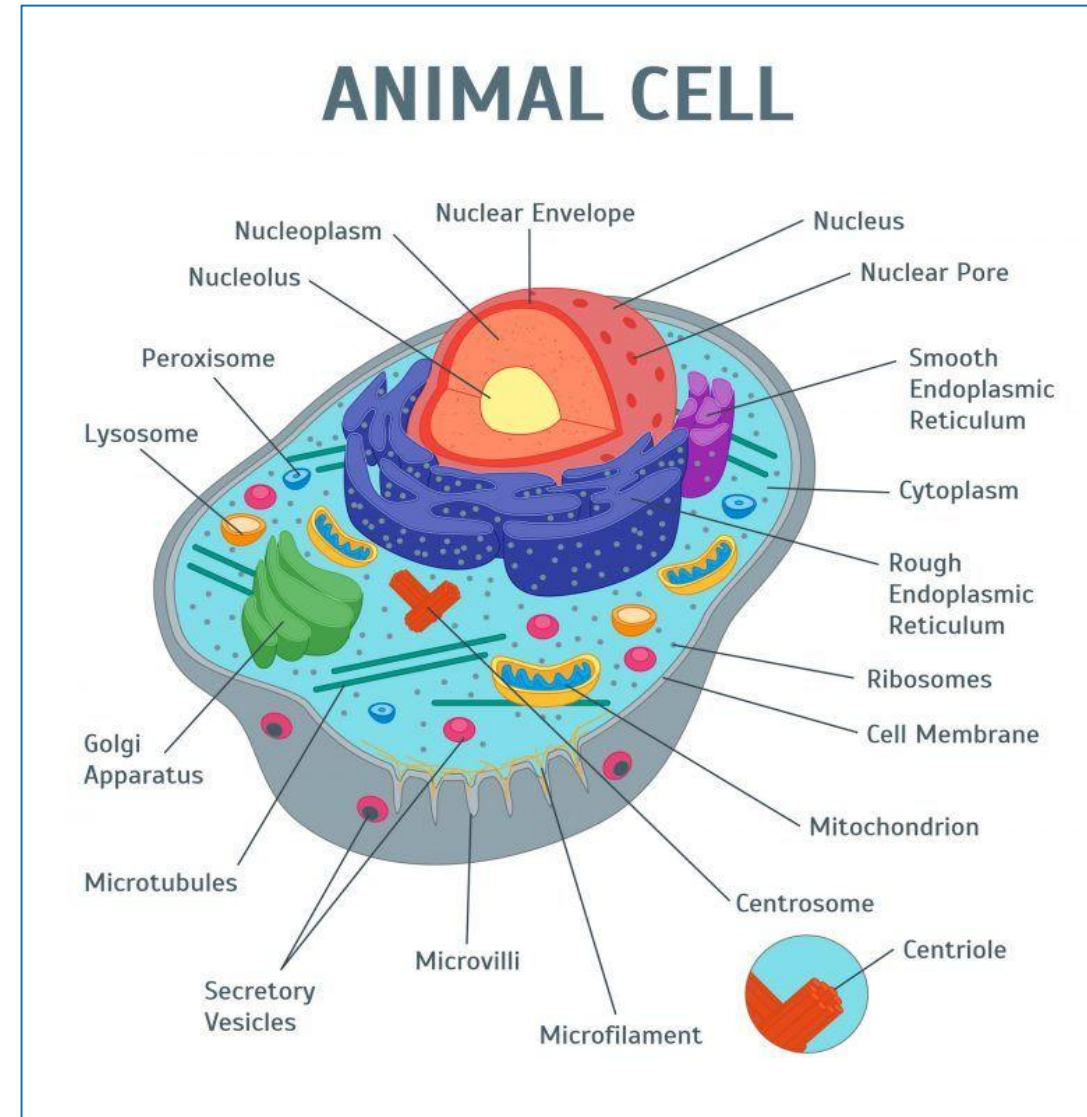
Rudolf Virchow

Cell Theory

- 1) Every organism is composed of one or more cells
- 2) Cell is smallest unit having properties of life
- 3) Continuity of life arises from growth and division of single cells

Cell

- Smallest unit of life.
- Can survive on its own or has potential to do so.
- Is highly organized for metabolism.
- Senses and responds to environment.
- Has potential to reproduce.



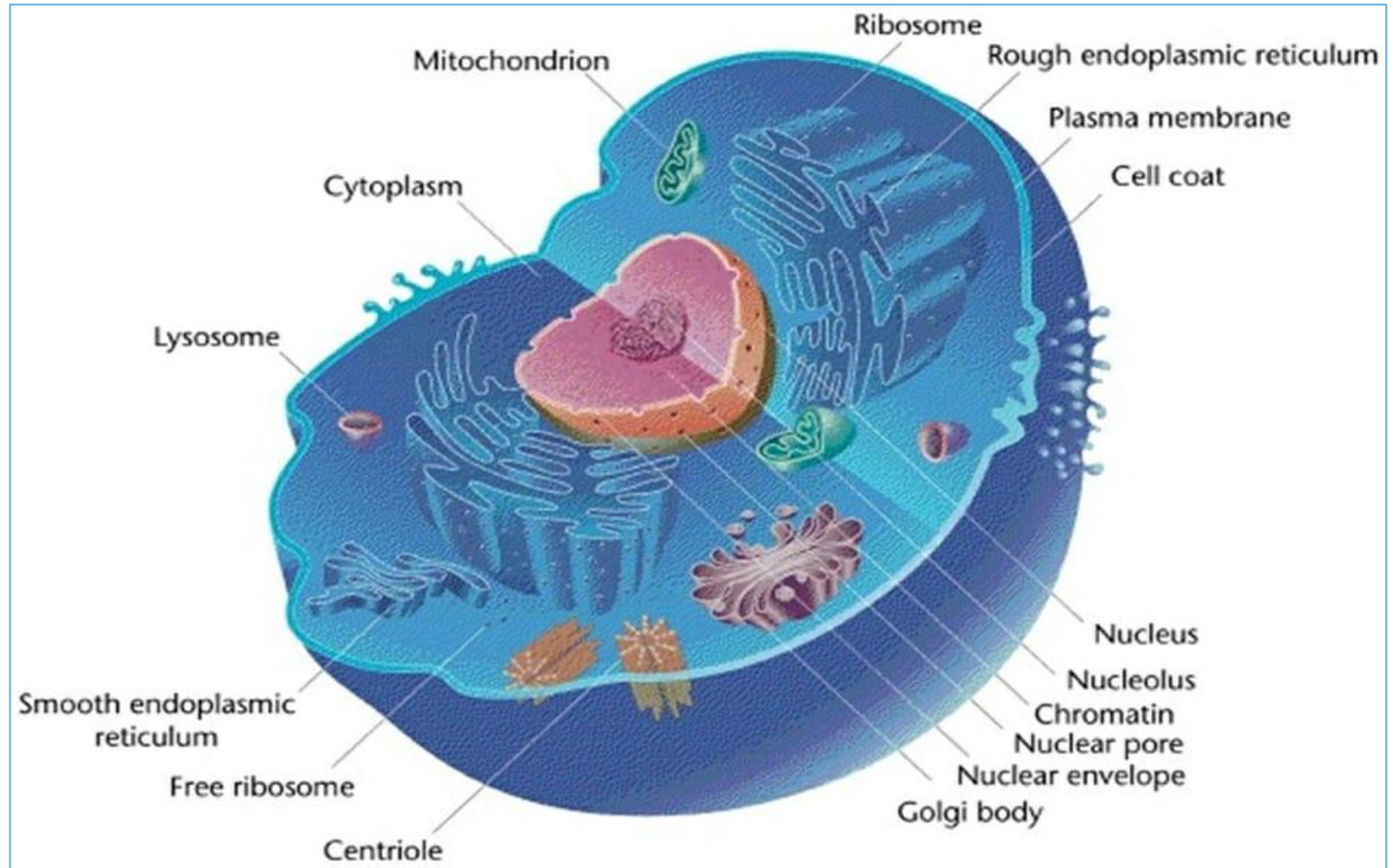
Structure of Cells

All start out life with:

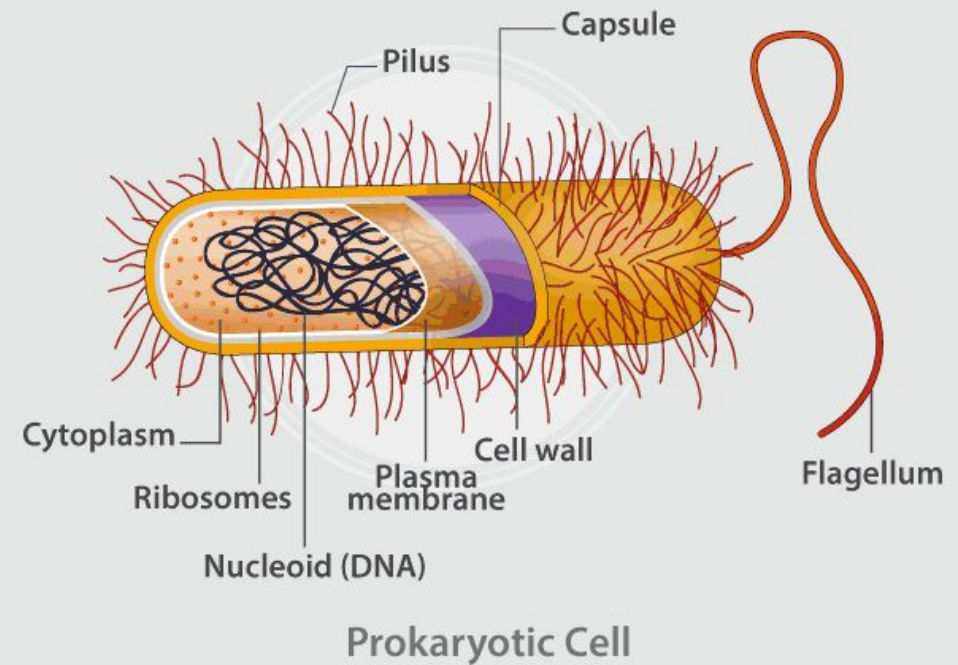
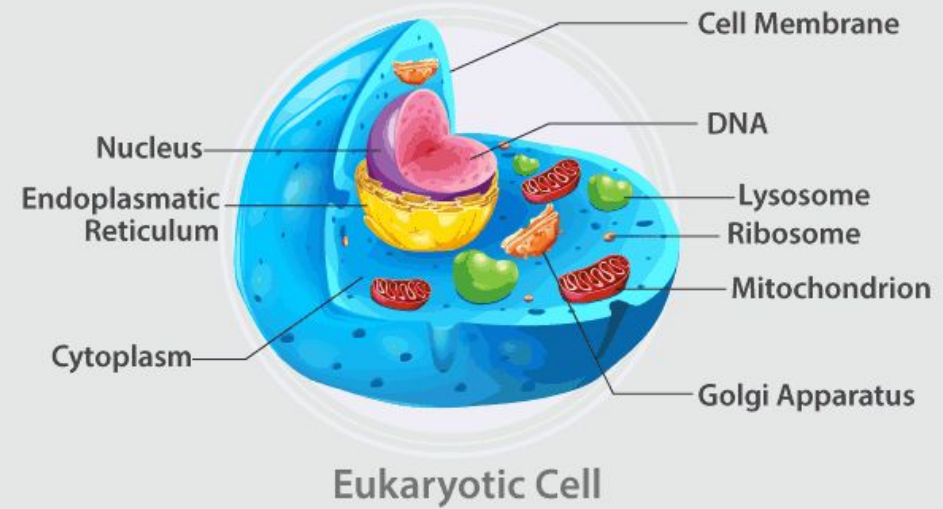
- Plasma membrane
- Nucleus/DNA
- Cytoplasm

Two types:

- Prokaryotic
- Eukaryotic



Prokaryotic Cell & eukaryotic cell



Prokaryotic and Eukaryotic Cells Venn Diagram



Prokaryotic Cells

- Small and simple
- 0.1 to 5.0 μm in size
- Unicellular
- Nucleus is absent
- Circular DNA
- Single haploid (n) chromosome
- Lack membrane-bound organelles
- Reproduce both sexually and asexually
- Cell division by binary fission
- Examples are bacteria and archaea cells

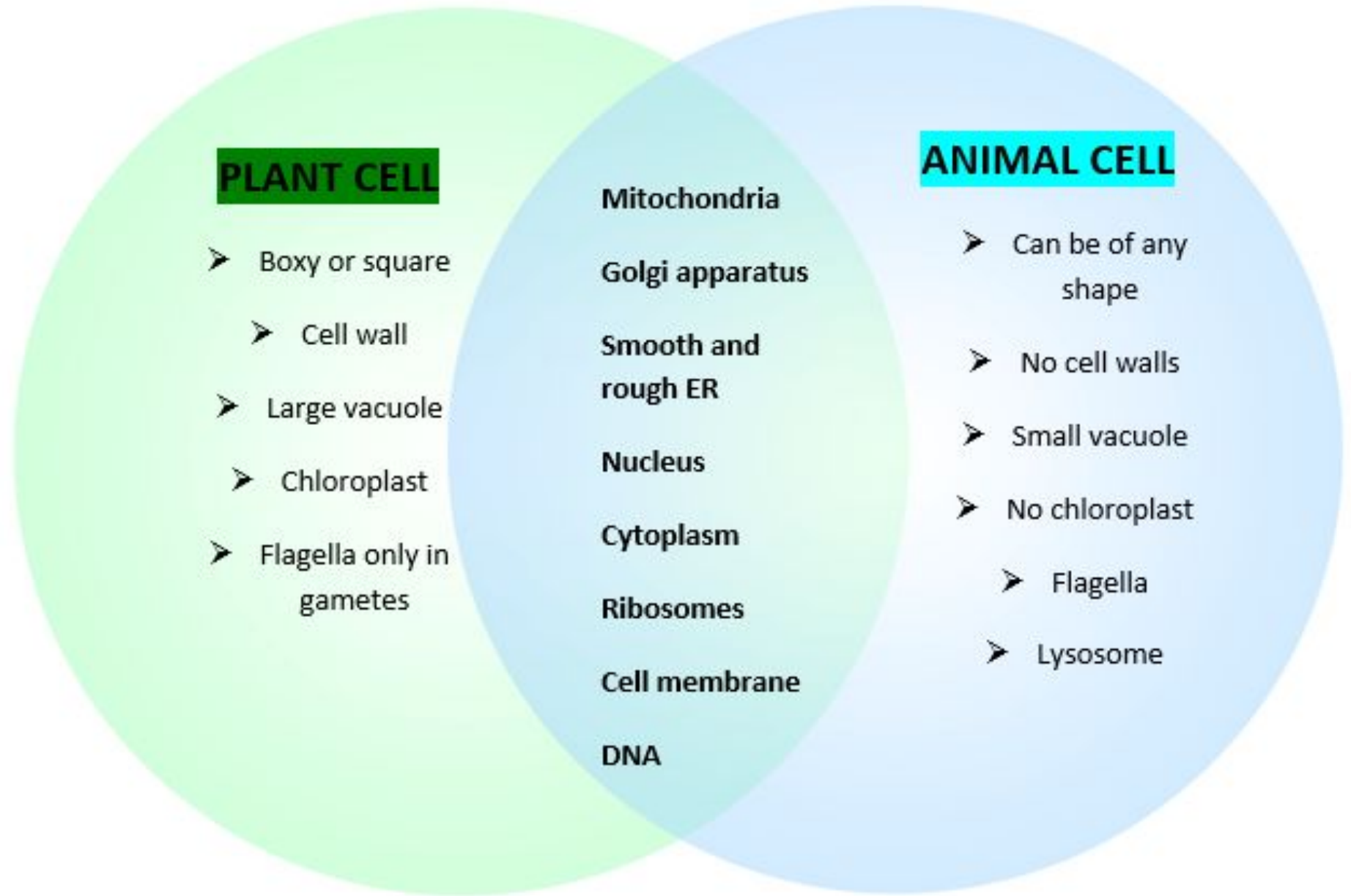
Similarities

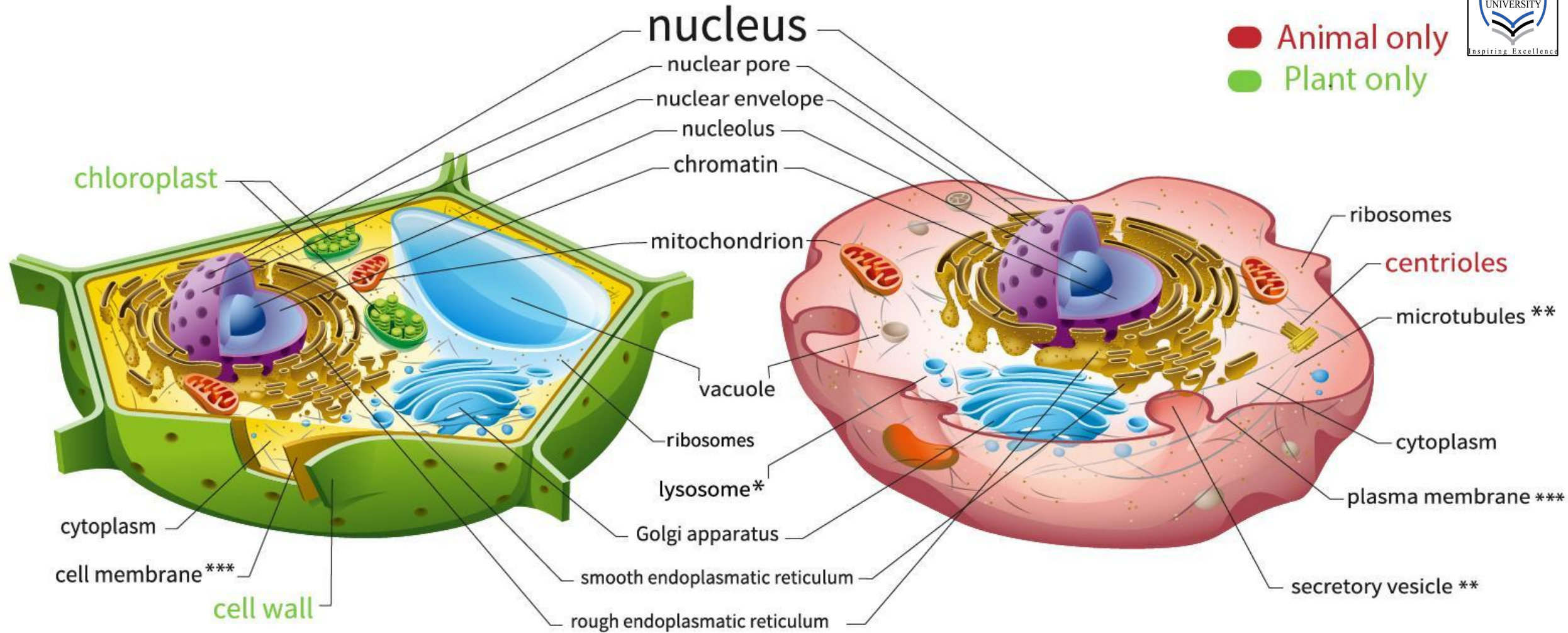
- Have cell (plasma) membrane
- Have cytoplasm
- Have ribosomes
- Have DNA

Eukaryotic Cells

- Large and complex
- 10 to 100 μm in size
- Unicellular or multicellular
- Nucleus is present
- Linear DNA
- Paired diploid (2n) chromosome
- Has membrane-bound organelles
- Mostly reproduce sexually
- Cell division by mitosis
- Examples are plant and animal cells, including humans

Animal Cell & Plant Cell





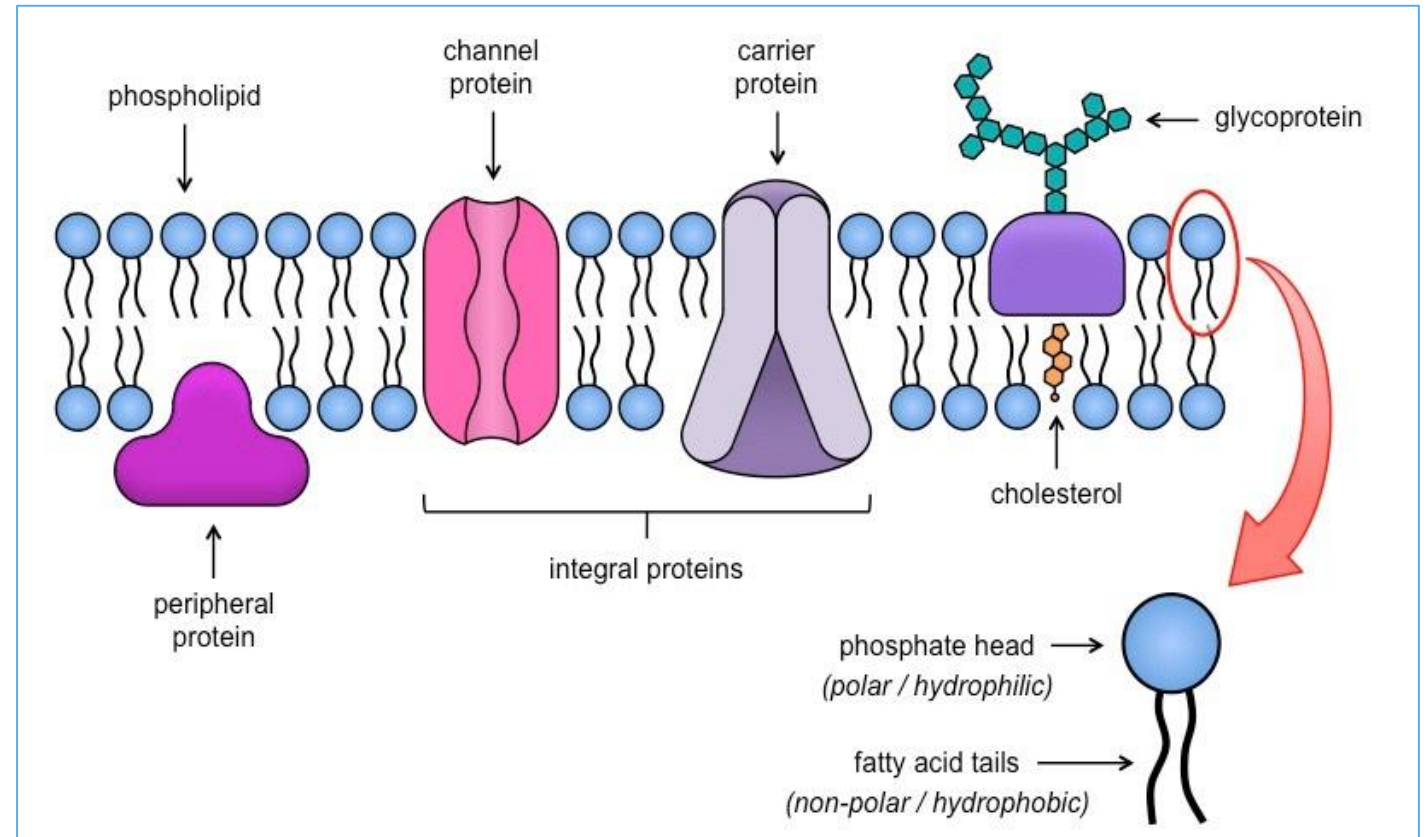
* Plants may have lytic vacuoles, which act like lysosomes in animal cells.

** Although they're not labelled here, plant cells have microtubules and secretory vesicles, too.

*** Cell membrane and plasma membrane are just different names for the same structure.

Structure of Cells (Cell Membrane)

- The cell membrane, also called the plasma membrane, is found in all cells and separates the interior of the cell from the outside environment.
- The cell membrane consists of a lipid bilayer that is semipermeable.
- The cell membrane regulates the transport of materials entering and exiting the cell.



Cell Membrane (Fluid Mosaic Model)

Structure of Cells (Cell Membrane)

Fluid Mosaic Model

- The fluid mosaic model was proposed by S.J. Singer and Garth L. Nicolson.
- This model explains the structure of the plasma membrane of animal cells as a mosaic of components such as phospholipids, proteins, cholesterol, and carbohydrates.
- These components give a fluid character to the membranes.
- Each phospholipid has a hydrophilic head pointing outside and a hydrophobic tail forming the inside of the bilayer.
- Cholesterol and proteins are embedded in the bilayer that gives the membrane a mosaic look. Each component has a specific function to perform.

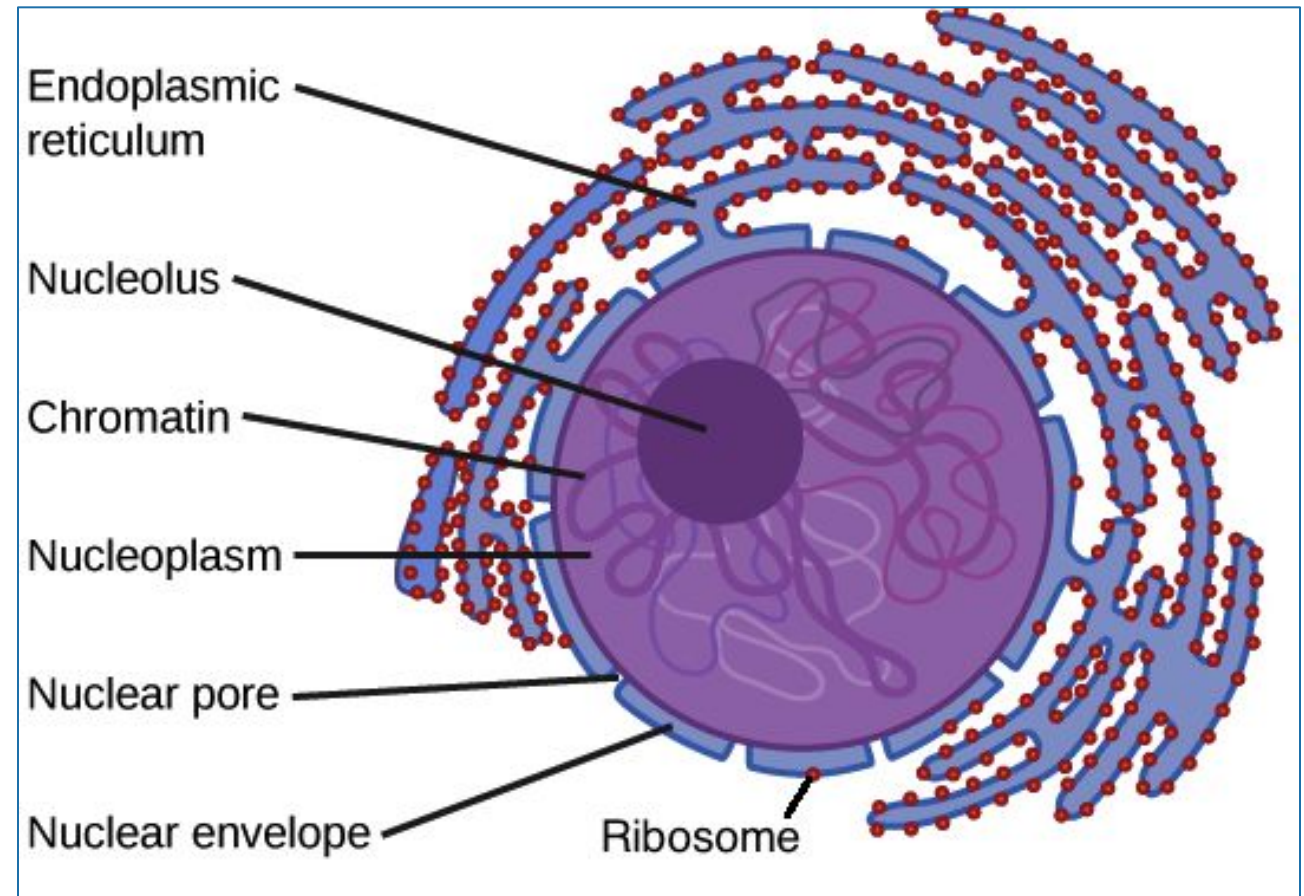
Components of Plasma Membrane

Components	Location
Phospholipid	The main fabric of plasma membrane
Cholesterol	Between phospholipids and phospholipid bilayers
Integral proteins	Embedded within phospholipid layers
Peripheral proteins	Inner or outer surface of the phospholipid bilayer
Carbohydrates	Attached to proteins on outside membrane layers

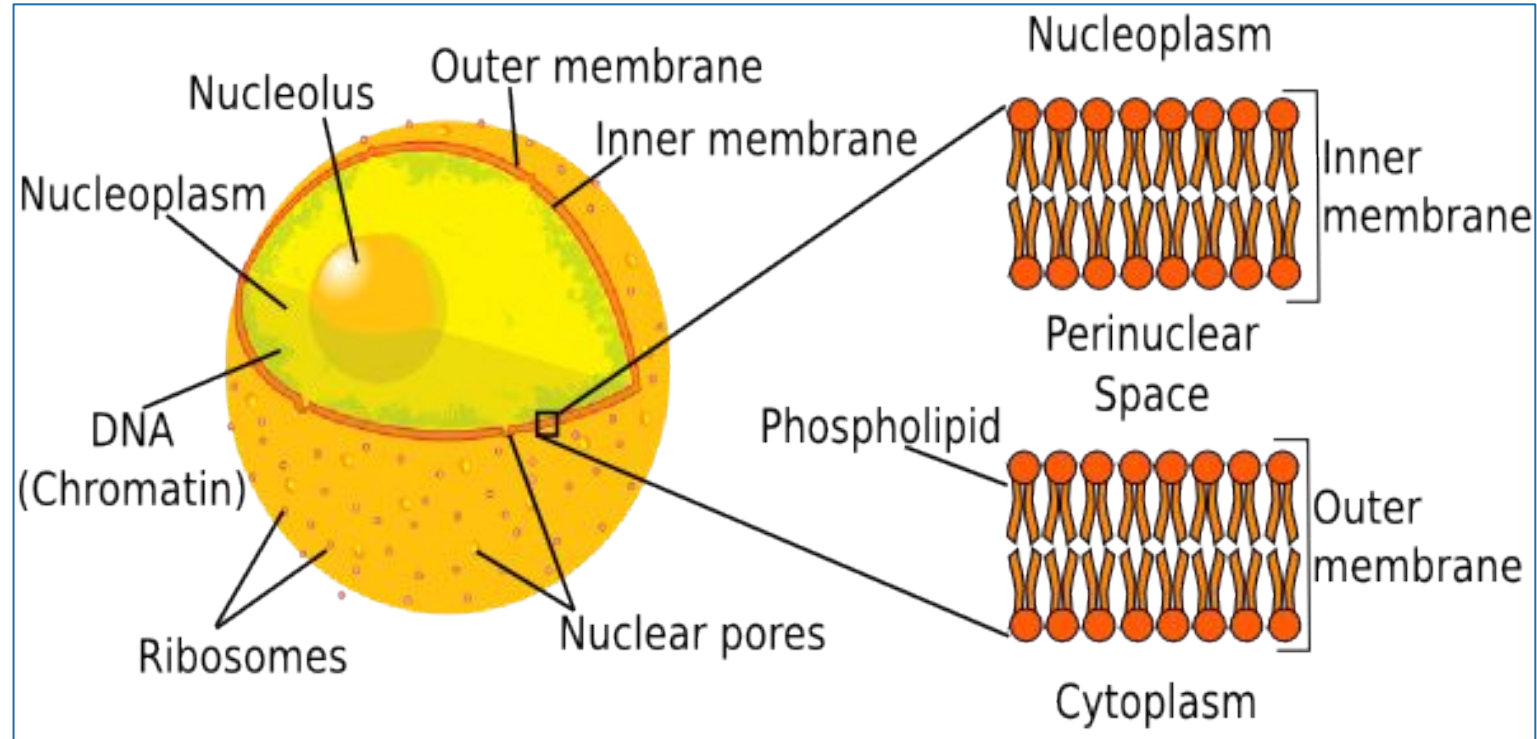
Structure of Cells (Nucleus)

Components of Nucleus

- Nuclear envelope
- Nucleolus
- Nucleoplasm
- Nuclear pore
- Chromatin
- Chromosome/DNA



Structure of Cells (Nucleus)



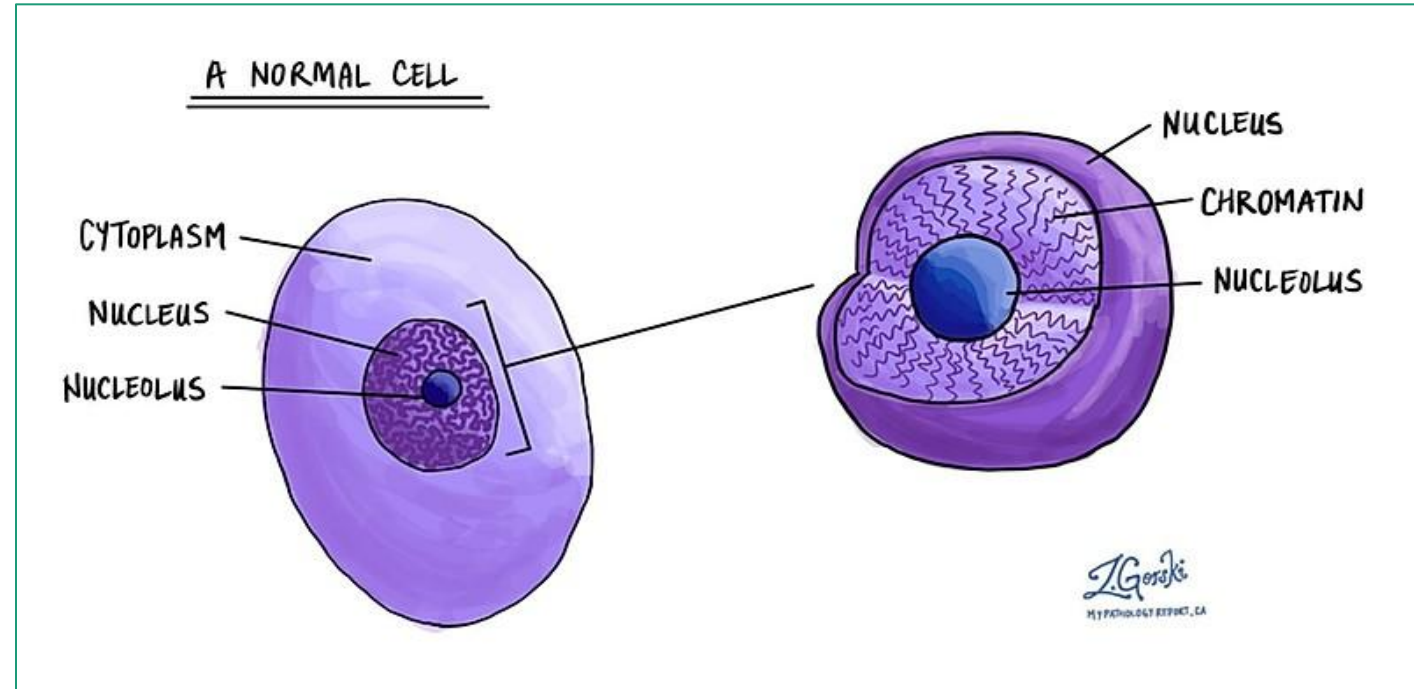
Nuclear Envelope

- Two outer membranes (lipid bilayers)
- Innermost surface has DNA attachment sites
- Pores span bilayer

Structure of Cells (Nucleus)

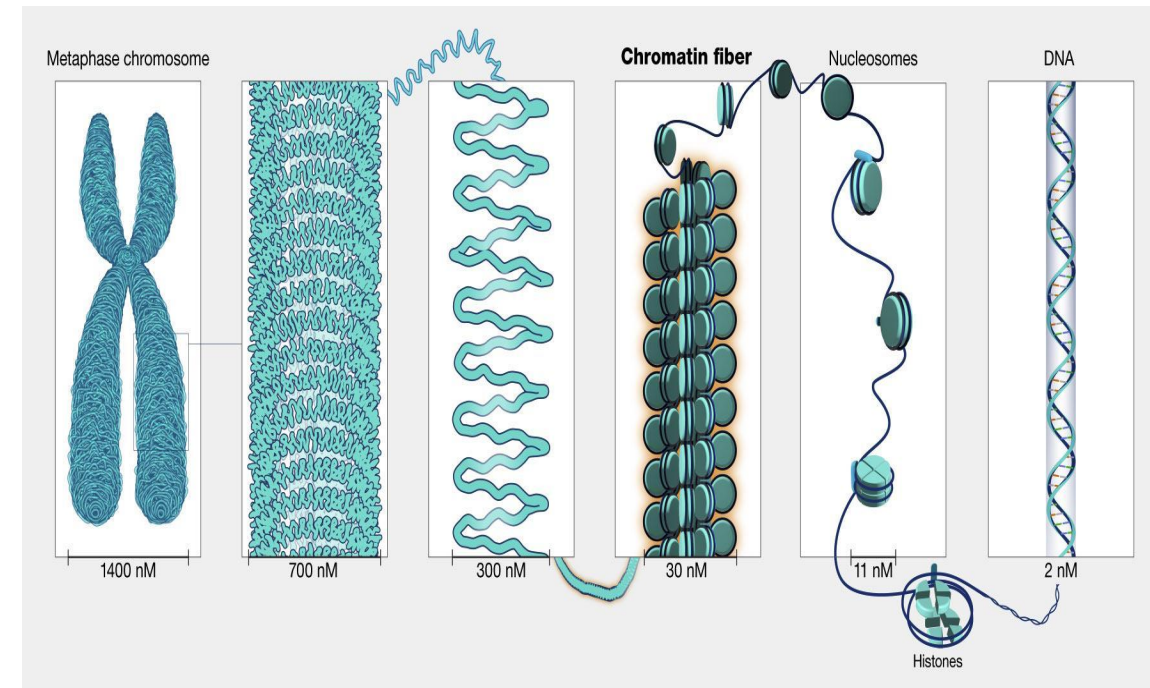
Nucleolus

- May be one or more
- Cluster of DNA and proteins
- Dense mass of material in nucleus
- Materials from which ribosomal subunits are built
- Subunits must pass through nuclear pores to reach cytoplasm



Structure of Cells (Nucleus)

- **Nuclear Pores:** Tiny channels or pores in the nuclear envelope allow for the exchange of molecules between the nucleus and the cytoplasm.
- **Chromatin & Chromosomes:** The DNA is packaged by special proteins called histones to form chromatin. The chromatin further condenses to form chromosomes. This means chromatin is a lower order of DNA organization, whereas chromosomes are a higher order of DNA organization.

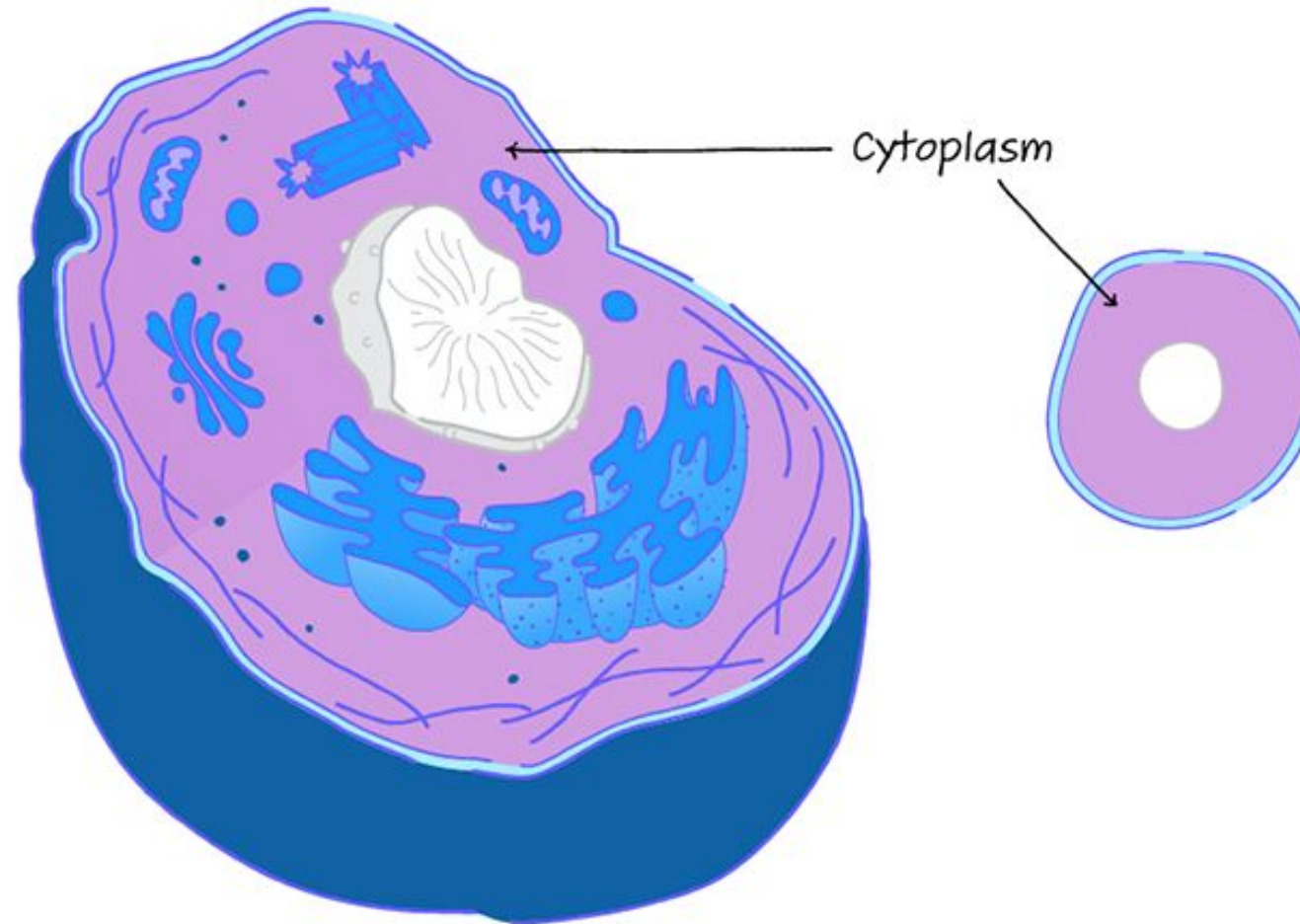


Structure of Cells (Nucleus)

Functions of Nucleus

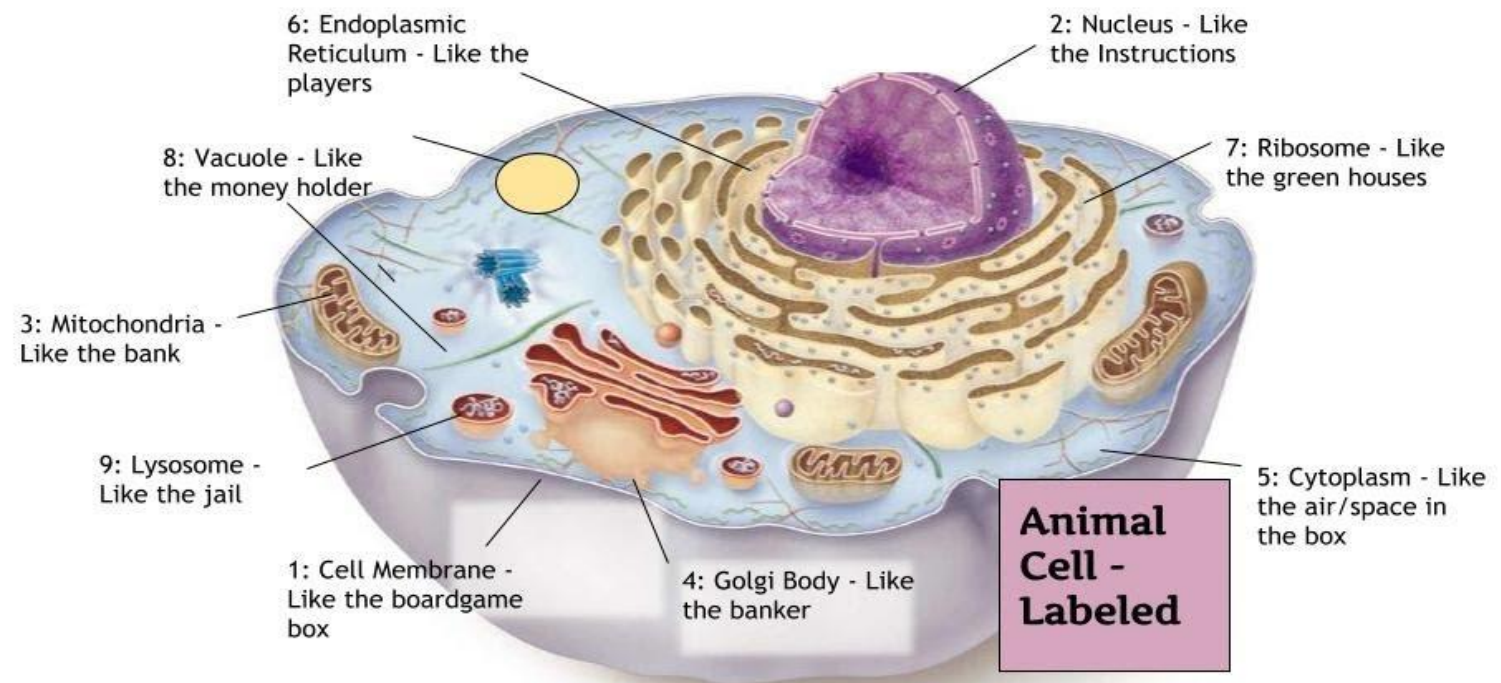
- Controls all cellular functions.
- Controls the synthesis of structural proteins.
- Contains genetic information for reproduction, development and behavior.
- Makes it easier to organize DNA and to copy it before parent cells divide into daughter cells

Structure of Cells (Cytoplasm)



Structure of Cells (Cytoplasm)

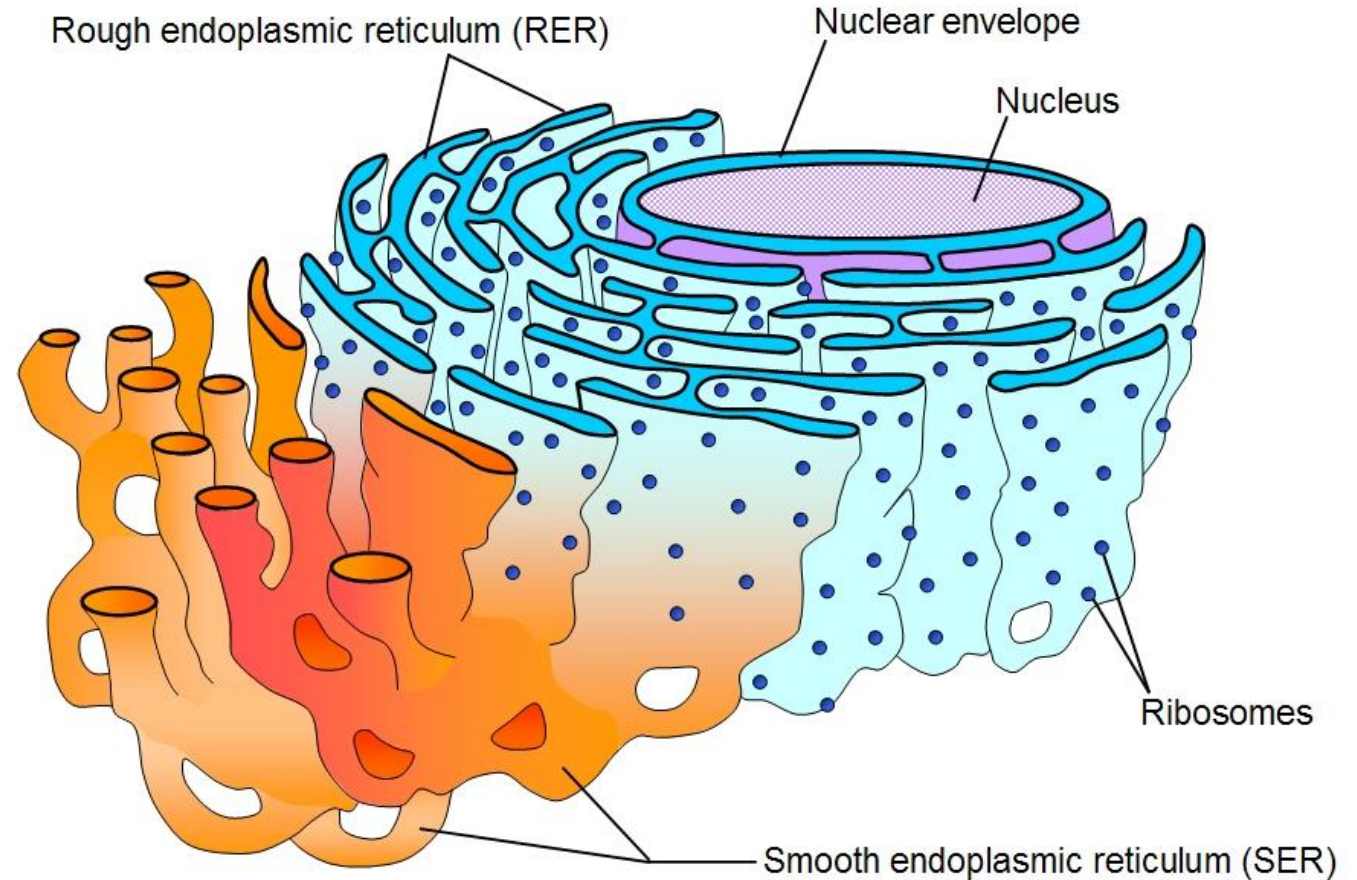
- Cytomembrane System
 - Endoplasmic reticulum (ER)
 - ❖ Rough ER
 - ❖ Smooth ER
 - Golgi bodies
 - Vesicles
- Mitochondria
- Lysosomes (only in animal)
- Cell wall (only in plant)
- Plastids (only in plant)



Structure of Cells (Cytoplasm)

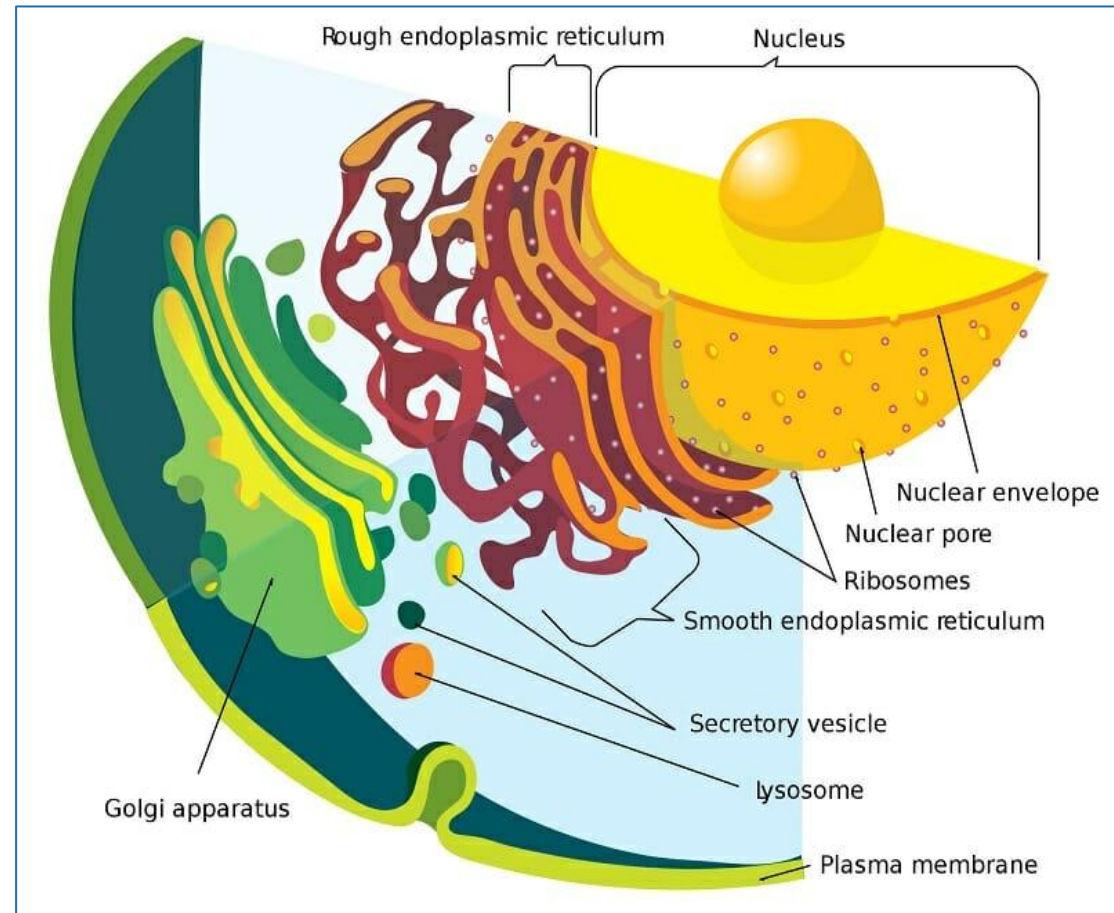
Endoplasmic Reticulum (ER)

- In animal cells, continuous with nuclear membrane
- Extends throughout cytoplasm
- Two regions - rough and smooth



Structure of Cells (Cytoplasm)

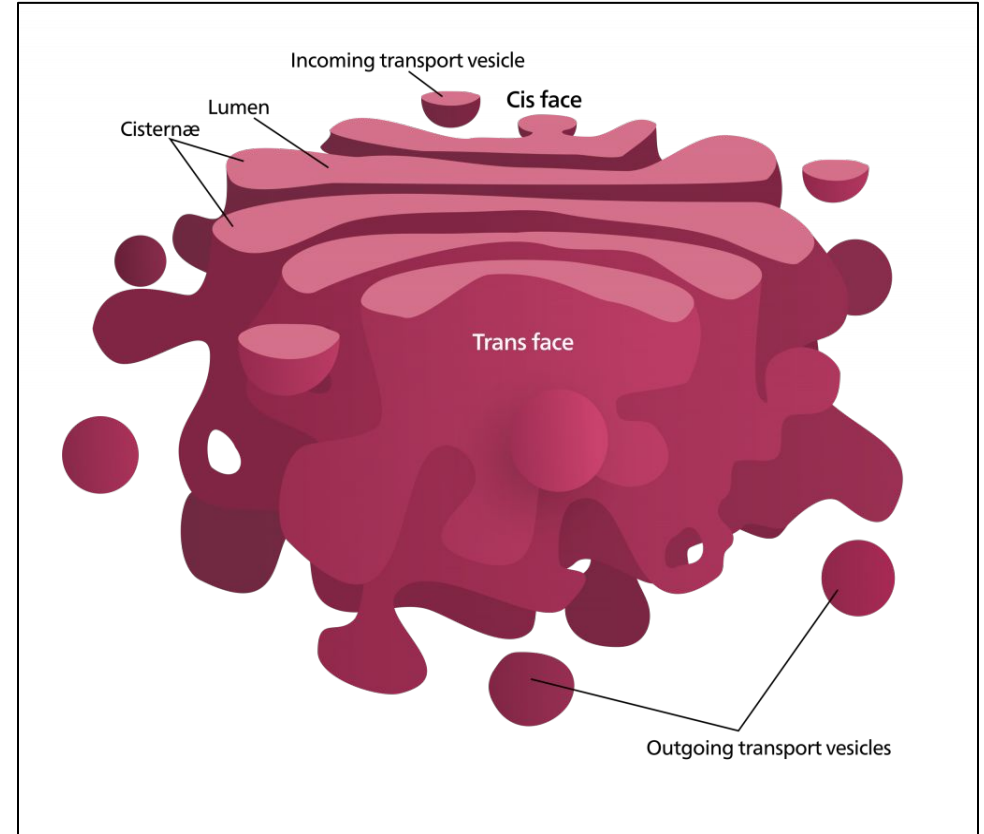
S.No.	Rough Endoplasmic Reticulum (RER)	Smooth Endoplasmic Reticulum (SER)
1	Has ribosomes attached to its surface.	Has no ribosomes attached to its surface.
2	Helps in synthesis of proteins and enzymes.	Helps in synthesis of glycogen, lipids
3	It is mainly formed of cisternae and few tubules.	It is formed mainly of vesicles and tubules.
4	RER is internal.	SER is peripheral.
5	It is connected with nuclear envelope.	It is connected with plasmalemma.
6	Enzymes for detoxification are absent.	Enzymes for detoxification are present.
7	Develops from nuclear envelope.	Develops from RER.



Structure of Cells (Cytoplasm)

Golgi Bodies

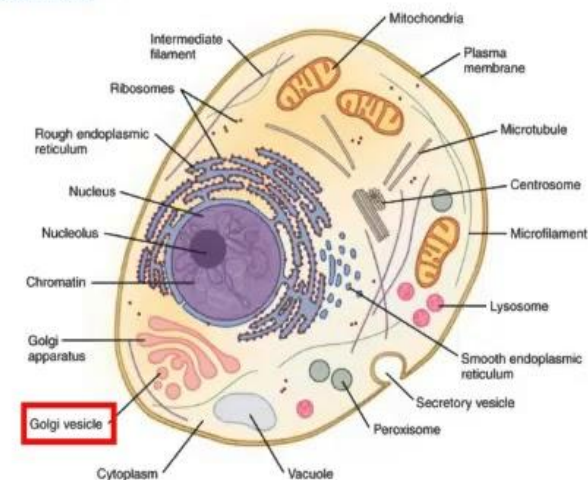
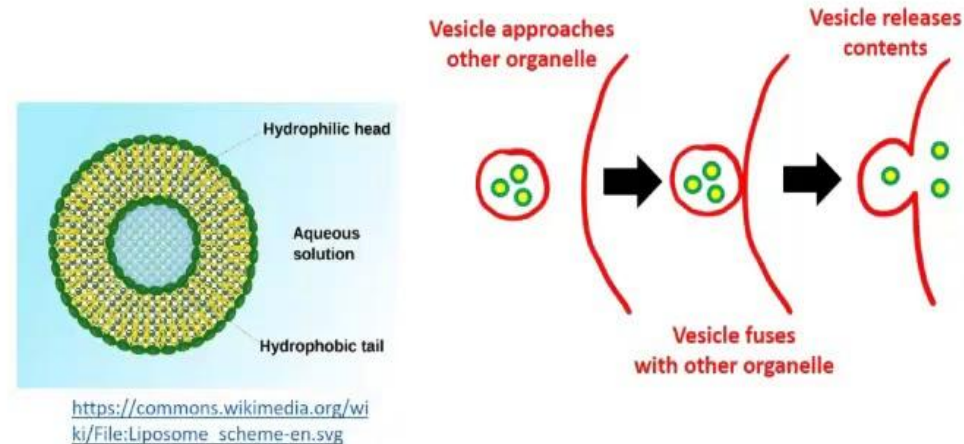
- Put finishing touches on proteins and lipids that arrive from ER
- Package finished material for shipment to final destinations
- Material arrives and leaves in vesicles



Structure of Cells (Cytoplasm)

Vesicles

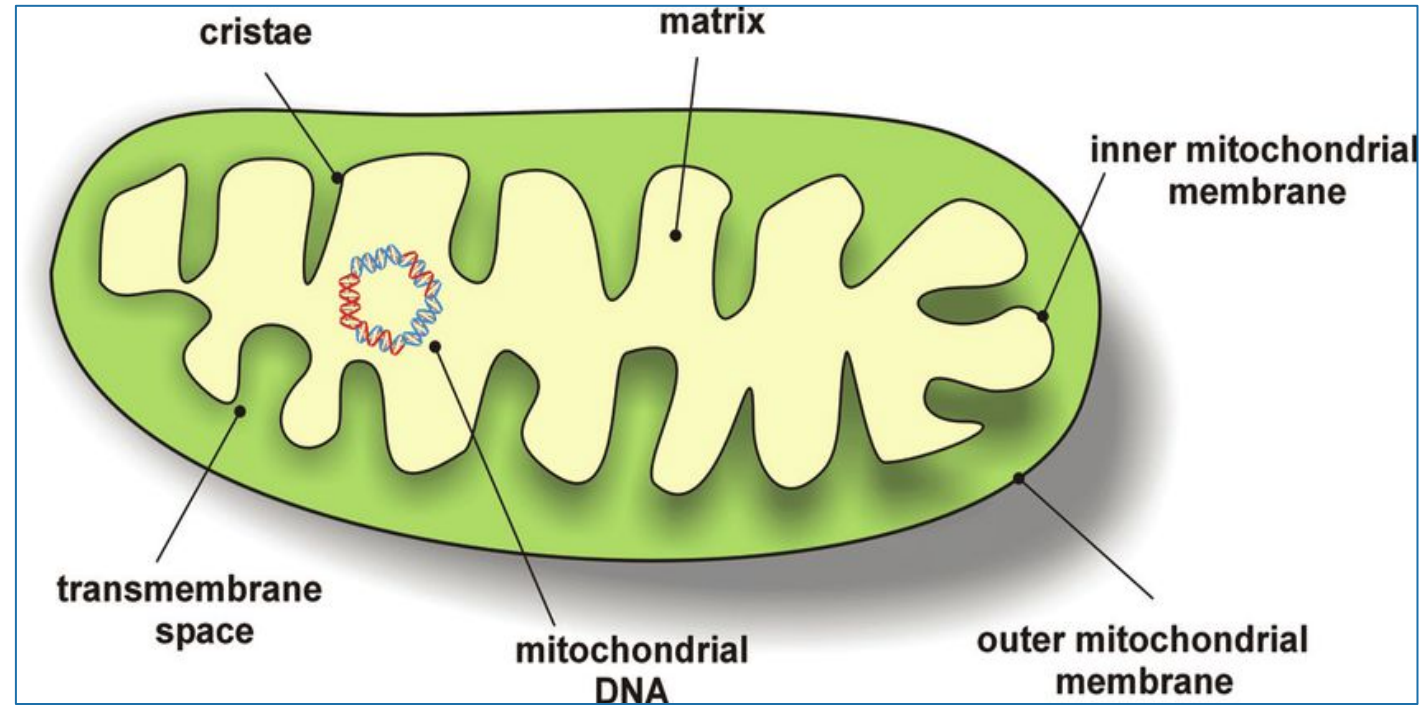
- Function: transport materials throughout cell
 - Like shipping boxes
- Structure: small spheres of membrane
 - Same material as RER, Golgi, plasma membrane, etc
 - Part of ENDOMEMBRANE system
 - Can fuse with or pinch off from any other membrane-bound organelle
- Found in ALL eukaryotic cells



Structure of Cells (Cytoplasm)

Mitochondria

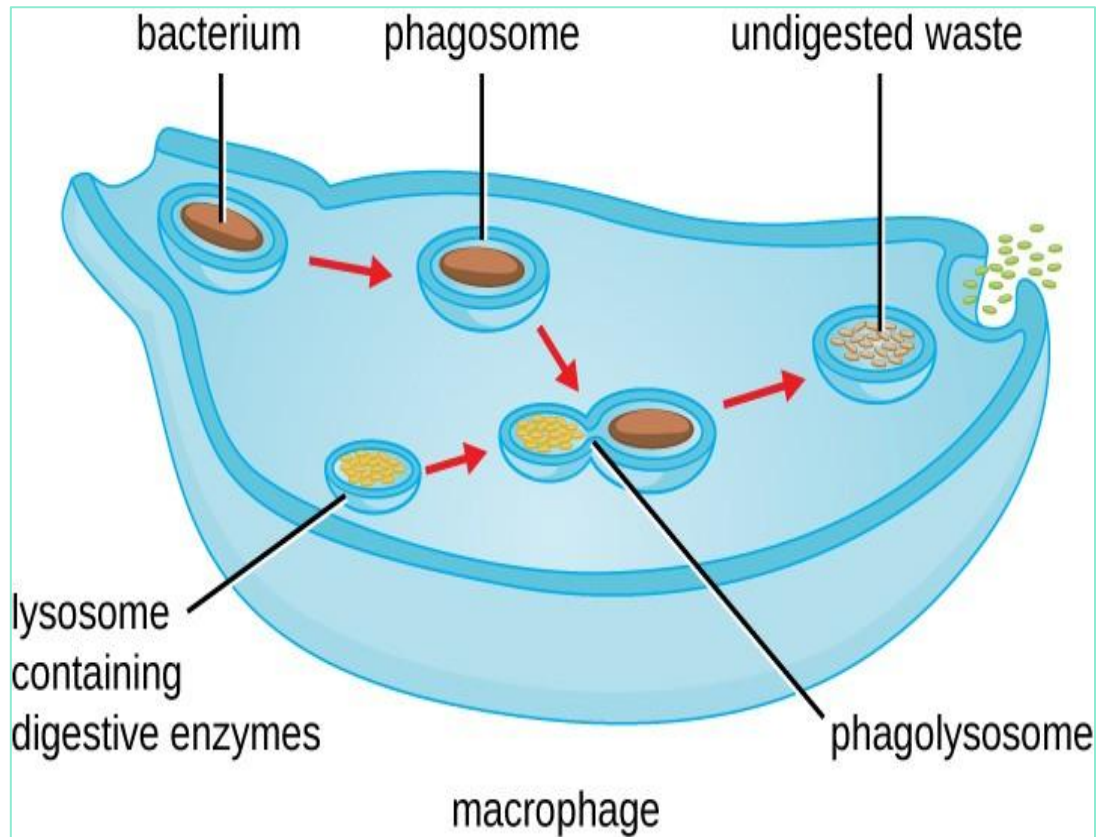
- **Double Membrane:** Mitochondria have a double membrane structure: an outer mitochondrial membrane and an inner mitochondrial membrane, which create two distinct compartments within the organelle.
- **Cristae:** The inner mitochondrial membrane contains numerous infoldings called cristae, which increase the surface area for various metabolic processes.
- **Matrix:** The innermost compartment, known as the matrix, contains enzymes, DNA, and ribosomes, allowing for the synthesis of some mitochondrial proteins.
- **Mitochondrial DNA (mtDNA):** Mitochondria contain their own genetic material in the form of a small circular DNA molecule, separate from the cell's nuclear DNA.



Mitochondria are often referred to as the "powerhouses" of the cell because they are responsible for generating the majority of the cell's adenosine triphosphate (ATP), which is the primary source of cellular energy.

Structure of Cells (Cytoplasm)

Lysosomes



Lysosomes have hydrolytic enzymes that destroy pathogens and worn-out cells, so known as scavengers of the cells.

If something bursts, the lysosomes release digestive enzymes with digests all the cells. This leads to the death of cells. Hence, Lysosomes are referred to as “suicide bags of cell”.

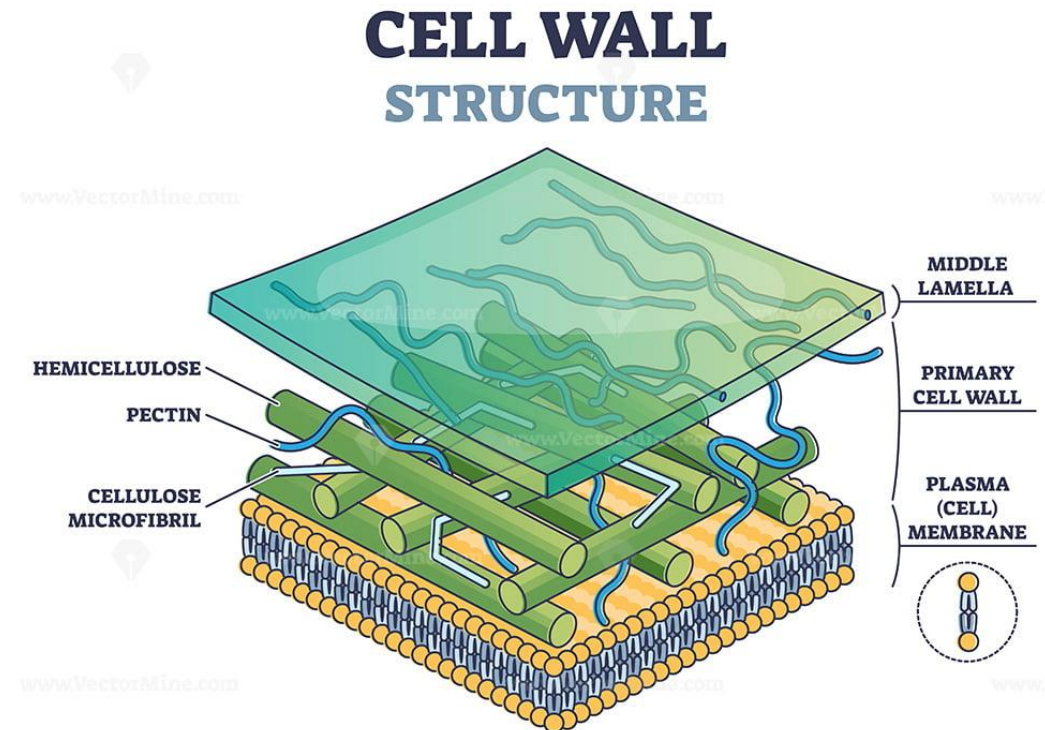
Structure of Cells (Cytoplasm)

Cell wall

The cell wall is an integral component of the plant cell and it performs many essential functions.

Following are some of the major cell wall functions observed:

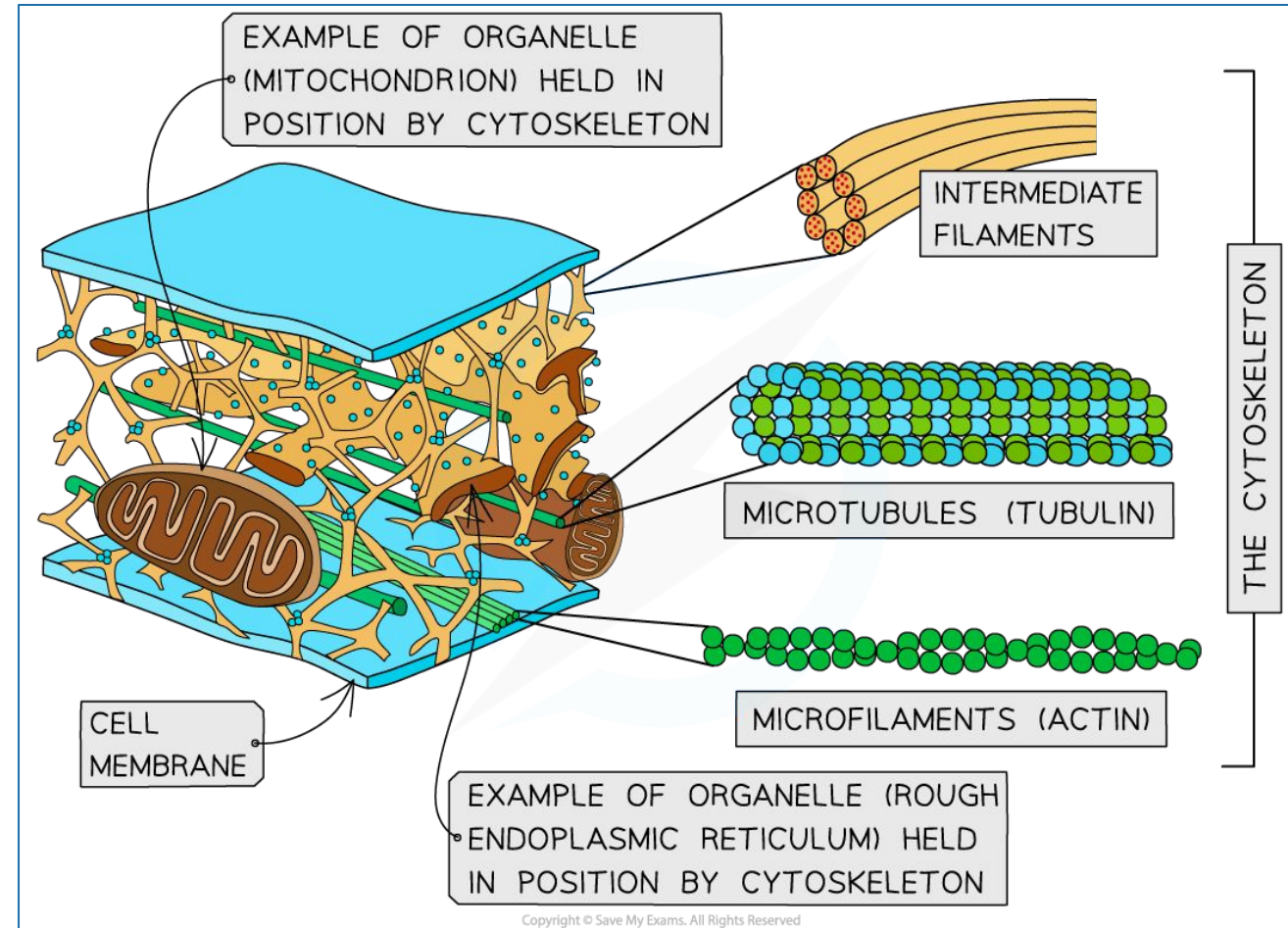
- The plant cell wall provides definite shape, strength, and rigidity
- It also provides protection against mechanical stress and physical shocks
- It helps to control cell expansion due to the intake of water
- It helps in preventing water loss from the cell
- It is responsible for transporting substances between and across the cell
- It acts as a barrier between the interior cellular components and the external environment



Structure of Cells (Cytoplasm)

Cytoskeleton

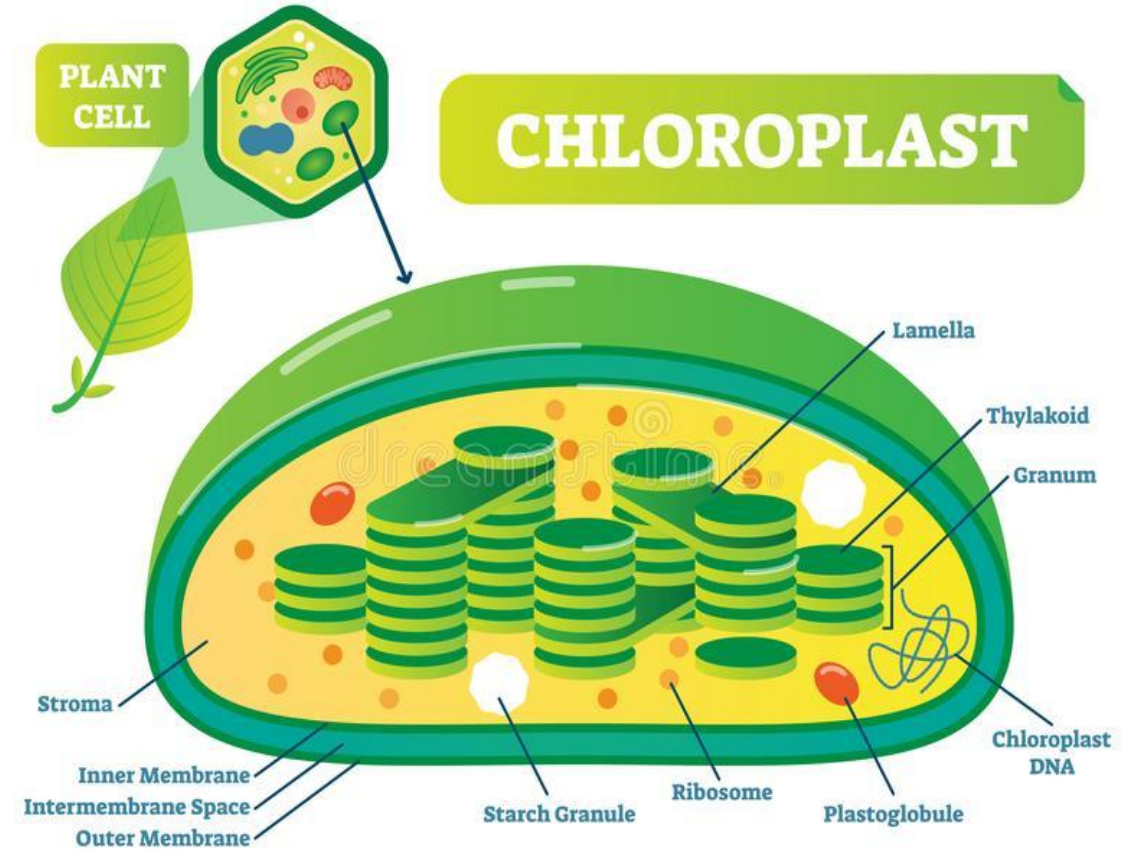
- Present in all eukaryotic cells
- Basis for cell shape and internal organization
- Allows organelle movement within cells and, in some cases, cell motility
 - Microtubules
 - Microfilaments
 - Intermediate Filaments



Structure of Cells

Chloroplast

- Chloroplast is an organelle that contains the photosynthetic pigment chlorophyll that captures sunlight and converts it into useful energy, thereby, releasing oxygen from water.
- These are found in mesophyll cells located in the leaves of the plants
- Chloroplast has its own extra-nuclear DNA and therefore are semiautonomous, like mitochondria. They also produce proteins and lipids required for the production of chloroplast membrane.



Structure of Cells

Chloroplast

Membrane Envelope

It comprises inner and outer lipid bilayer membranes. The inner membrane separates the stroma from the intermembrane space.

Intermembrane Space

The space between inner and outer membranes.

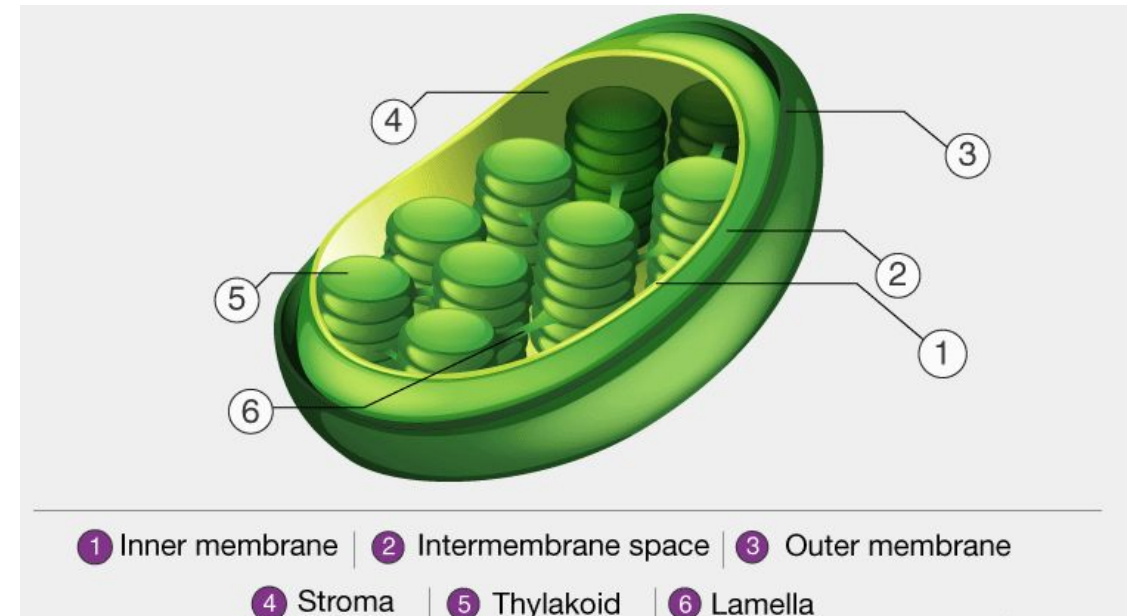
Thylakoid System (Lamellae)

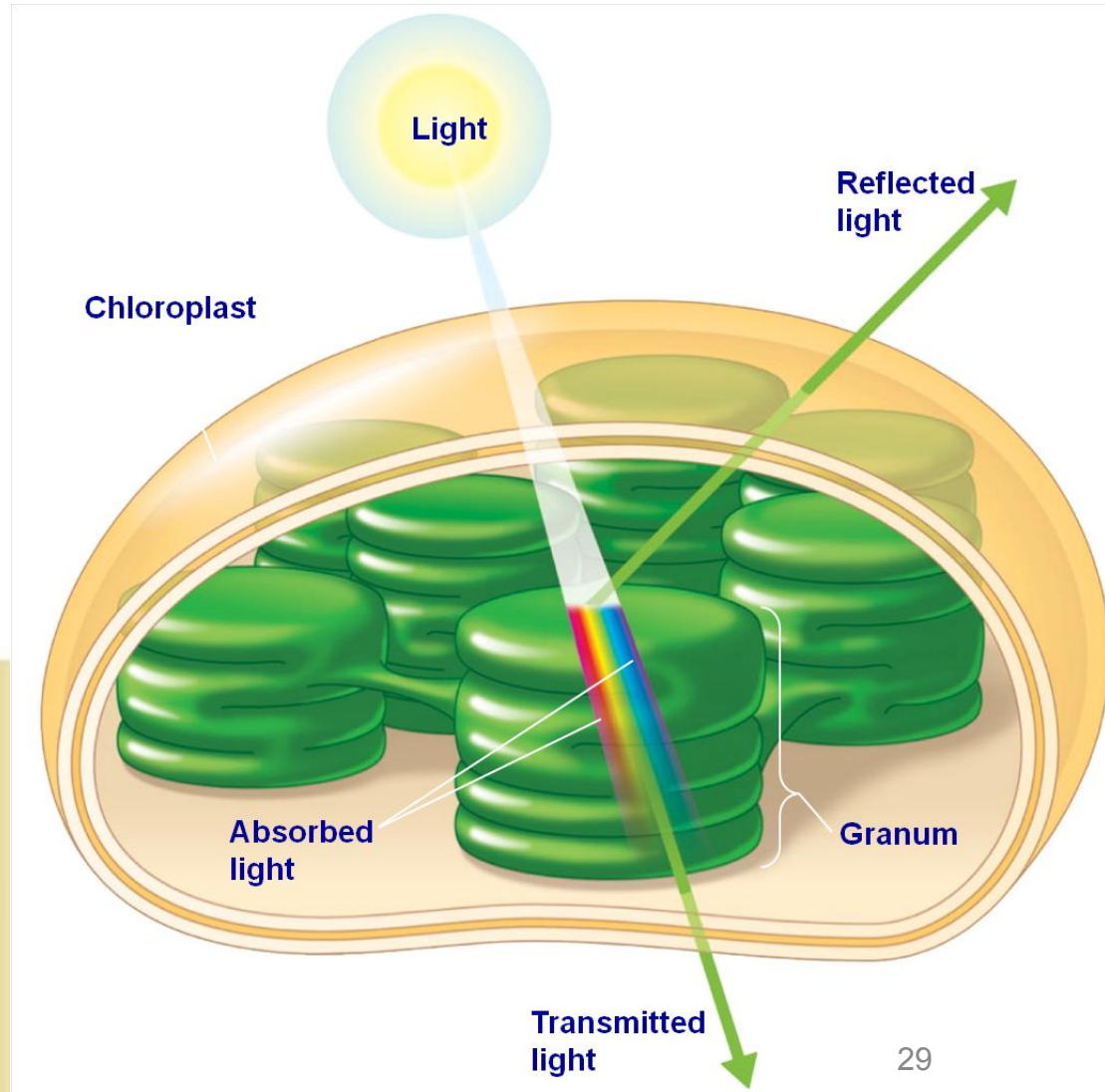
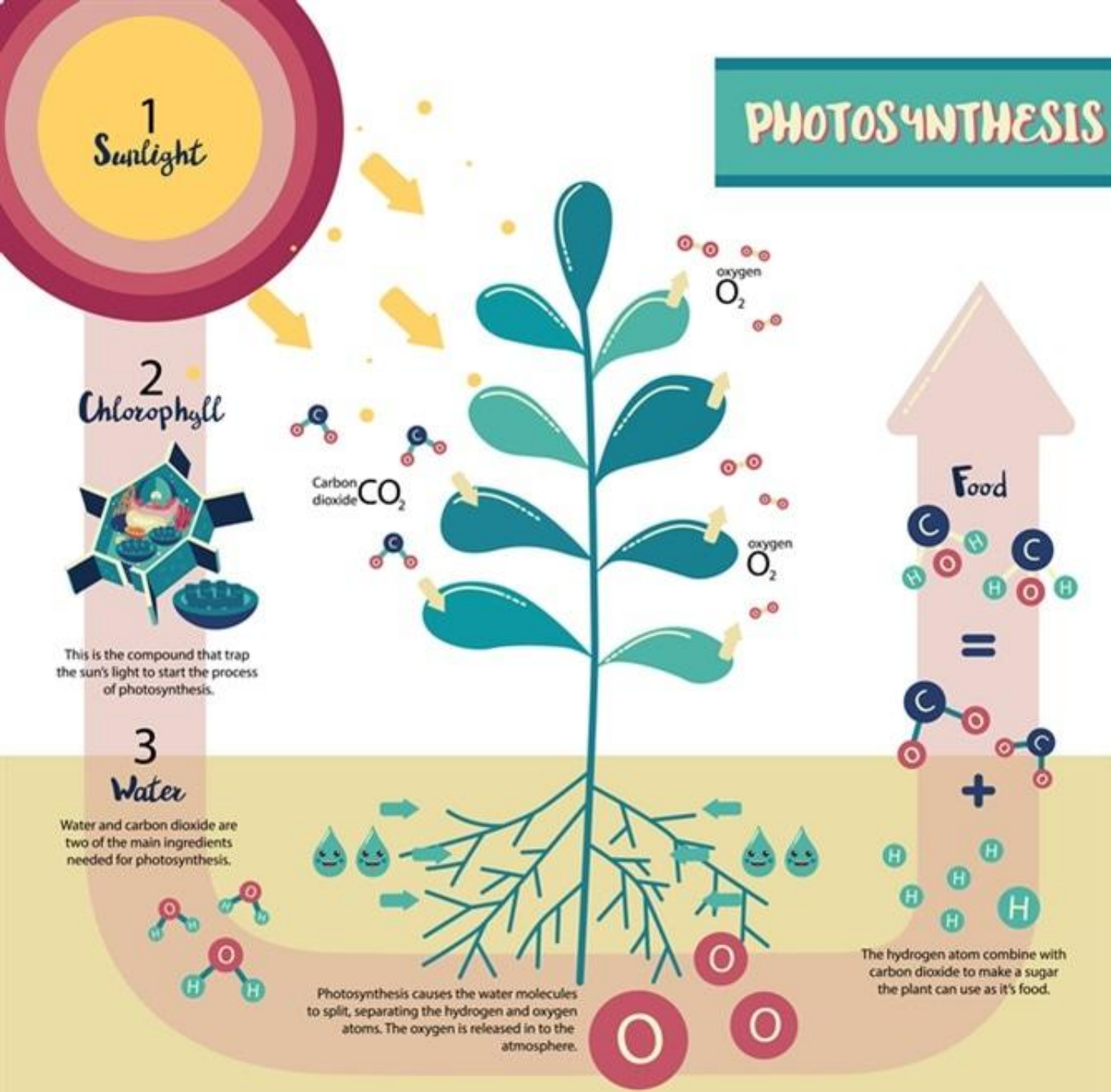
The system is suspended in the stroma. It is a collection of membranous sacs called thylakoids or lamellae. The green coloured pigments called chlorophyll are found in the thylakoid membranes.

Stroma: It is a colourless, alkaline, aqueous, protein-rich fluid present within the inner membrane of the chloroplast present surrounding the grana.

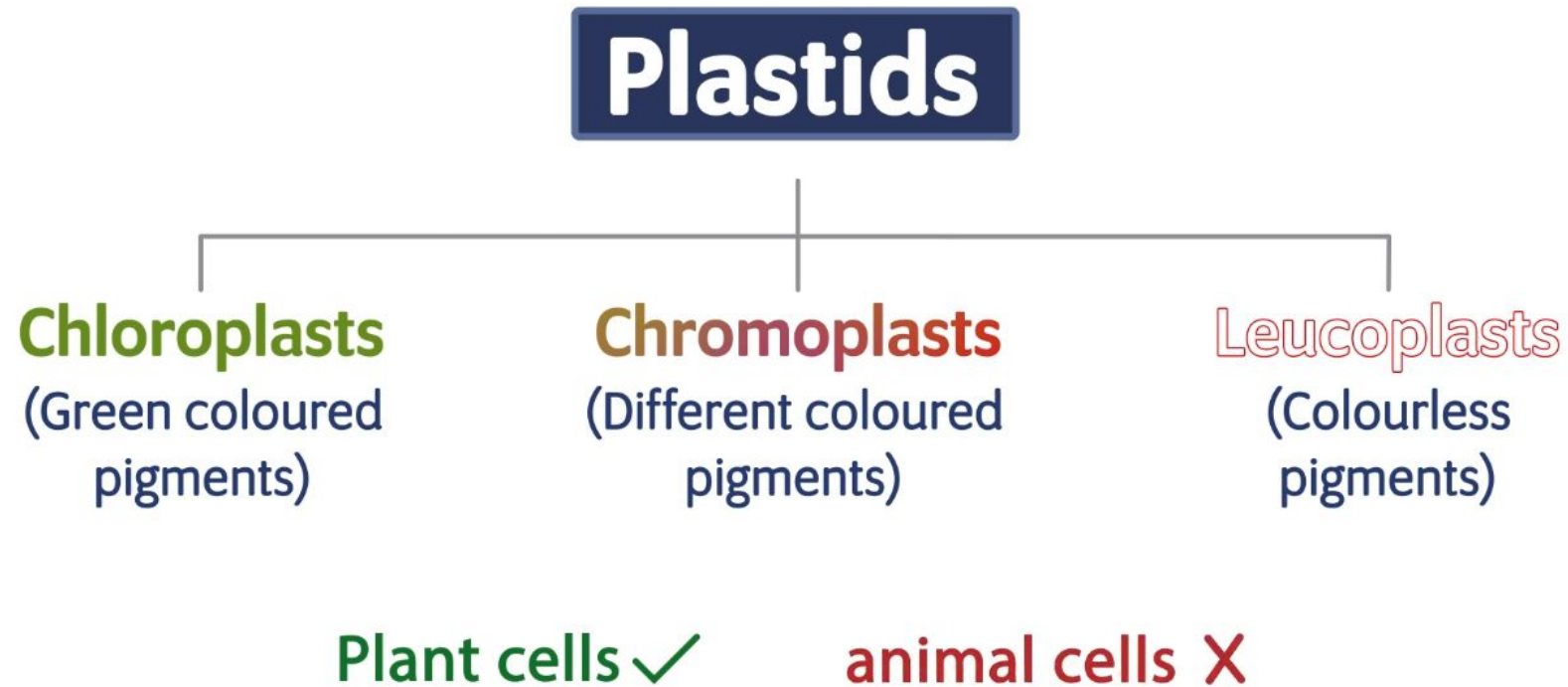
Grana: Stack of lamellae in plastids is known as grana. These are the sites of conversion of light energy into chemical energy.

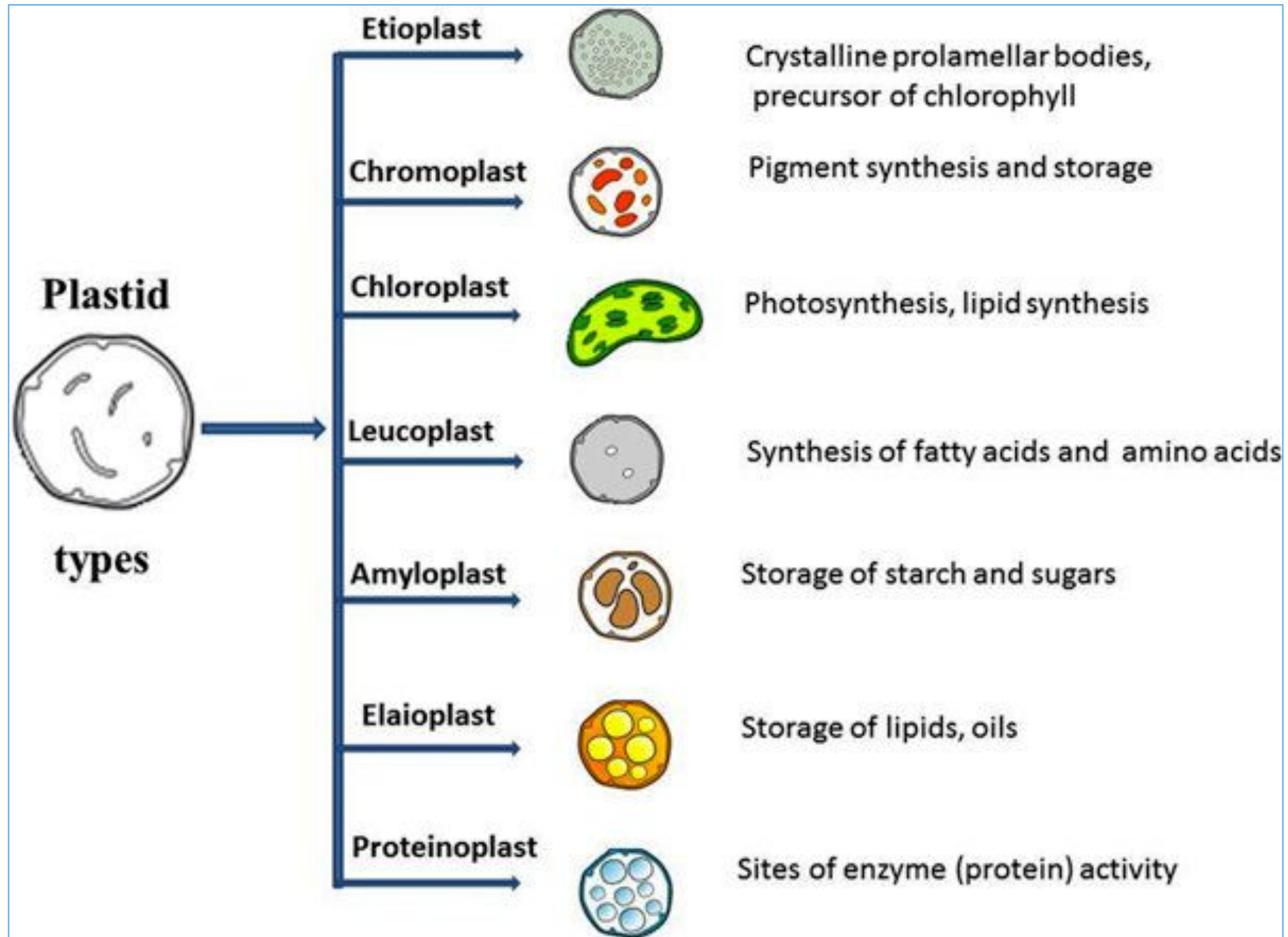
Chlorophyll: It is a green photosynthetic pigment that helps in the process of photosynthesis.





Structure of Cells





Function of cell organelles:

Organelle:	Function:
Nucleus	Contains DNA of the cell. Brain of the cell.
Nucleolus	Inner part of the nucleus that begins the assembly of ribosomes.
Chloroplast	Captures energy from light for photosynthesis. Solar panels of the cell.
Golgi Body/Apparatus	Modify, sort, and ship proteins and lipids. Post office of the cell.
Mitochondria	Makes ATP (energy). Powerhouse of the cell.
Ribosome	Creates polypeptide chains and proteins. Factory of the cell.
Smooth Endoplasmic Reticulum	Creates lipids for the cellular membrane.
Rough Endoplasmic Reticulum	Proteins are assembled and transported into/out of the cell.
Lysosome	Uses enzymes to break down old organelles and macromolecules. Garbage disposal of the cell.
Vacuole	Stores water, salts, and carbohydrates. Kitchen of the cell.
Cytoskeleton	Helps the cell maintain its shape; also involved in movement.
Cytoplasm	Material inside the cell membrane but outside of the nucleus.
Centriole	Help organize cell division.
Cell Wall	Gives plant cells extra stability and structure.
Cell Membrane	Controls what comes in and goes out of the cell.



THANK YOU