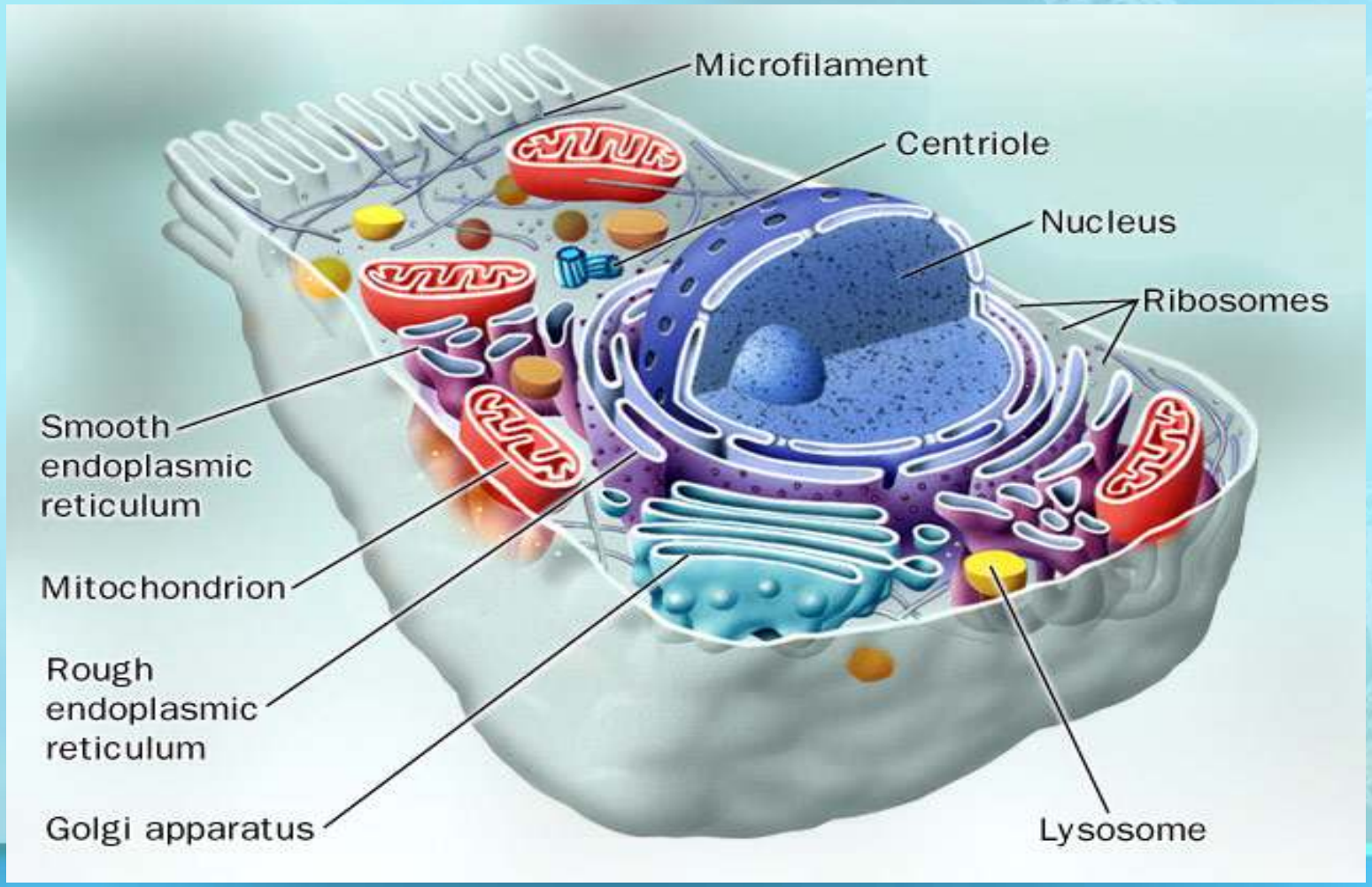
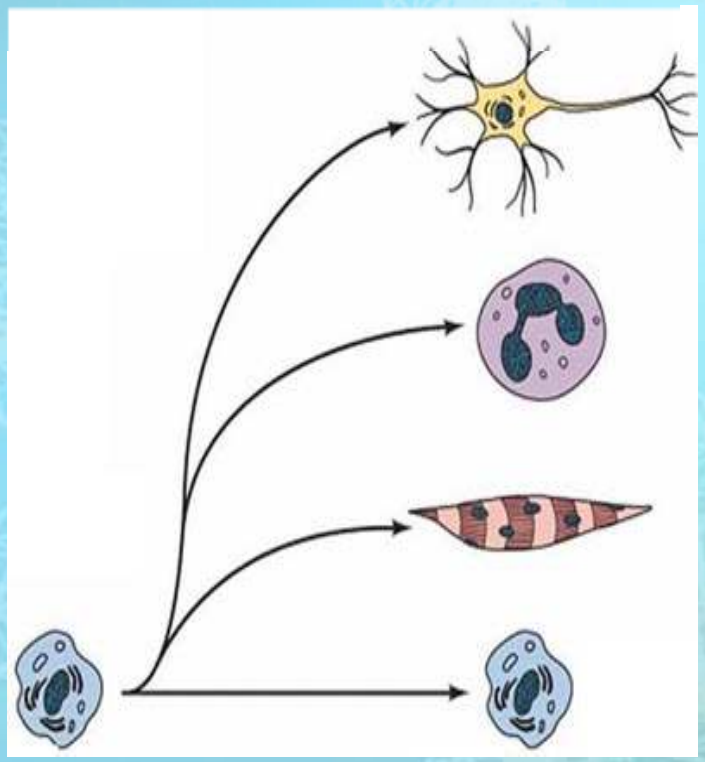
Basic Structure of a Cell



Animal cell

History of Cells & the Cell Theory

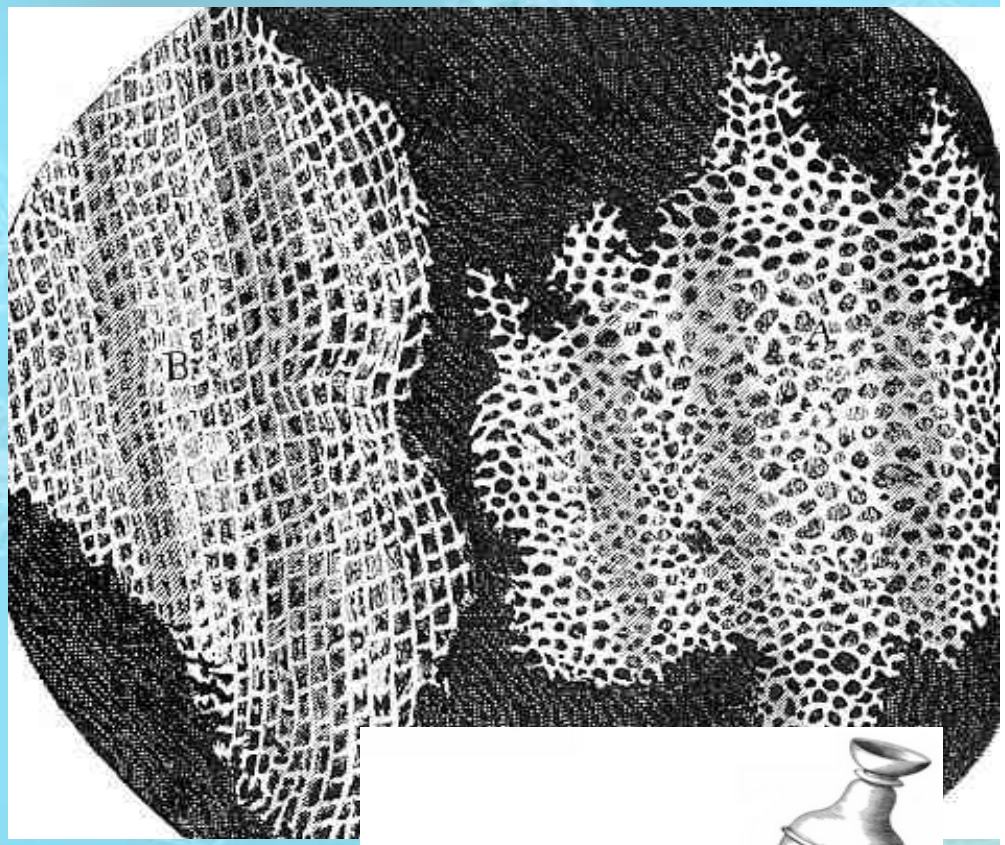
Virchow

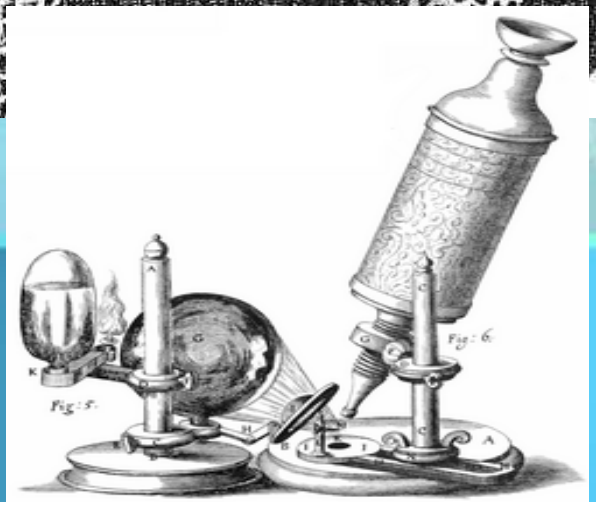


Cell Specialization

First to View Cells

- In 1665, Robert Hooke used a microscope to examine a thin slice of cork (dead plant cells)
- What he saw looked like small boxes



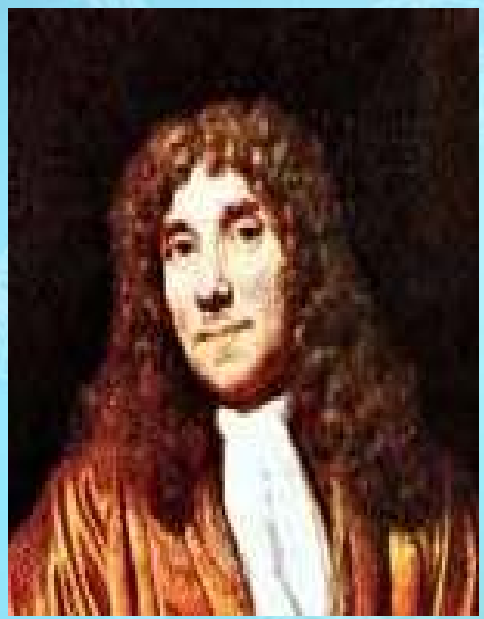


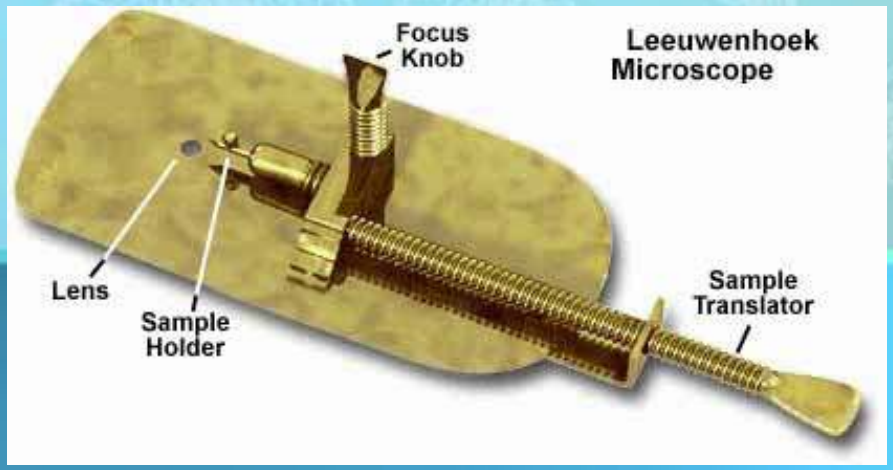
First to View Cells

- Hooke is responsible for naming cells
- Hooke called them "CELLS" because they looked like the small rooms that monks lived in called Cells

Anton van Leeuwenhoek

- In 1673, Leeuwenhoek (a Dutch microscope maker), was first to view organism (living things)
- Leeuwenhoek used a simple, handheld microscope to view pond water & scrapings from his teeth





Microscope

- Magnification:
  - Refers to the microscope's power to **increase an object's apparent size**
- Resolution:
  - Refers to the microscope's power to **show detail clearly**

Beginning of the Cell Theory

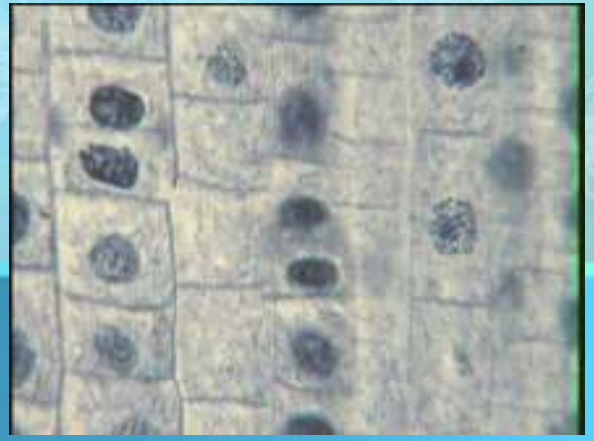
- In 1838, a German botanist named Matthias Schleiden concluded that all plants were made of cells
- Schleiden is a cofounder of the cell theory

Beginning of the Cell Theory

- In 1839, a German zoologist named Theodore Schwann concluded that all animals were made of cells
- Schwann also cofounded the cell theory

Beginning of the Cell Theory

- In 1855, a German medical doctor named Rudolph Virchow observed, under the microscope, cells dividing
- He reasoned that all cells come from other pre-existing cells by cell division



CELL THEORY

- All living things are made of cells
- Cells are the basic unit of structure and function in an organism (basic unit of life)
- Cells come from the reproduction of existing cells (cell division)

CELL

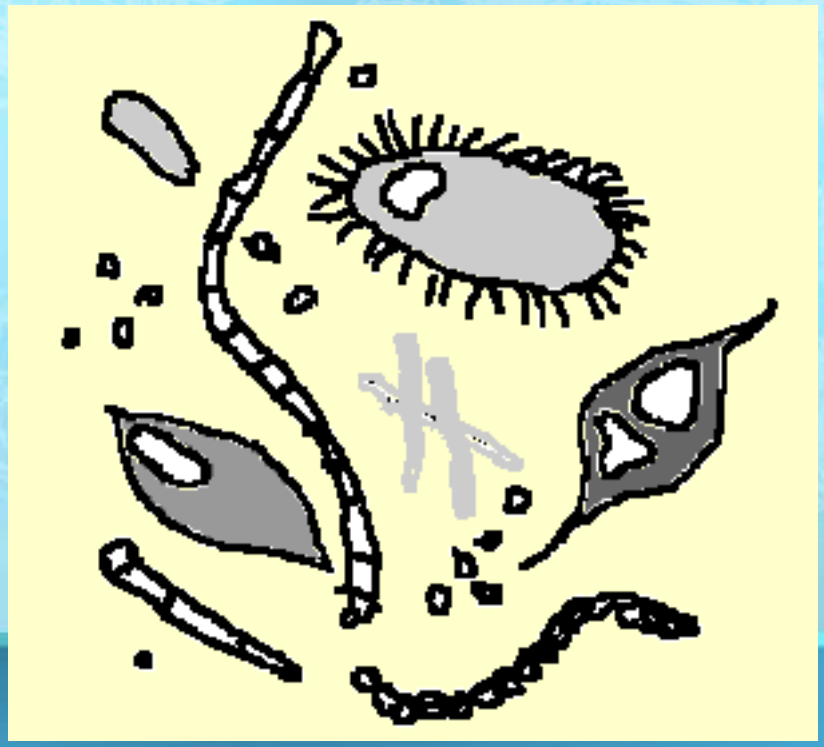
- A unit of protoplasm bounded by a plasma membrane and possessing a nucleus.

CELL

- Protoplasm is the life giving substance and includes the cytoplasm and nucleus.

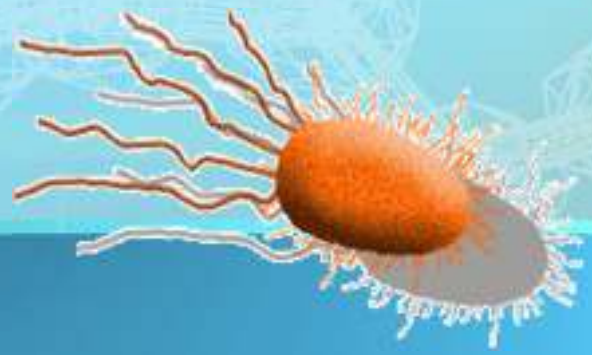
- Cytoplasm contains organelles (ribosome, mitochondria, golgi bodies, plastids, lysosomes, endoplasmic reticulum, vacuoles,etc.)

Simple or Complex Cells



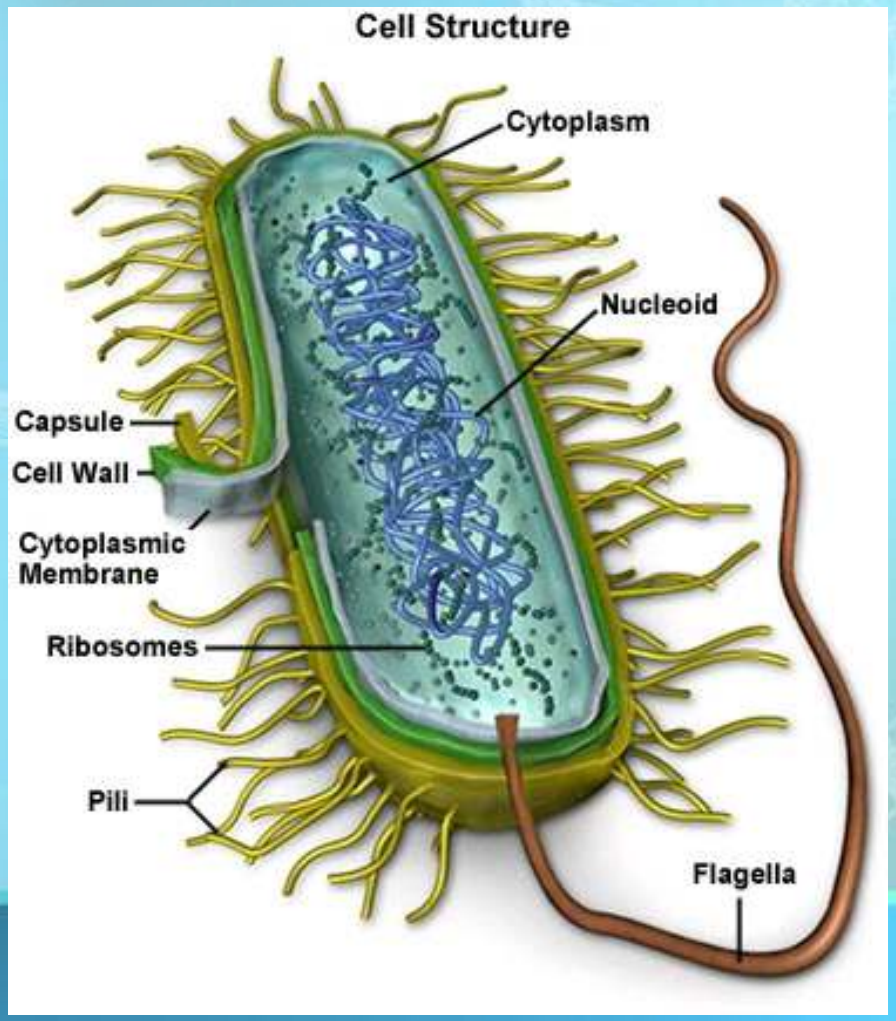
Prokaryotes – The first Cells

- Cells that lack a nucleus or membrane-bound organelles
- Includes bacteria
- Simplest type of cell
- Single, circular chromosome



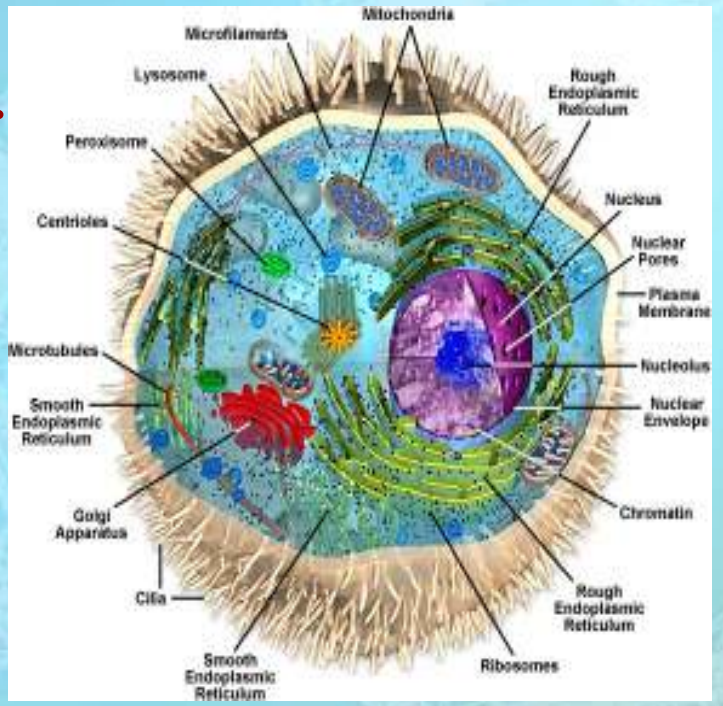
Prokaryotes

- Nucleoid region (center) contains the DNA
- Surrounded by cell membrane & cell wall (peptidoglycan)
- Contain ribosomes (no membrane) in their cytoplasm to make proteins



Eukaryotes

- Cells that HAVE a nucleus and membrane-bound organelles
- Includes protists, fungi, plants, and animals
- More complex type of cells



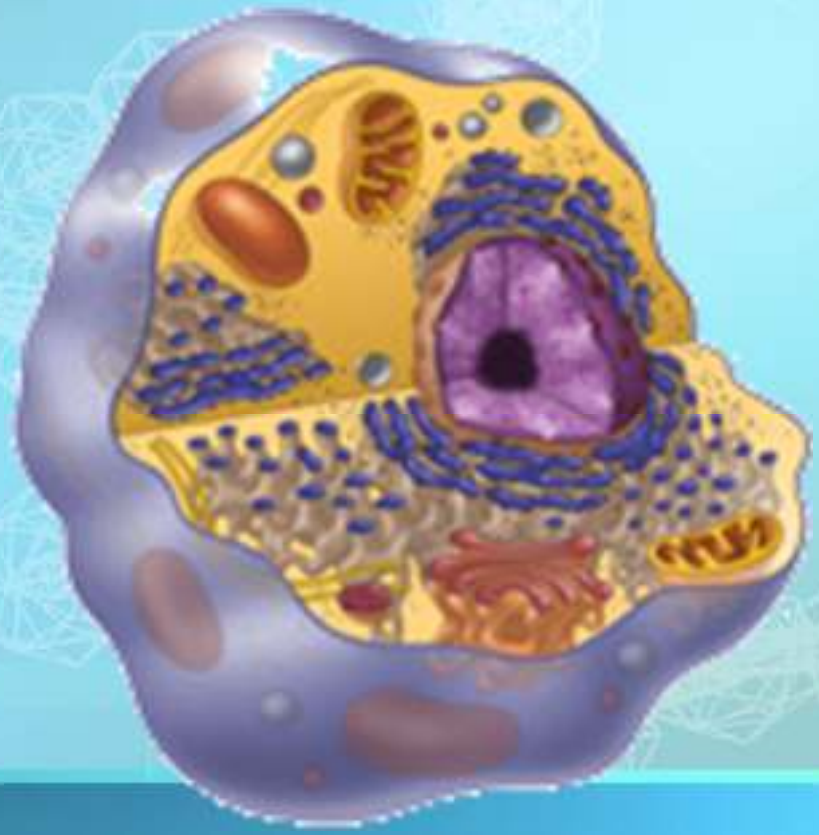
Prokaryotic cell vs Eukaryotic cell

Prokaryotic cell	Eukaryotic cell
Nucleus is not distinct (nucleoid)	Nucleus is distinct
Nuclear membrane absent	Nuclear membrane present
1-10 µm in size	10-50 µm in size
DNA is circular	DNA is linear
DNA lies free in the cytoplasm	DNA is contained in the nucleus
Organelles present are single-membrane bounded e.g. mesosome	Organelles are double-membrane bounded (chloroplast, mitochondria, nucleus), single-membrane bounded (golgi apparatus, endoplasmic reticulum, lysosome, vacuole)
Ribosome – 70 S	Ribosome – 80 S
No compartments	Distinct compartments in cell present i.e. the cytoplasm and the nucleus
Mainly unicellular	Majorly multicellular except in Protista
Cell division is binary fission, no spindle formed	Mitosis, meiosis or both, spindle formed

Eukaryotic Cell

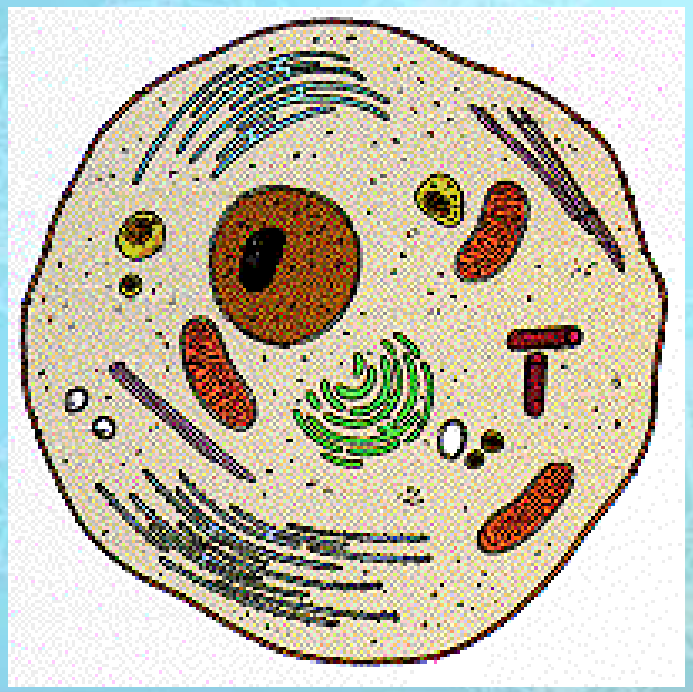
Contain 3 basic cell structures:

- Nucleus
- Cell Membrane
- Cytoplasm with organelles



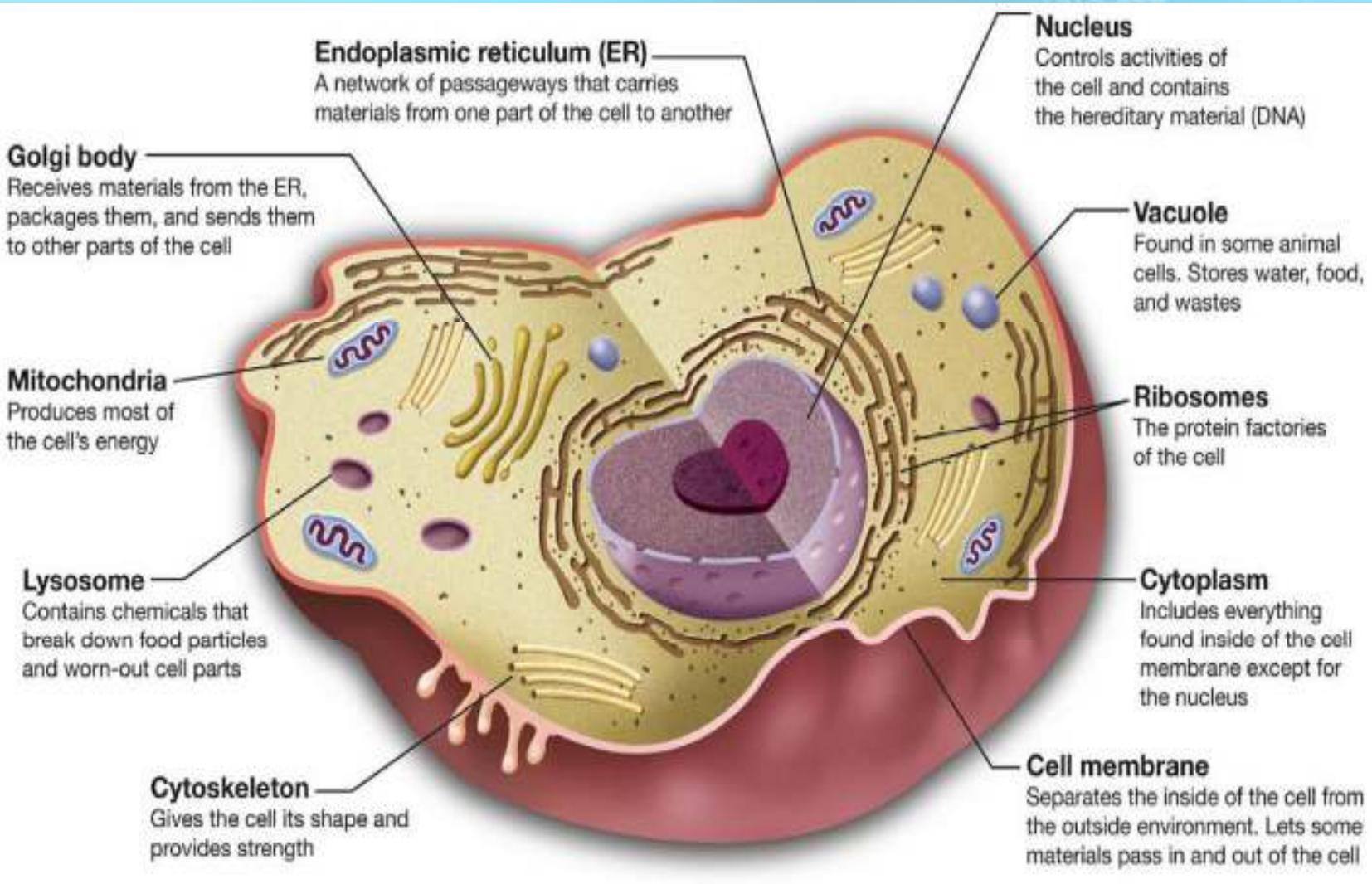
Two Main Types of Eukaryotic Cells

Plant Cell

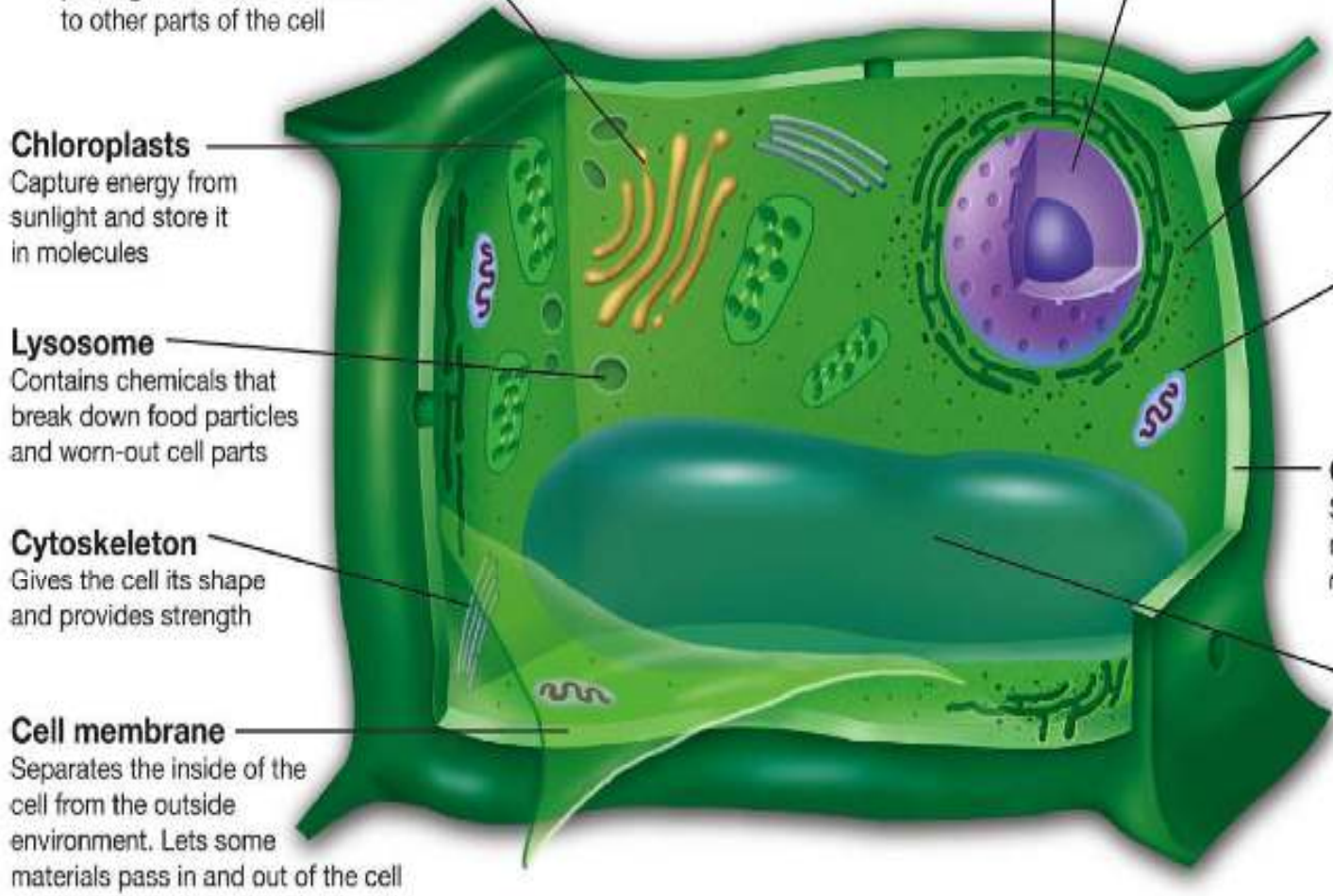


Animal Cell

Animal cell


Endoplasmic reticulum (ER)
A network of passageways that carries materials from one part of the cell to another
Nucleus
Controls activities of the cell and contains the hereditary material (DNA)
Golgi body
Receives materials from the ER, packages them, and sends them to other parts of the cell
Vacuole
Found in some animal cells. Stores water, food, and wastes
Mitochondria
Produces most of the cell's energy
Ribosomes
The protein factories of the cell
Lysosome
Contains chemicals that break down food particles and worn-out cell parts
Cytoplasm
Includes everything found inside of the cell membrane except for the nucleus
Cytoskeleton
Gives the cell its shape and provides strength
Cell membrane
Separates the inside of the cell from the outside environment. Lets some materials pass in and out of the cell

Plant cell



Golgi body
Receives materials from the ER, packages them, and sends them to other parts of the cell

Endoplasmic reticulum (ER)
A network of passageways that carries materials from one part of the cell to another

Nucleus
Controls activities of the cell and contains the hereditary material (DNA)

Chloroplasts
Capture energy from sunlight and store it in molecules

Ribosomes
The protein factories of the cell

Lysosome
Contains chemicals that break down food particles and worn-out cell parts

Mitochondria
Produces most of the cell's energy

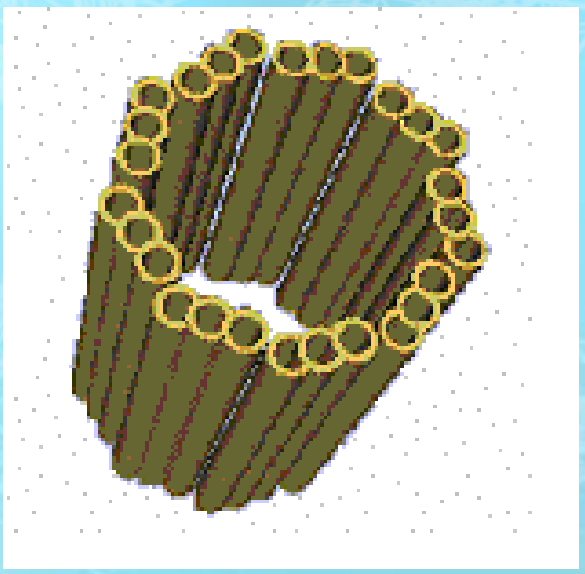
Cytoskeleton
Gives the cell its shape and provides strength

Cell wall
Surrounds the cell membrane and provides rigid structure.

Central Vacuole
Stores water, food, and wastes. Also provides support for the cell when full

Cell membrane
Separates the inside of the cell from the outside environment. Lets some materials pass in and out of the cell

Organelles

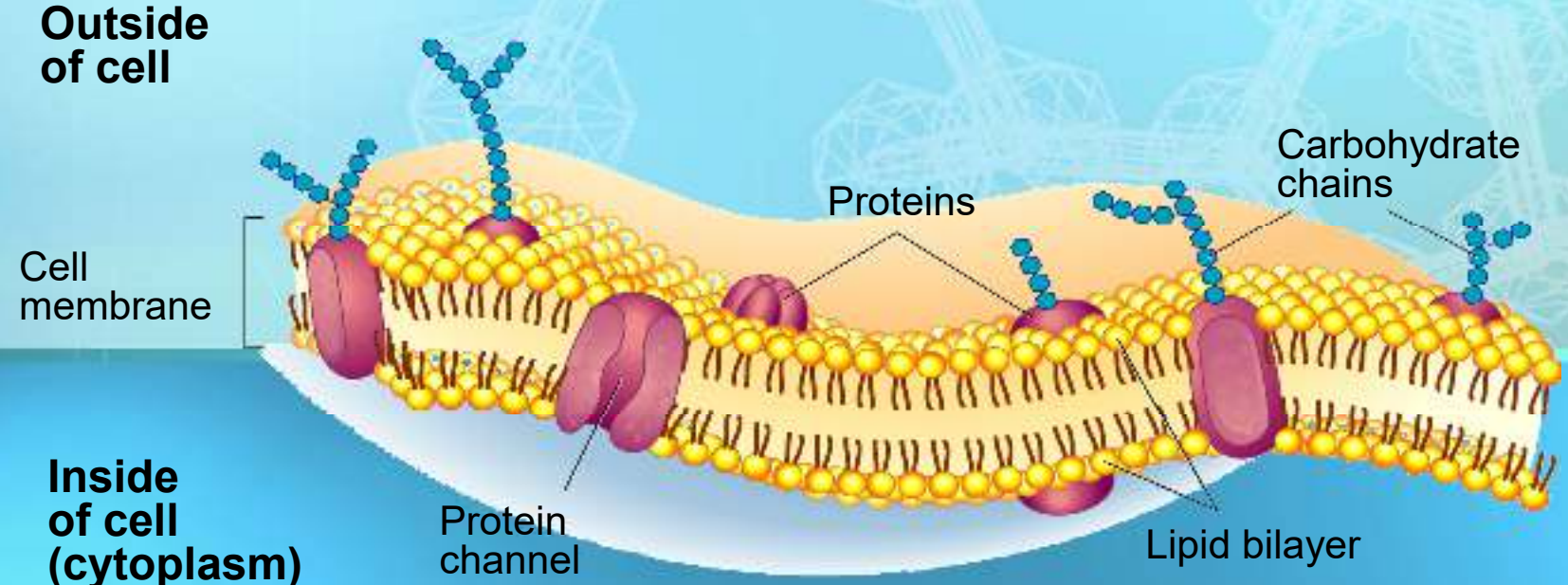


Organelles

- Very small (Microscopic)
- Perform various functions for a cell
- Found in the cytoplasm
- May or may not be membrane-bound

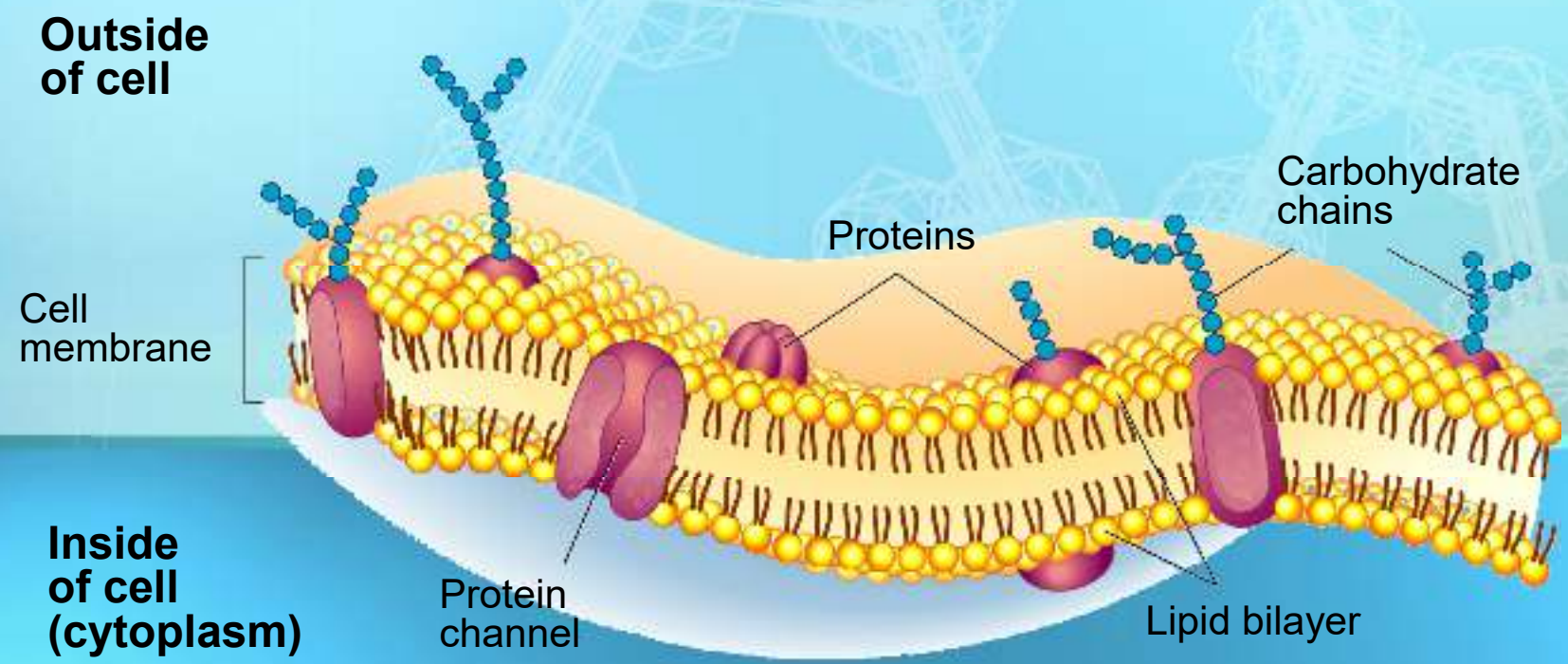
Cell or Plasma Membrane

- Composed of double layer of phospholipids and proteins
- Surrounds outside of ALL cells enclosing the cell contents
- Controls what enters or leaves the cell
- Living layer (selectively permeable)



Cell or Plasma Membrane

- Provides cell shape (RBC, nerve cells, bone cells etc)
- Allows transport of certain substances into and out of the cell.

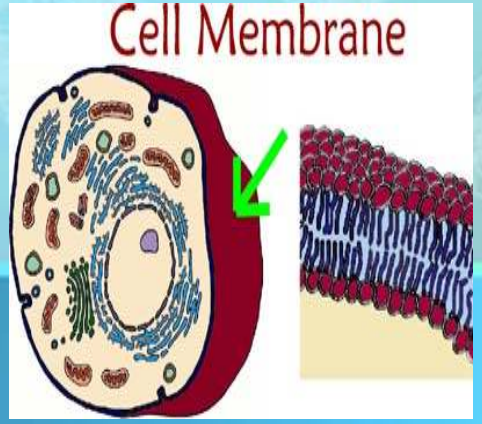


Cell or Plasma Membrane

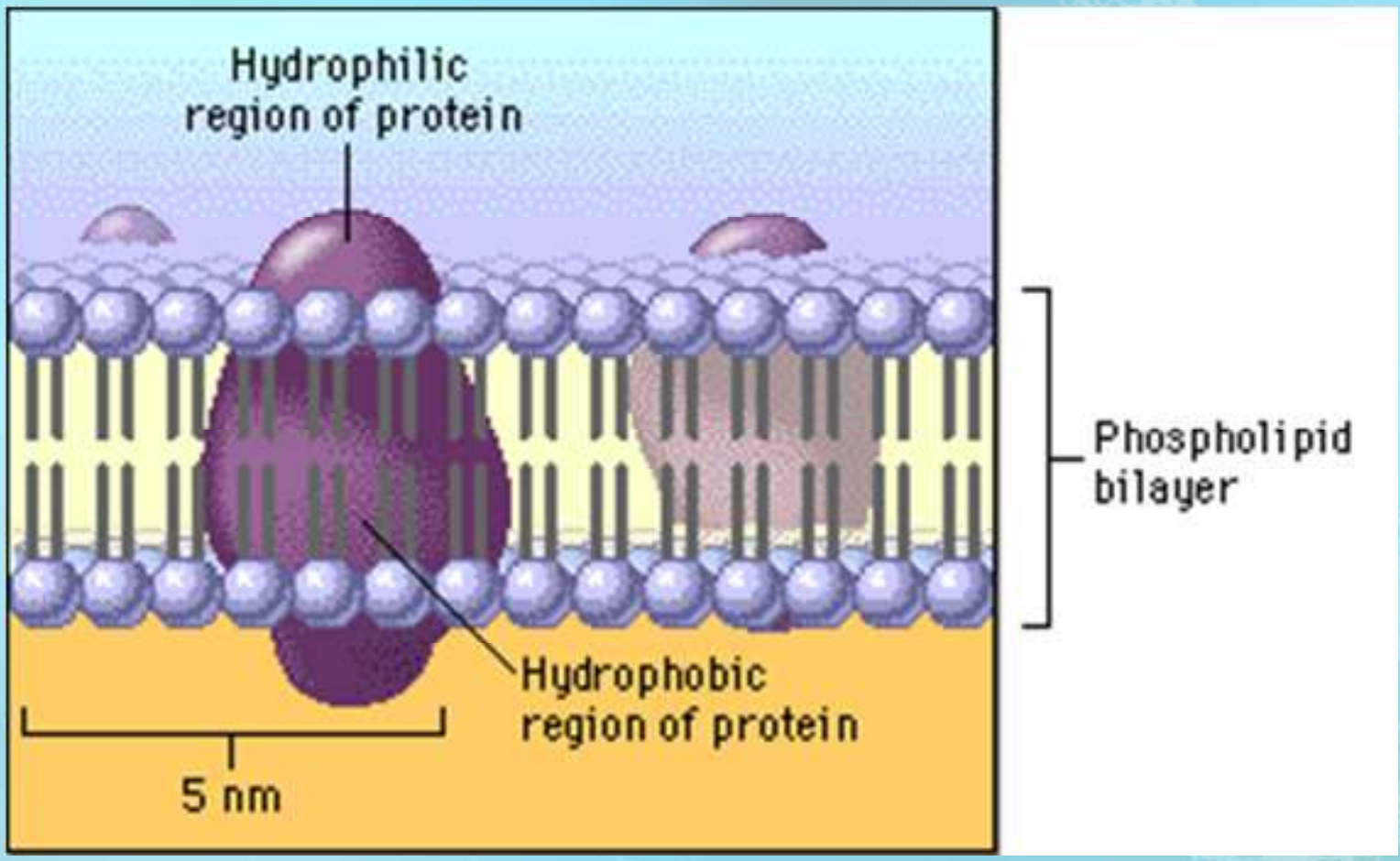
- **Diffusion:**
  - Movement of H_2O molecules from higher concentration to lower concentration
- **Osmosis:**
  - Diffusion through a semi-permeable membrane
- **Active transport:**
  - Movement of certain molecules from lower concentration to higher concentration. Energy is required for active transport

Phospholipids

- **Heads** contain glycerol & phosphate and are **hydrophilic** (attract water)
- **Tails** are made of **fatty acids** and are **hydrophobic** (repel water)
- Make up a **bilayer** where tails point inward toward each other
- Can **move laterally** to **allow small molecules** (O_2, CO_2, & H_2O to enter)



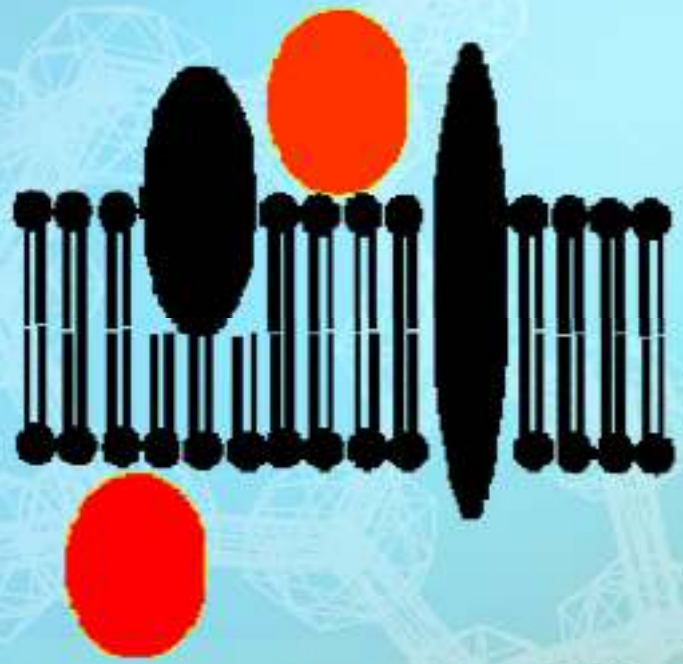
The Cell Membrane is Fluid



Molecules in cell membranes are constantly moving and changing

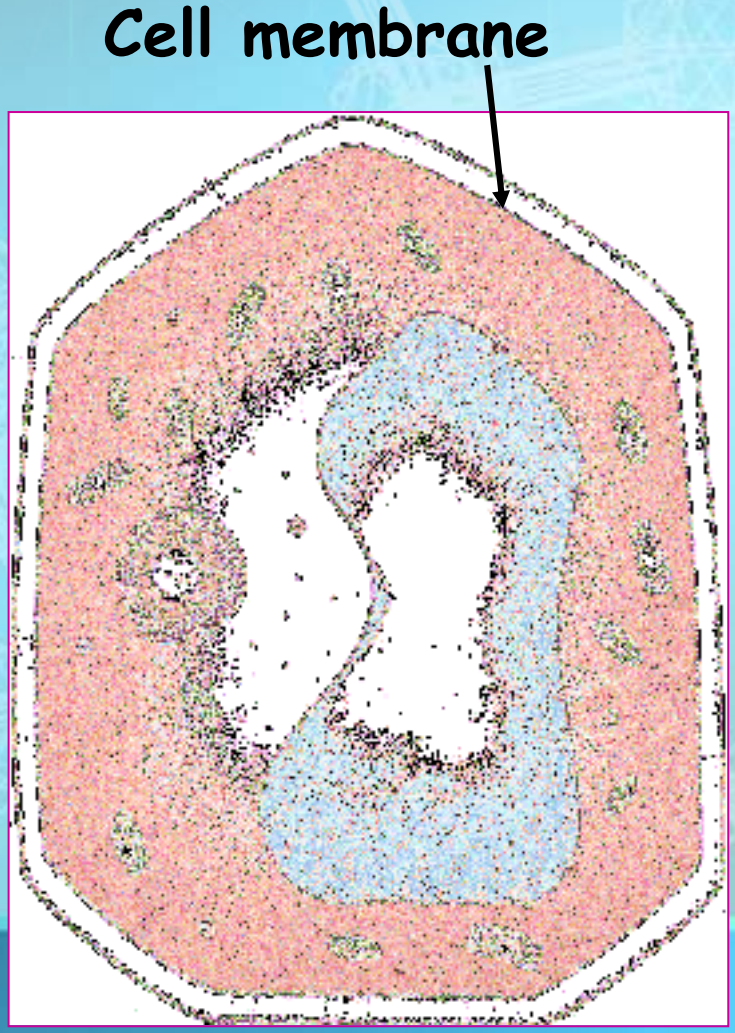
Cell Membrane Proteins

- Proteins help move large molecules or aid in cell recognition
- Peripheral proteins are attached on the surface (inner or outer)
- Integral proteins are embedded completely through the membrane



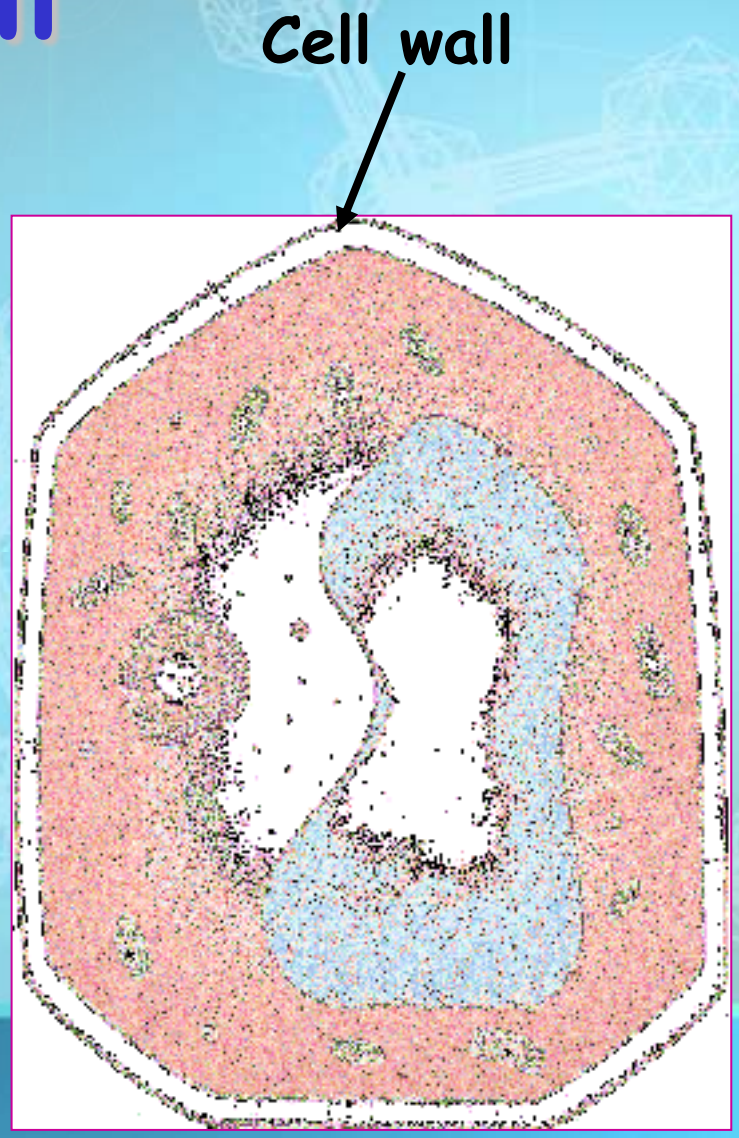
Cell Membrane in Plants

- Lies immediately against the cell wall in plant cells
- Pushes out against the cell wall to maintain cell shape



Cell Wall

- Found outside of the cell membrane
- Nonliving layer
- Composed of cellulose, other chemical materials like pectin & lignin
- Supports and protects cell
- Found in plants, fungi, & bacteria



Cell Wall

Functions;

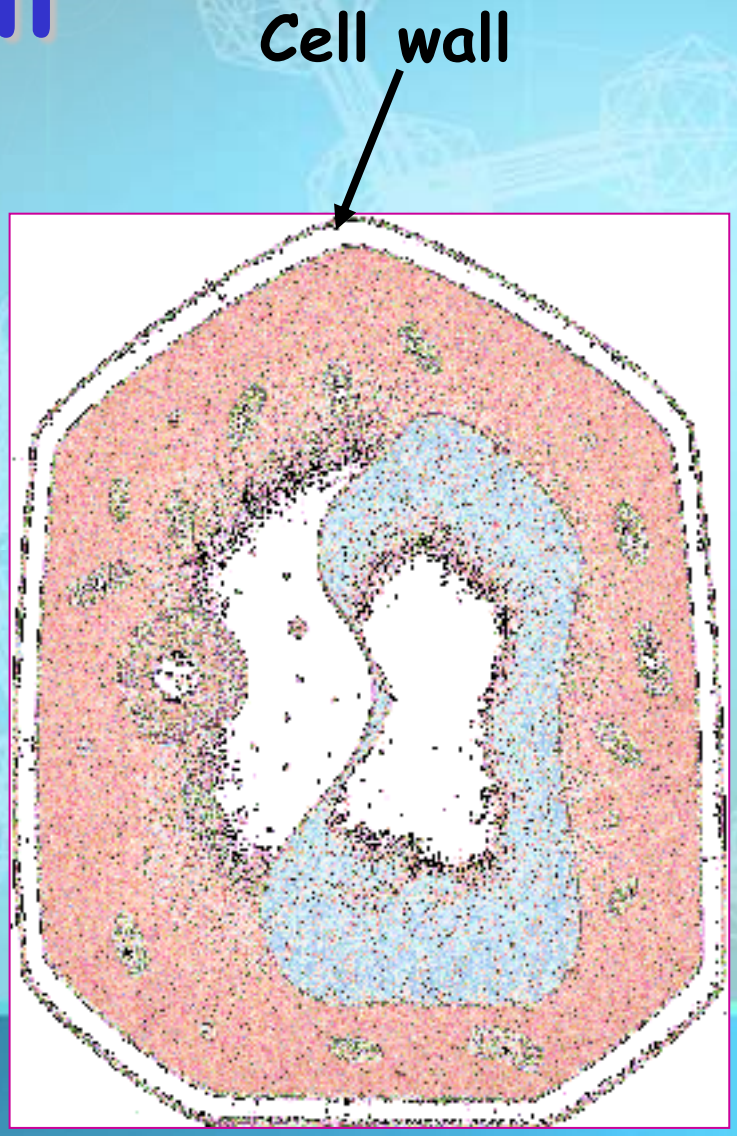
- **Protection**
- **Shape**

Plasmodesmata:

Breaks in the primary cell wall of adjacent cell walls

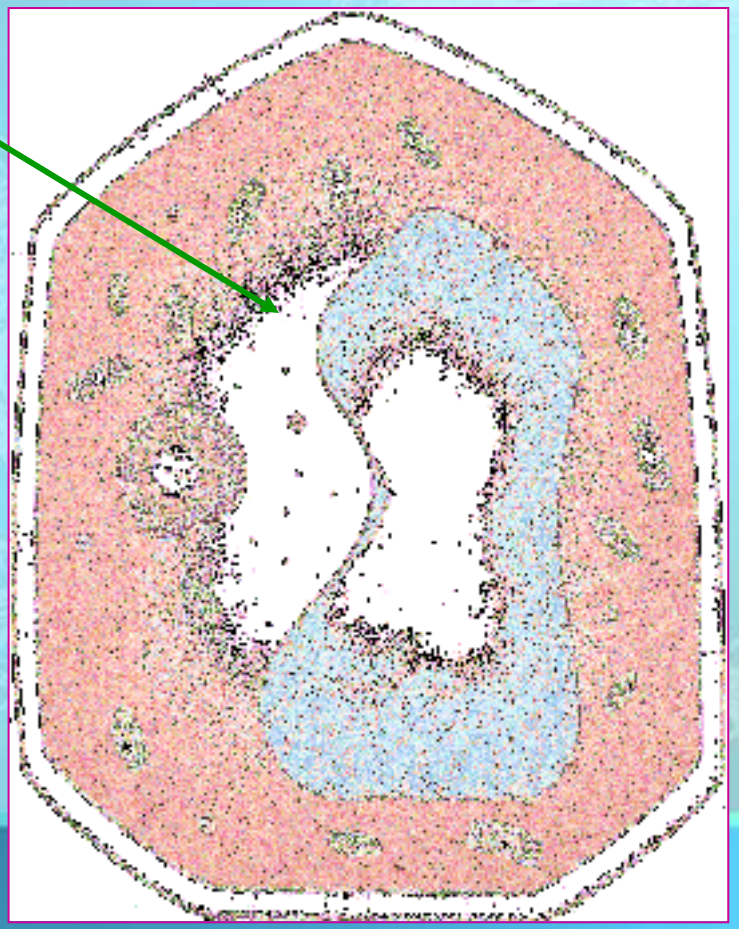
Middle lamella;

Connects two adjacent cell walls



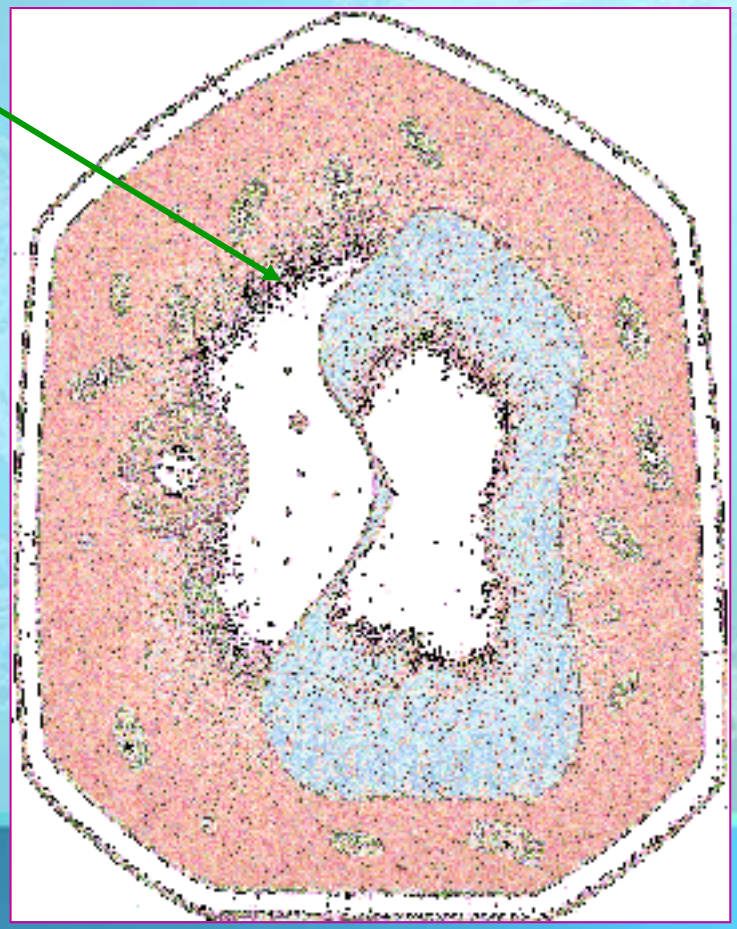
Cytoplasm of a Cell

- Jelly-like substance enclosed by cell membrane
- Provides a medium for chemical reactions to take place



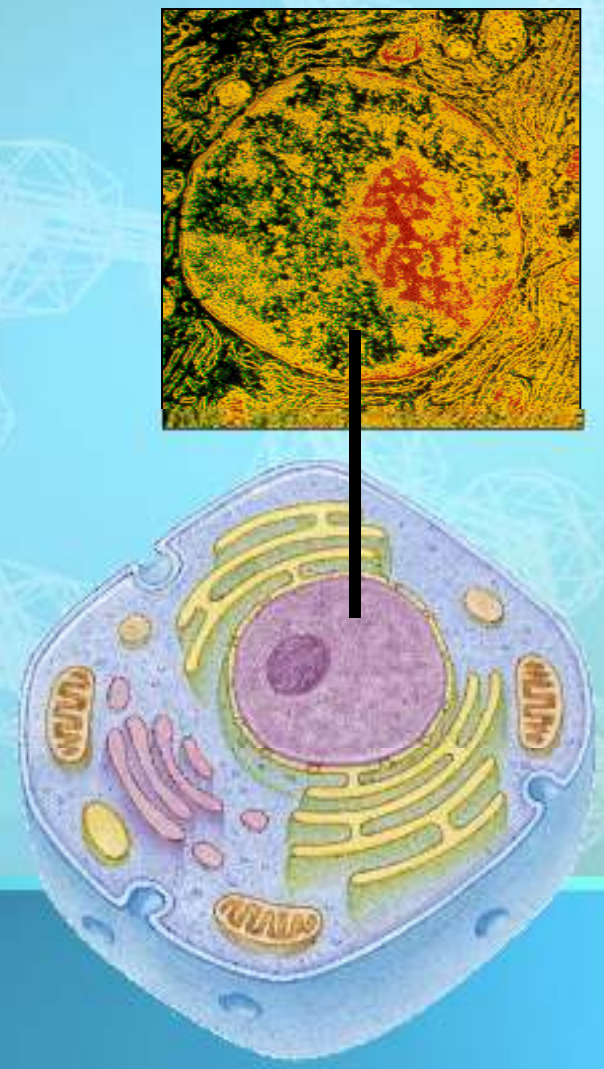
More on Cytoplasm

- Contains **organelles** to carry out specific jobs



The Control Organelle - Nucleus

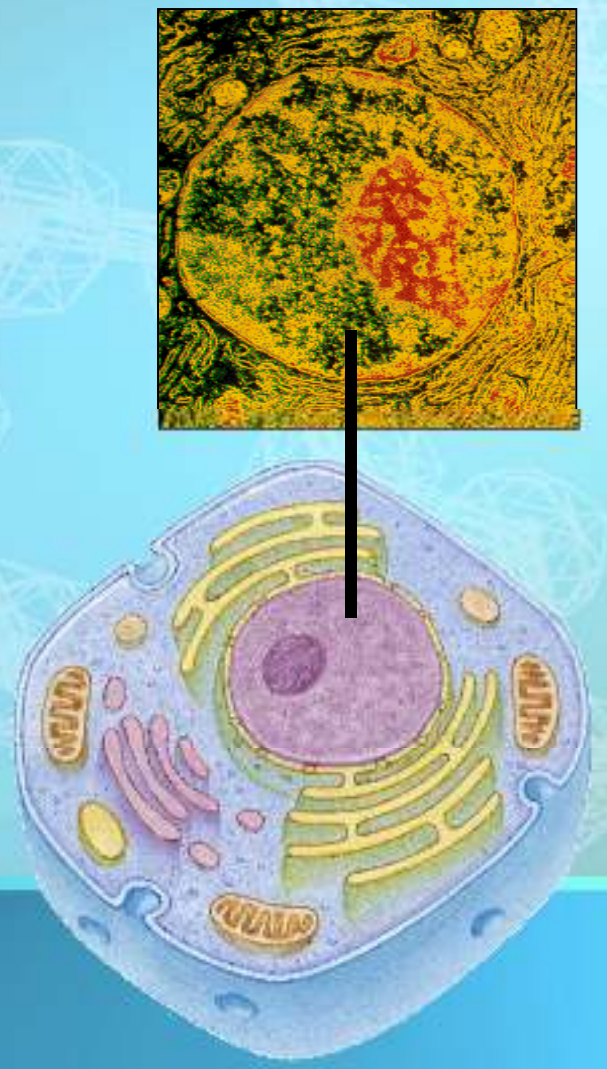
- Controls the normal activities of the cell
- Contains the DNA in chromosomes
- Bounded by a nuclear envelope (membrane) with pores
- Usually the largest organelle

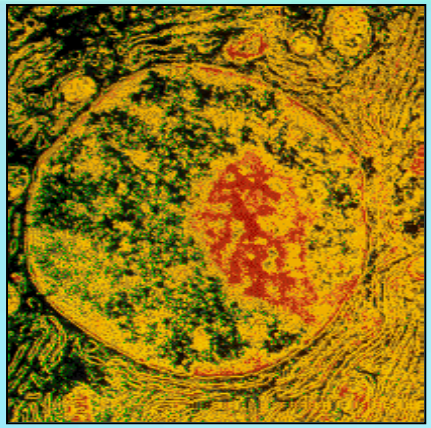


The Control Organelle - Nucleus

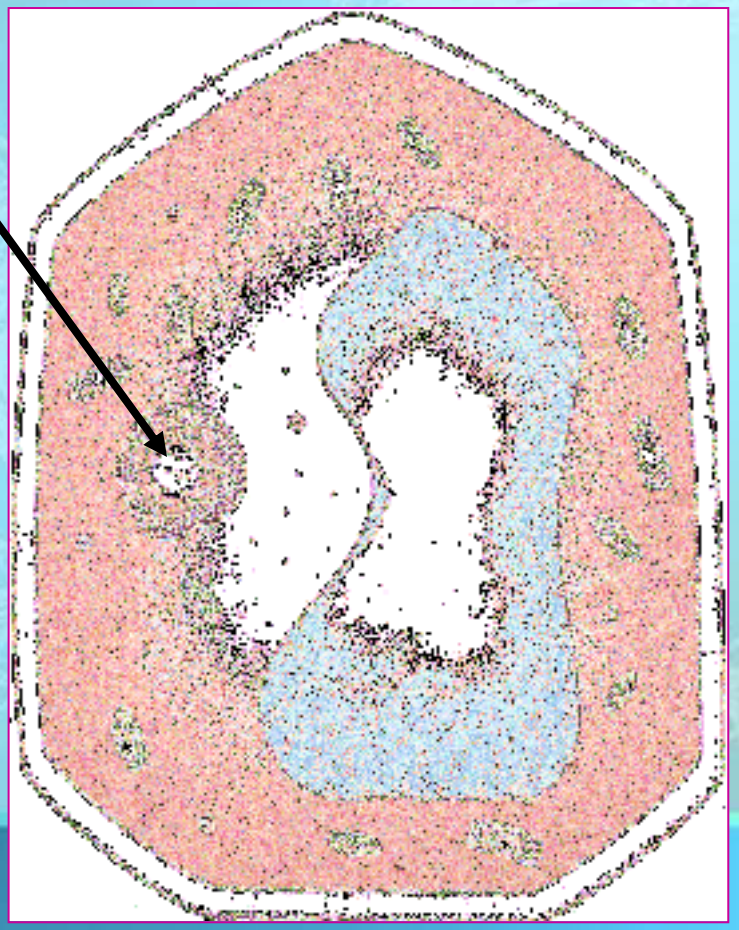
- Co-ordinates the activities of the cell

- Cell division
  - -mitosis (growth and repair)
  - -meiosis (gamete formation)





More on the Nucleus

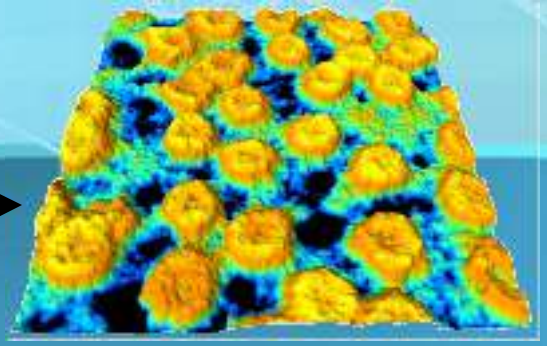


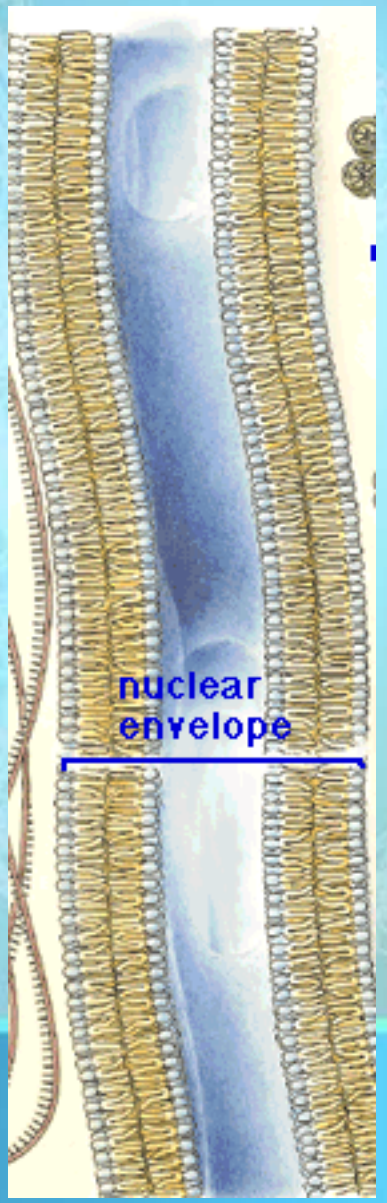
- Each cell has fixed number of chromosomes that carry genes
- Genes control cell characteristics

Nuclear Envelope

- Double membrane surrounding nucleus
- Also called nuclear membrane
- Contains nuclear pores for materials to enter & leave nucleus

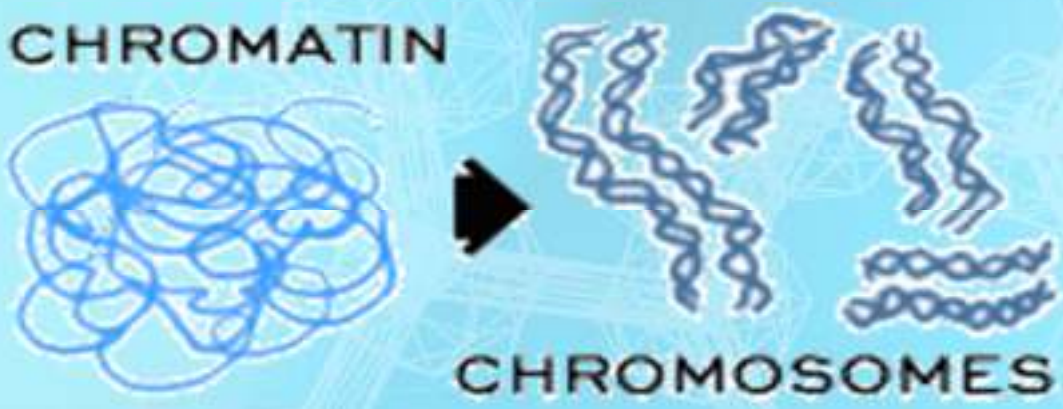
Nuclear pores





Inside the Nucleus -

The genetic material (DNA) is found

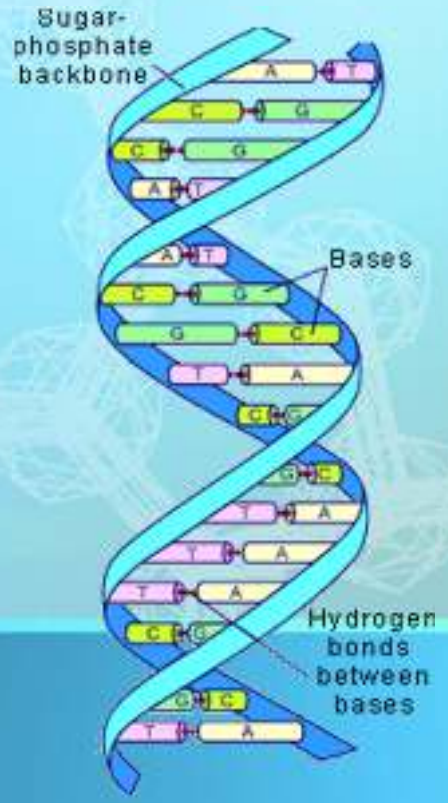


DNA is spread out
And appears as
CHROMATIN
in non-dividing cells

DNA is condensed &
wrapped around proteins
forming
as CHROMOSOMES
in dividing cells

What Does DNA do?

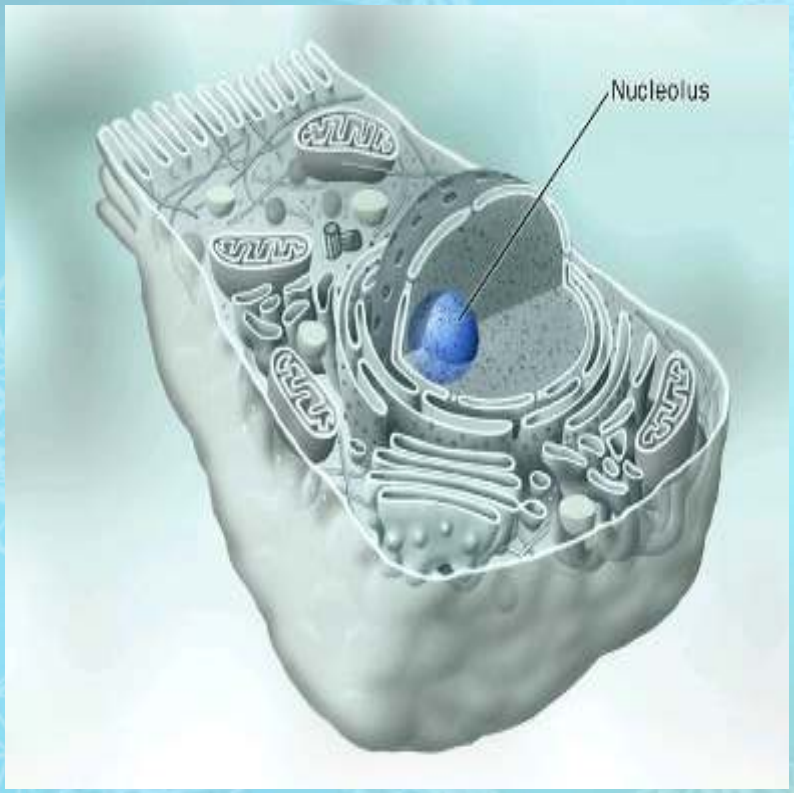
DNA is the **hereditary material** of the cell

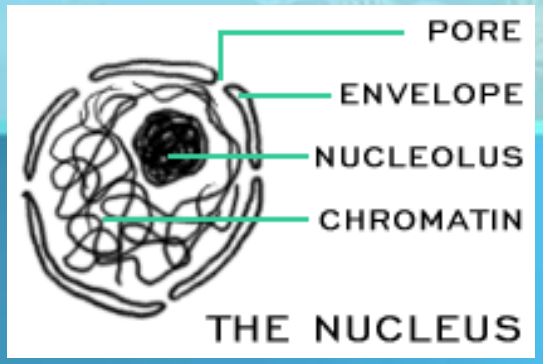


Genes that make up the DNA molecule code for different **proteins**

Nucleolus

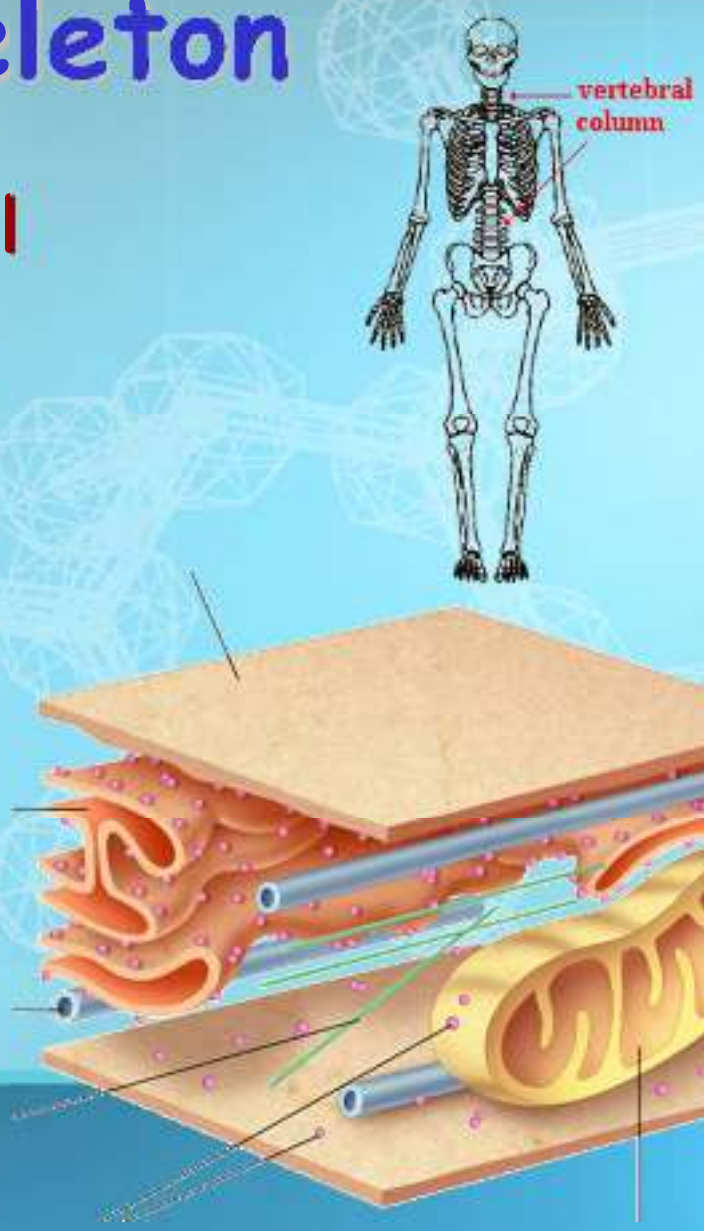
- Inside nucleus
- Disappears when cell divides
- Makes ribosomes that make proteins



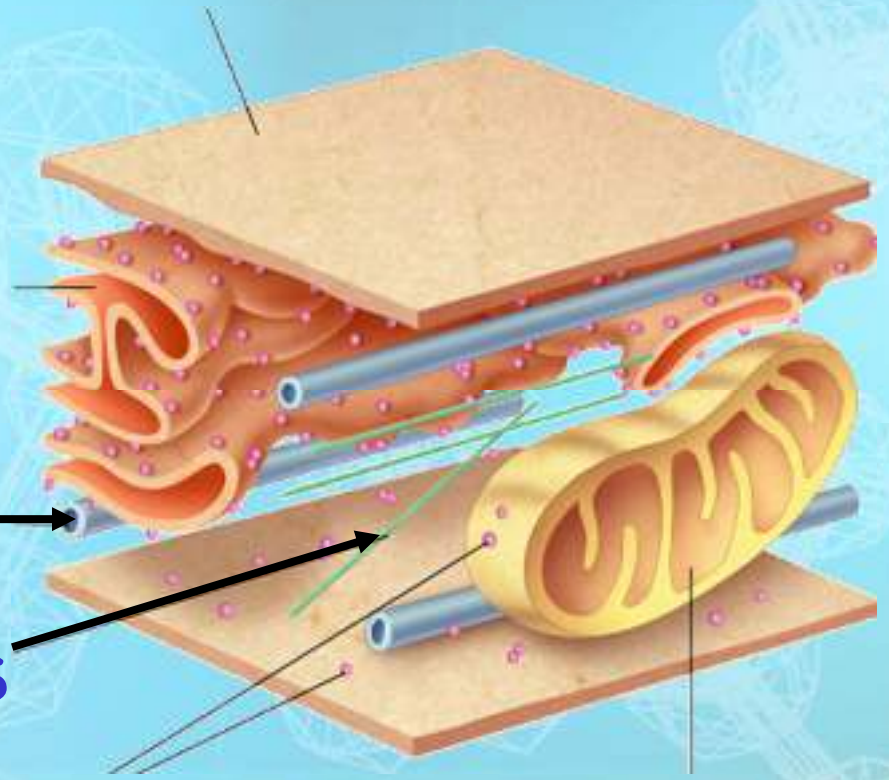


Cytoskeleton

- Helps cell maintain **cell shape**
- Also help **move organelles** around
- Made of **proteins**
- **Microfilaments** are threadlike & made of ACTIN
- **Microtubules** are tubelike & made of TUBULIN



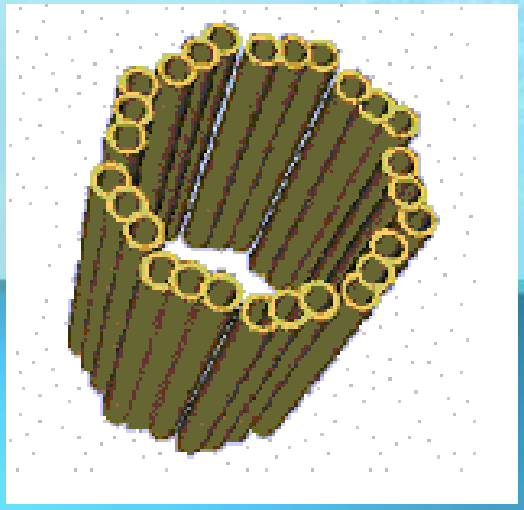
Cytoskeleton



MICROTUBULES

MICROFILAMENTS

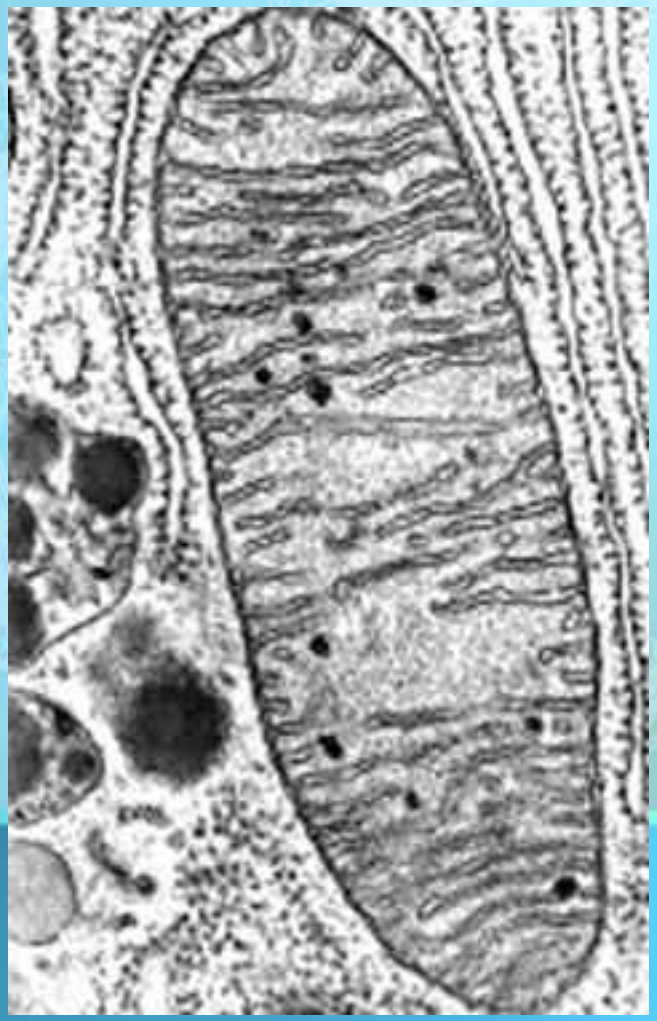
Centrioles



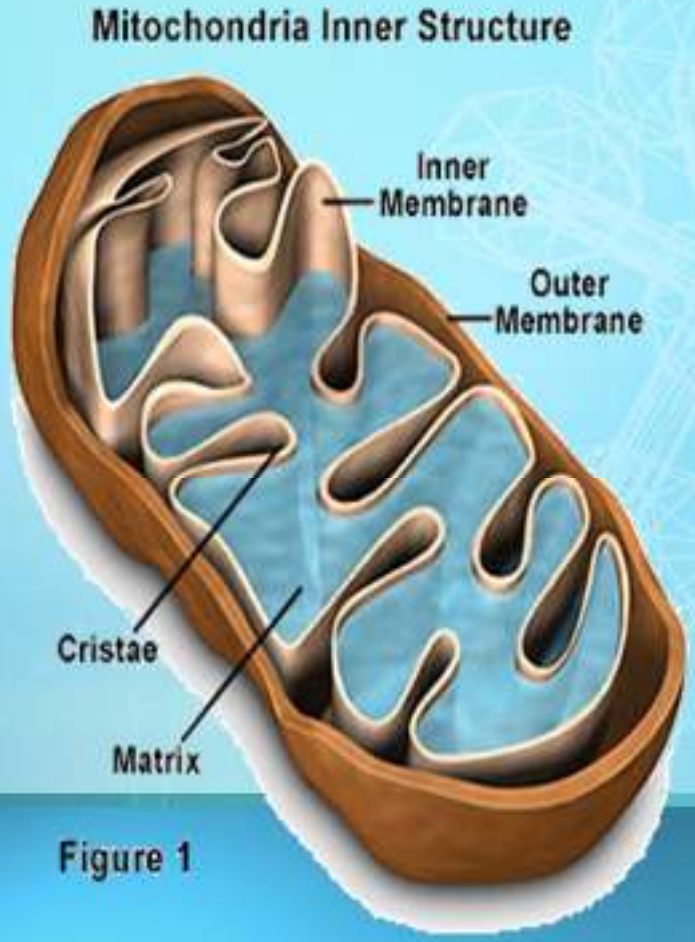
- Found only in animal cells
- Paired structures near nucleus
- Made of bundle of microtubules
- Appear during cell division forming mitotic spindle
- Help to pull chromosome pairs apart to opposite ends of the cell

Mitochondrion (plural = mitochondria)

- "Powerhouse" of the cell
- Generate cellular energy (ATP)
- Both plants & animal cells have mitochondria
- Site of CELLULAR RESPIRATION (burning glucose)



MITOCHONDRIA



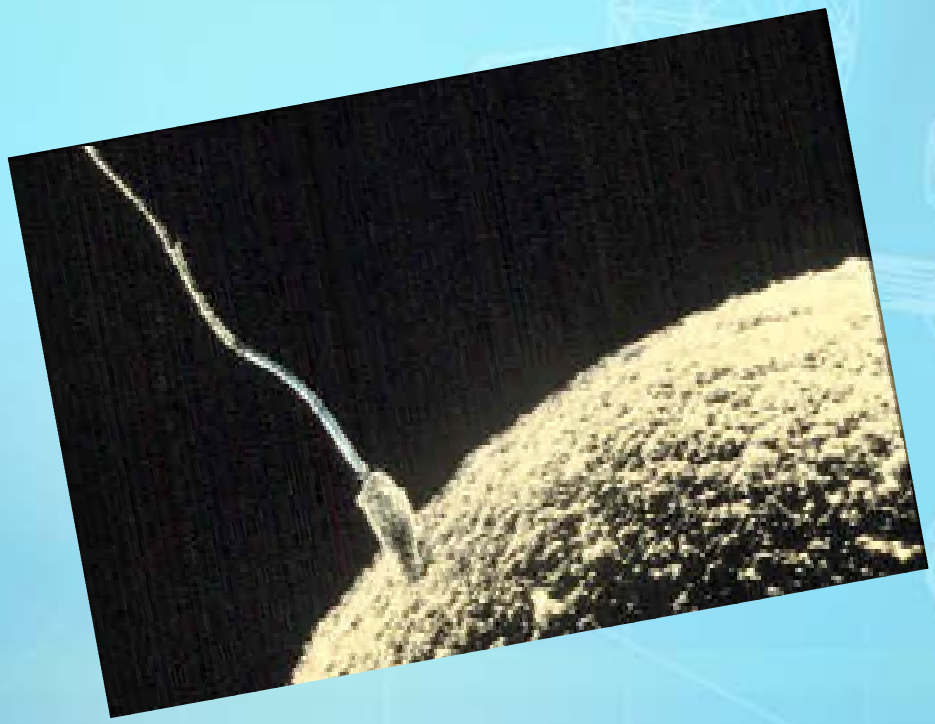
Surrounded by a DOUBLE membrane

Has its own DNA

Folded inner membrane called CRISTAE (increases surface area for more chemical Reactions)

Interior called MATRIX

Interesting Fact ---



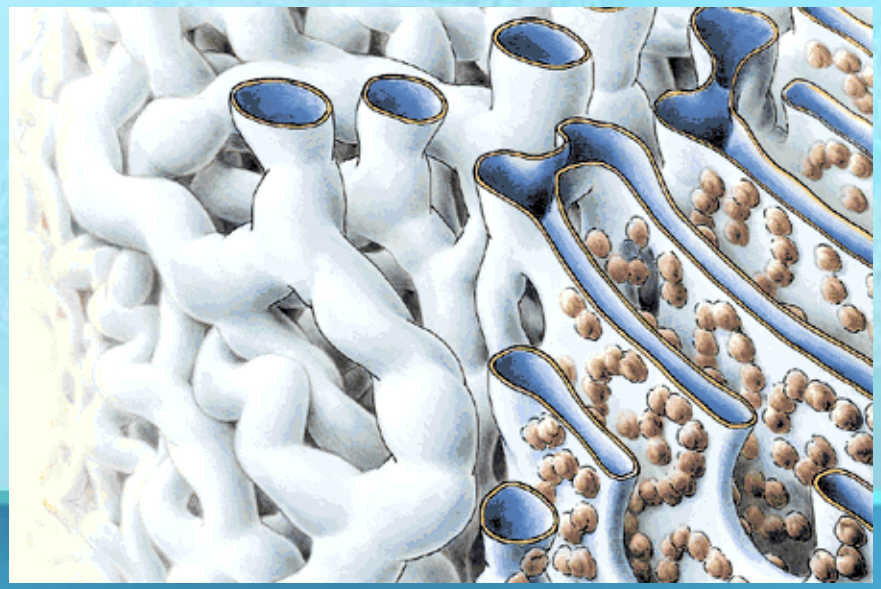
- Mitochondria Come from cytoplasm in the EGG cell during fertilization

Therefore …

- You inherit your mitochondria from your mother!

Endoplasmic Reticulum - ER

- Network of hollow membrane tubules
- Connects to nuclear envelope & cell membrane
- Functions in Synthesis of cell products & Transport



Two kinds of ER ---ROUGH & SMOOTH

Rough Endoplasmic Reticulum (Rough ER)

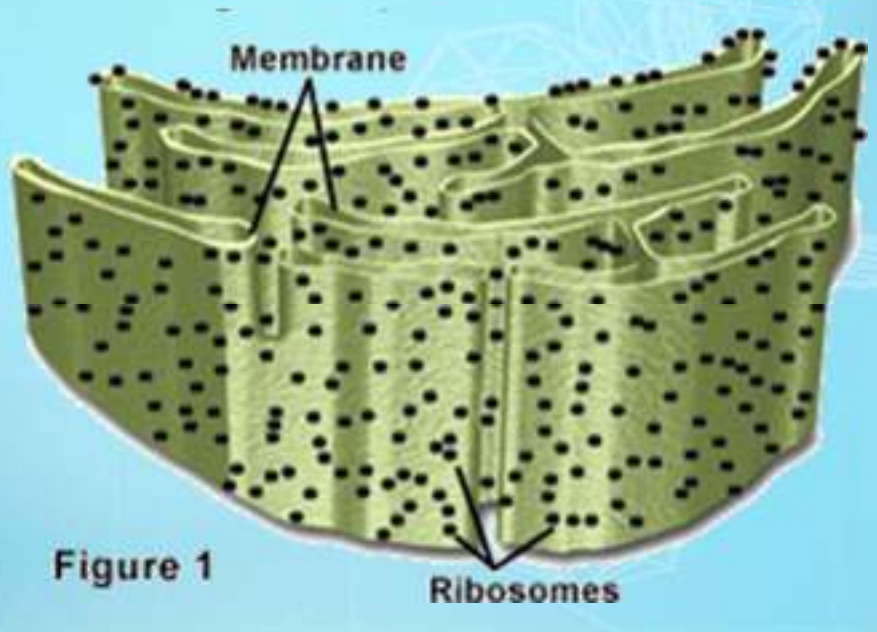
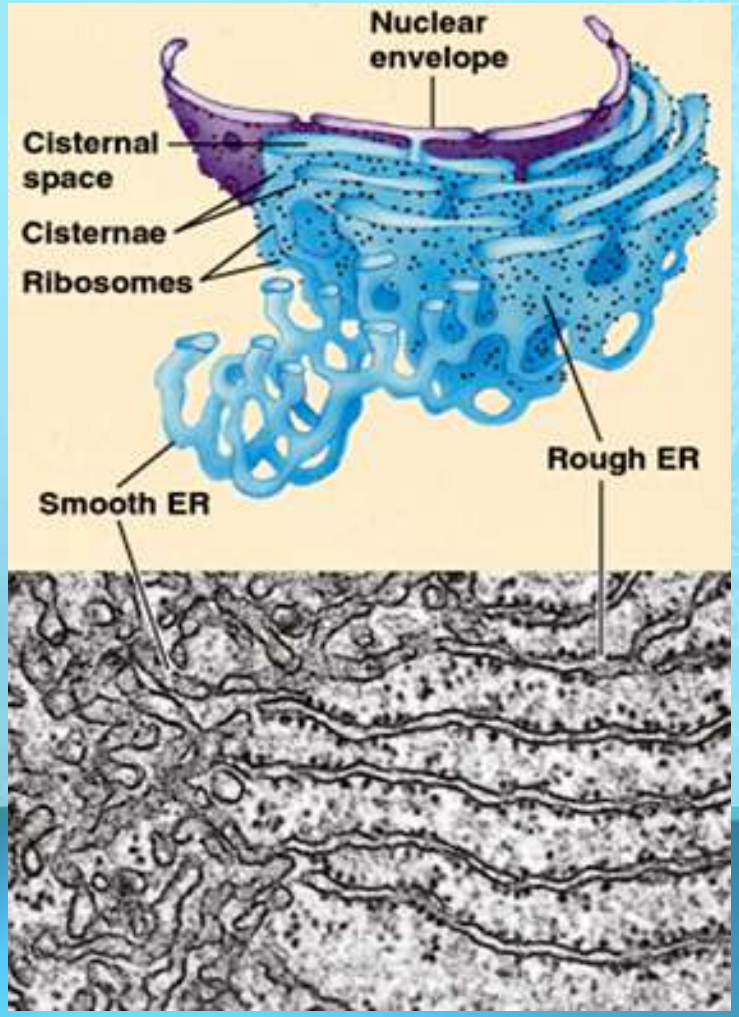


Figure 1

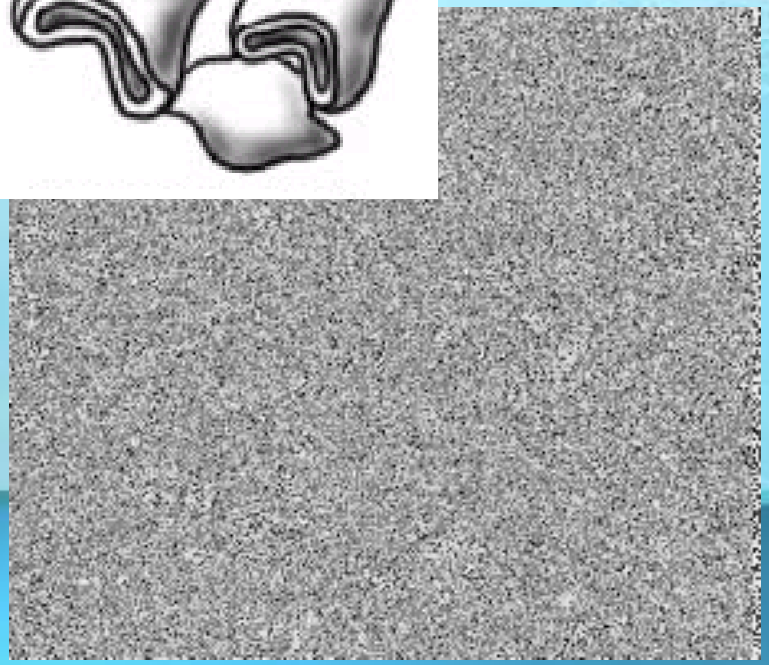
- Has ribosomes on its surface
- Makes membrane proteins and proteins for export out of cell

Rough Endoplasmic Reticulum (Rough ER)



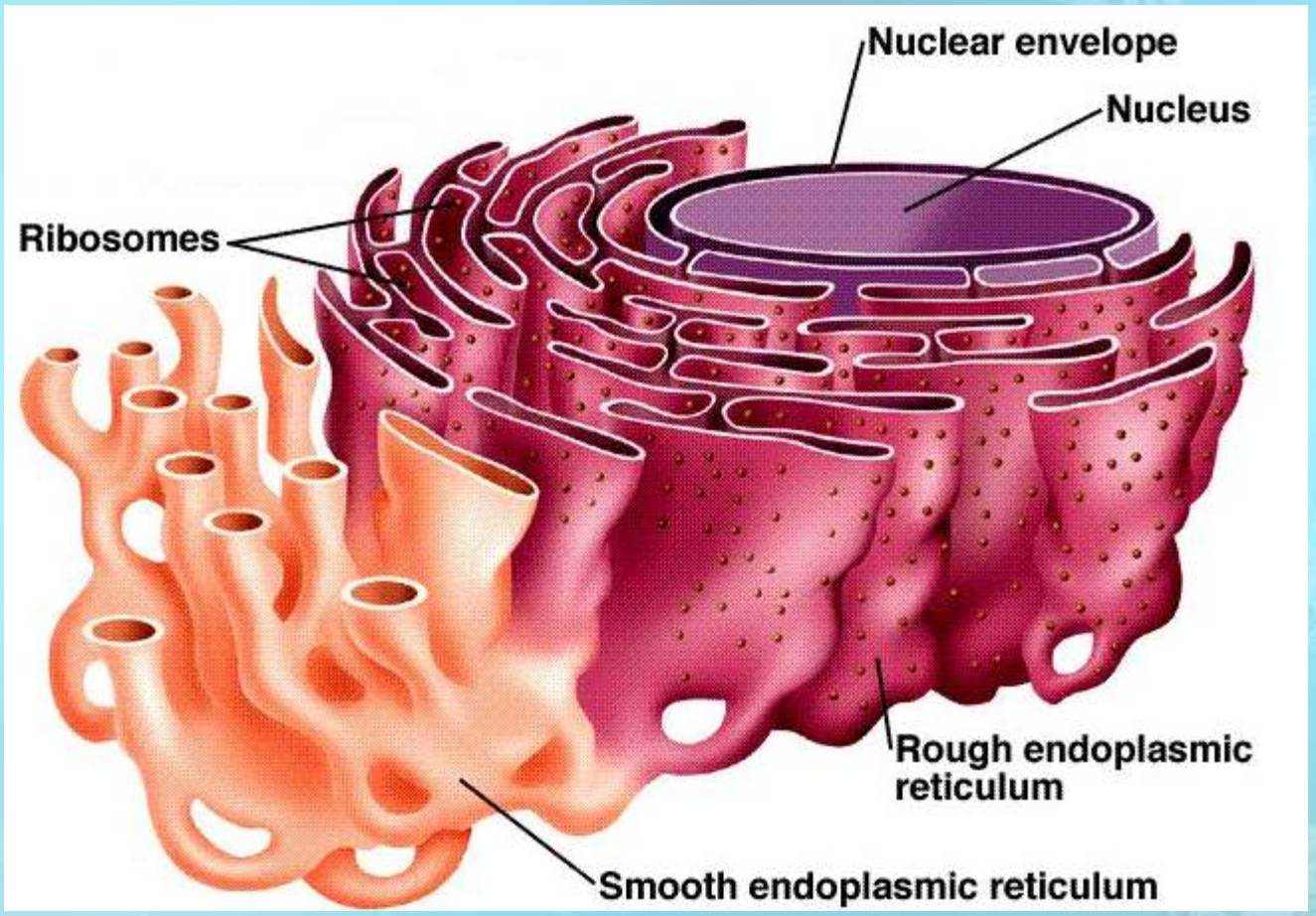
- Proteins are made by ribosomes on ER surface
- They are then threaded into the interior of the Rough ER to be modified and transported

Functions of the Smooth ER



- Makes membrane lipids (steroids)
- Regulates calcium (muscle cells)
- Destroys toxic substances (Liver)

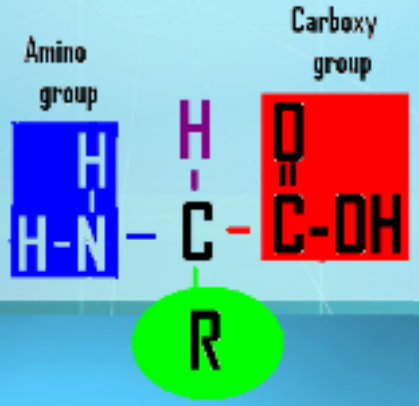
Endomembrane System



Includes nuclear membrane connected to ER connected to cell membrane (transport)

Ribosomes

- Made of PROTEINS and rRNA
- "Protein factories" for cell
- Join amino acids to make proteins through protein synthesis



Ribosomes

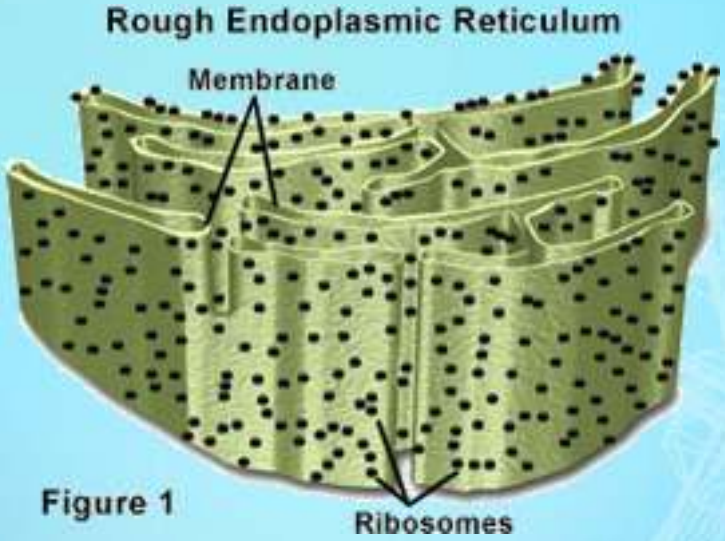
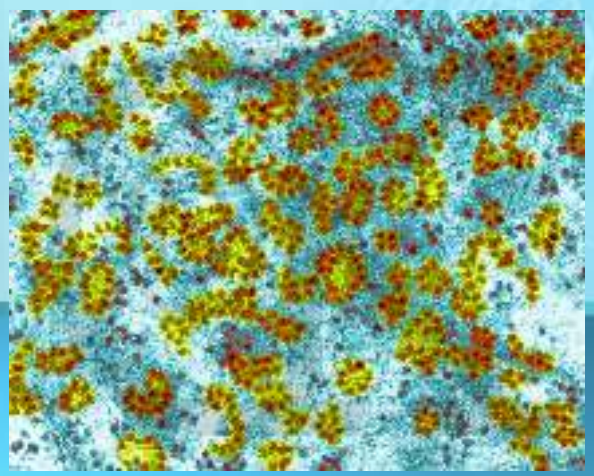


Figure 1



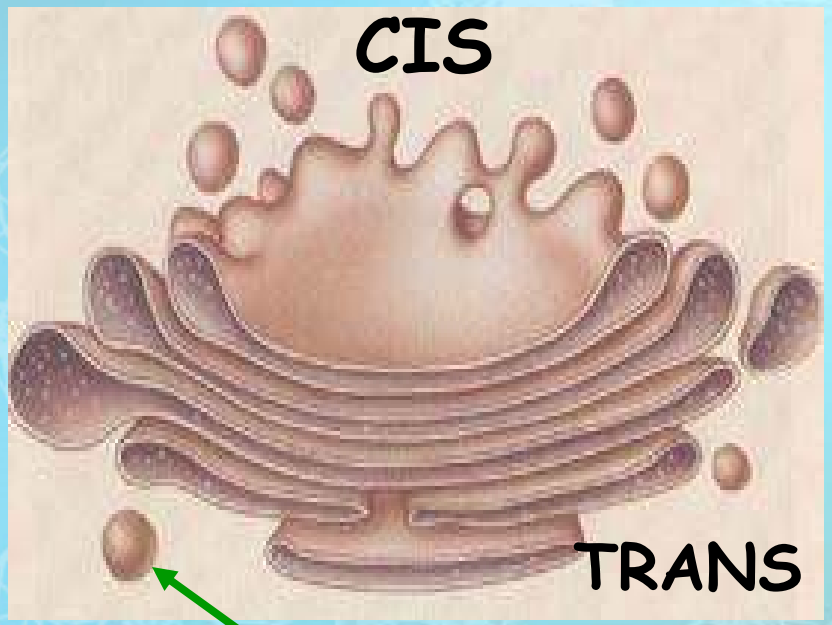
Can be attached to Rough ER

OR

Be free (unattached) in the cytoplasm

Golgi Bodies

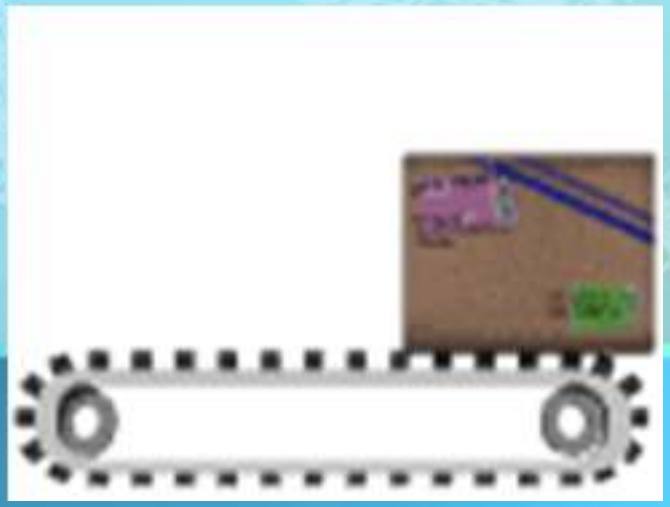
- Stacks of flattened sacs
- Have a shipping side (cis face) & a receiving side (trans face)
- Receive proteins made by ER
- Transport vesicles with modified proteins pinch off the ends



Golgi Bodies

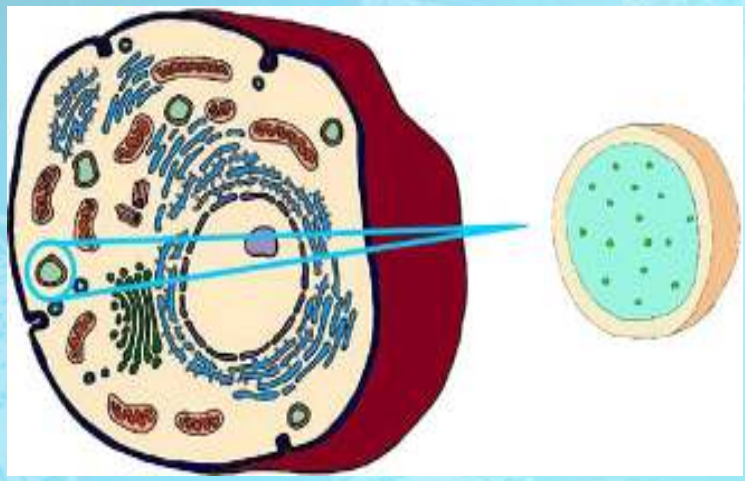
Look like a stack of pancakes

Modify, sort, & package molecules from ER for **storage** OR **transport** out of cell



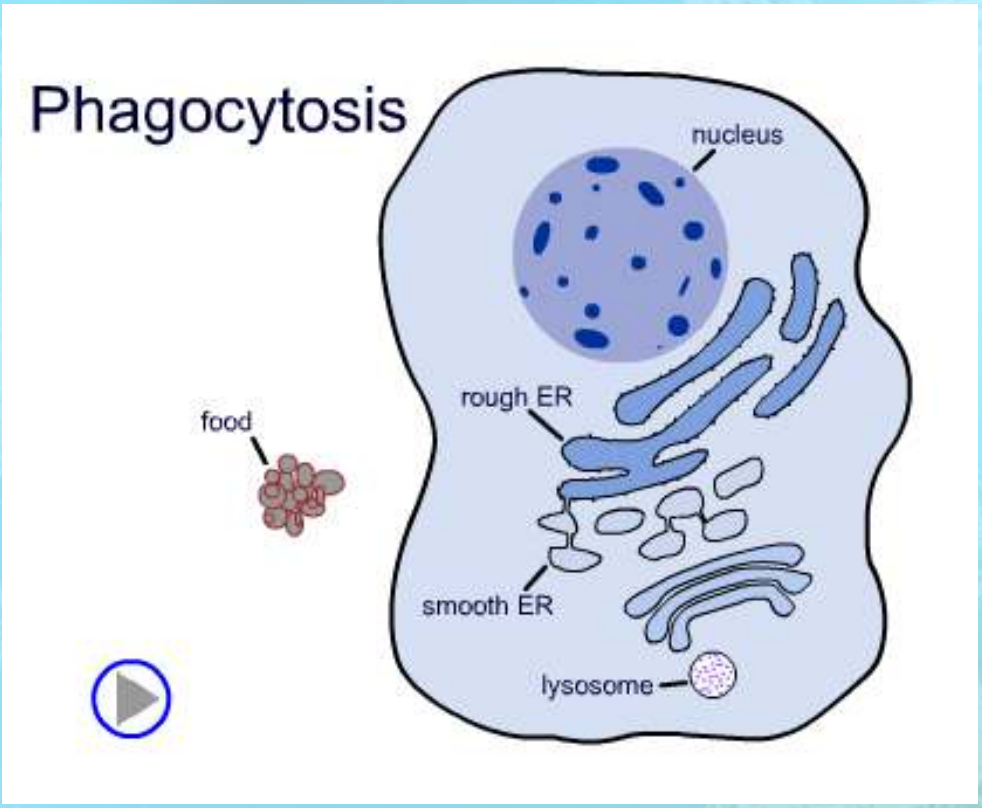
Lysosomes

- Contain digestive enzymes
- Break down food, bacteria, and worn out cell parts for cells
- Programmed for cell death (APOPTOSIS)
- Lyse & release enzymes to break down & recycle cell parts)



Lysosome Digestion

- Cells take in food by **phagocytosis**
- Lysosomes **digest** the food & get **rid of wastes**

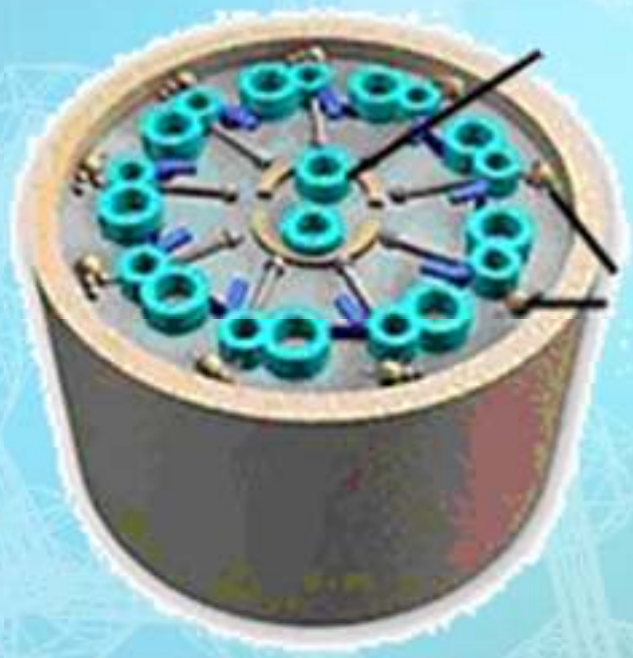


Lysosome Digestion

- Help in defence by digesting germs, WBC
- Help in cleaning up the cell by digesting damaged materials in the cell
- Provides energy by digesting other cell parts, old, diseased or injured cells (autophagic)

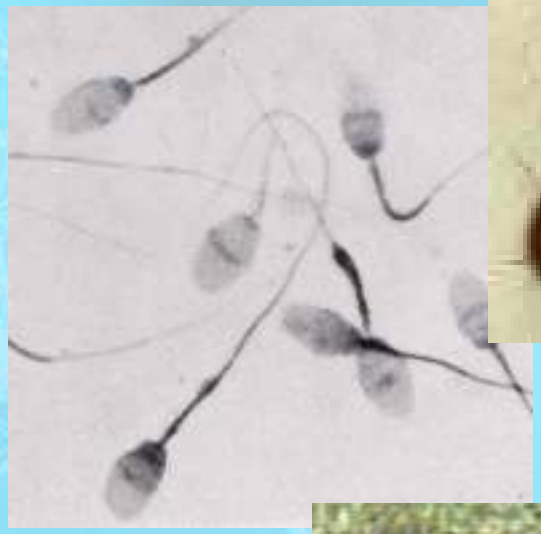
Cilia & Flagella

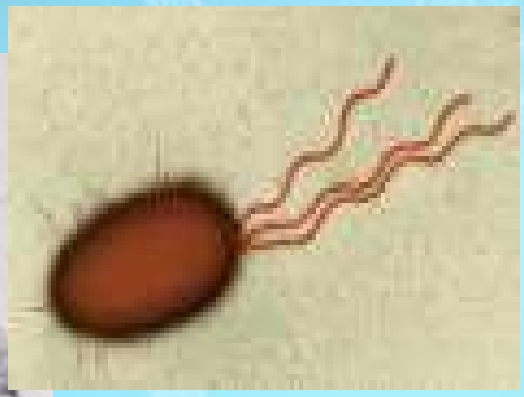
- Function in moving cells, in moving fluids, or in small particles across the cell surface



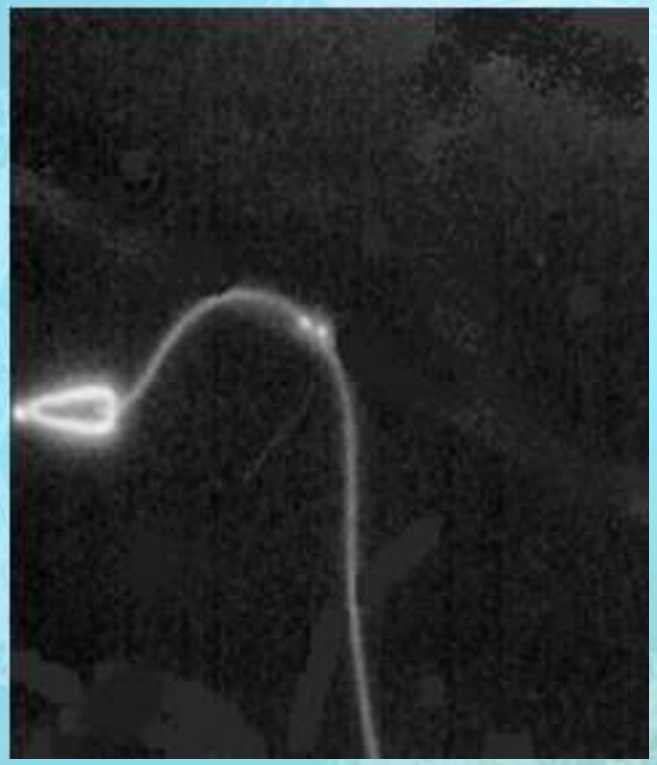
Cilia & Flagella

- **Cilia** are shorter and more numerous on cells
- **Flagella** are longer and fewer (usually 1-3) on cells

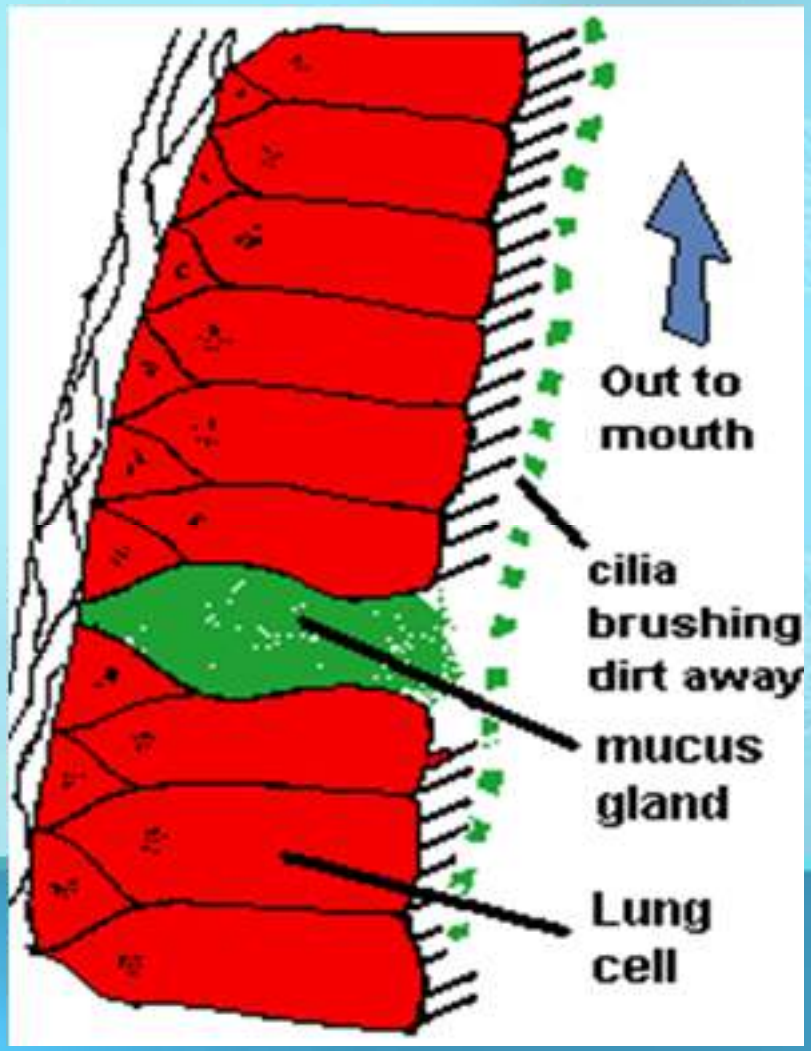




Cell Movement with Cilia & Flagella

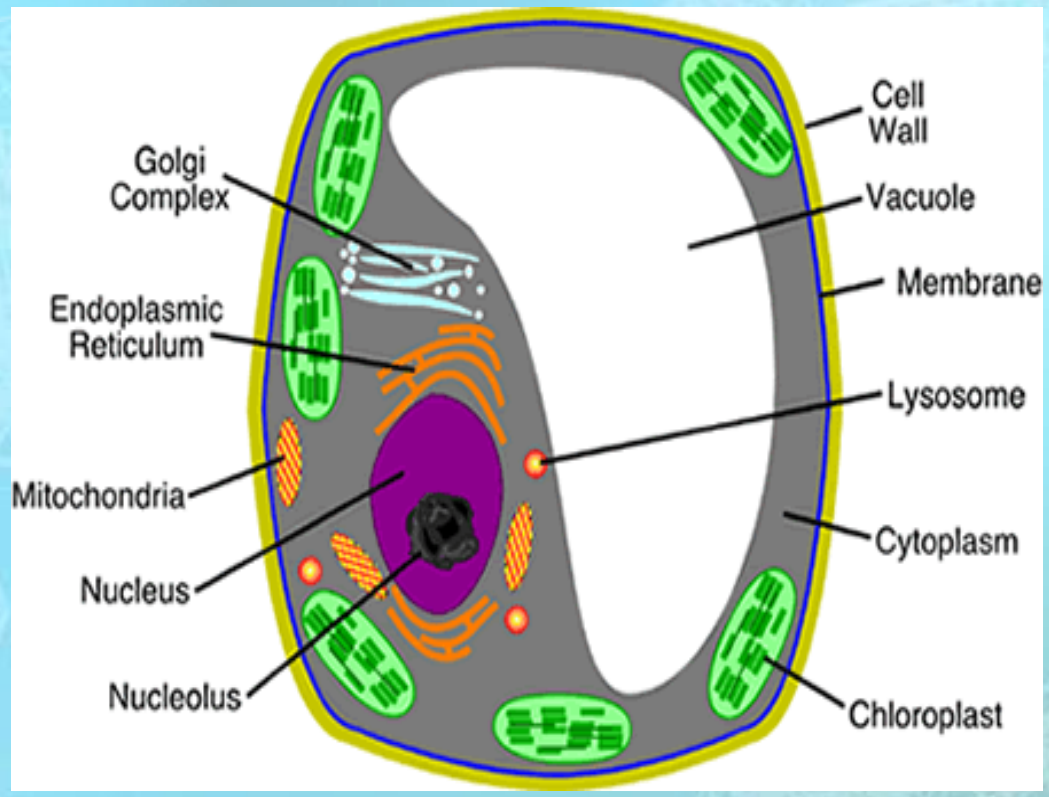


Cilia Moving Away Dust Particles from the Lungs



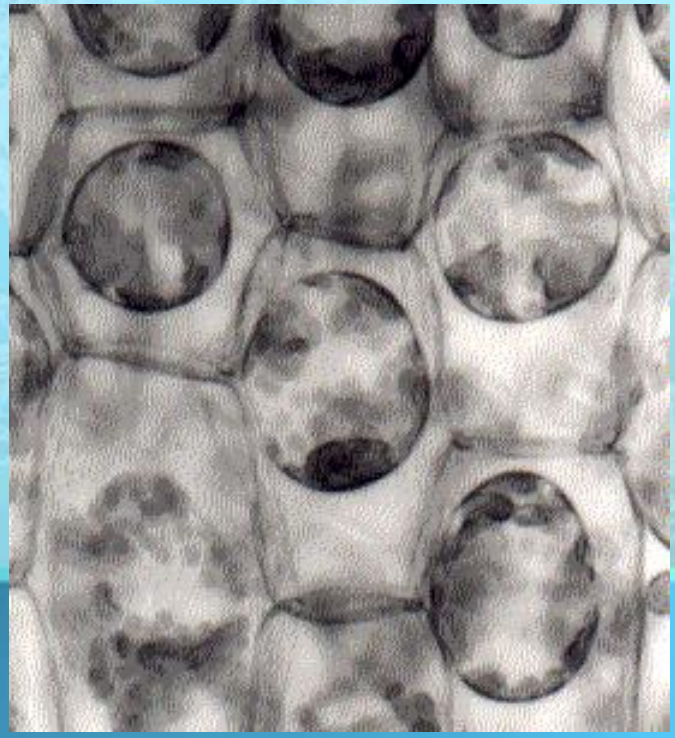
Vacuoles

- **Fluid filled** sacks for storage
- **Small or absent** in *animal* cells
- *Plant* cells have a **large Central Vacuole**



Vacuoles

- In plants, they store **Cell Sap**
- Includes storage of sugars, proteins, minerals, lipids, wastes, salts, water, and enzymes

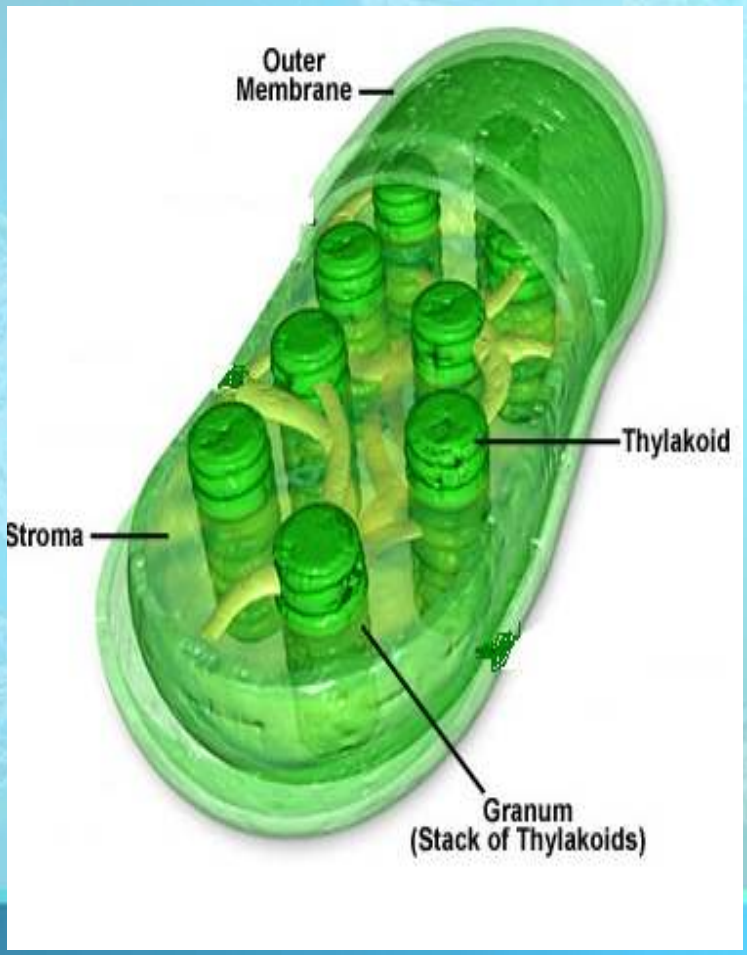


Chloroplasts

- Found only in producers (organisms containing chlorophyll)
- Use energy from sunlight to make own food (glucose)
- Energy from sun stored in the Chemical Bonds of Sugars

Chloroplasts

- Surrounded by DOUBLE membrane
- Outer membrane smooth
- Inner membrane modified into sacs called Thylakoids
- Thylakoids in stacks called Grana & interconnected
- Stroma – gel like material surrounding thylakoids



Elements necessary for Life

Elements	Functions
Hydrogen, carbon, oxygen, nitrogen	Required for organic compound of the cell and present as major constituents
Sodium, potassium	Acts as major cation
Chlorine	Acts as major major anion in physiological process
Iron, cupper, zinc, boron	As cofactor of enzymes participate in most biochemical reaction of the cell
Magnesium	Green pigment of chlorophyll in plants

Biomolecules

Biomolecule	Structure	Function
Carbohydrate	1. Compose of C, H, O	1. Most abundant organic substance present in nature in the form of cellulose in plant cell wall In both
	2. Simple 6 C sugar (glucose) called monosaccharide	2. Source of energy both plant and animal
	3. Two molecules or units joined together to form disaccharides (sucrose)	3. Important storage form of starch (plant) and glycogen (animal)
	4. More than 10 units join to form polysaccharides	4. Present in nucleic acids as 5 C sugar (ribose)

Biomolecules

Biomolecule	Structure	Function
Amino acid	1. Basic amino acid structure shows that the central carbon atom is attached with an amino group (-NH2), a carboxylic acid group (-COOH), one hydrogen and one side group (R). 2. There are 20 different side groups which give 20 different amino acids	1. Plants have the ability to utilize inorganic nitrogen and synthesize amino acid. 2. In animals principal source of amino acid is the plant or animals that it consumes in its diet (pulses are rich in protein).

Biomolecules

Biomolecule	Structure	Function
Protein	1. Composed of C, H, O and N.	1. Structurally proteins form integral part of the membranes
	2. Amino acids join together by "peptide" bonds to form protein molecules.	2. Functionally in the form of enzymes they play a vital role in metabolic reactions.
	3.Twenty different amino acids make numerous simple and complex protein.	3. Synthesis of DNA is regulated by proteins.
	4. Based on the complexity of structure they can have primary, secondary, tertiary and quaternary structures.	4. Proteins are so important that nucleic acids directly regulates protein synthesis
	5. When proteins exist with other molecules they are known as conjugated proteins e.g. glycoprotein, lipoprotein, chromoprotein etc.	

Biomolecules

Biomolecule	Structure	Function
Nucleic acid	1. They are of two types: Deoxyribose nucleic acid (DNA) and Ribose nucleic acid (RNA) 2. They are long chain polymers composed of units called **nucleotides**. 3. Each nucleotide has pentose sugar, nitrogen base and phosphate group. 4. DNA has one oxygen less in its sugar molecule.	1. DNA is the main genetic material for almost all organisms except certain viruses. 2. RNA molecules are involved in information transfer and protein synthesis.

Biomolecules

Biomolecule	Structure	Function
Lipids	1. Composed of C, H, O. Amount of oxygen is very less. 2. They are synthesized from fatty acids and glycerol. Simple lipids are called glycerides. 3. Fats can be saturated or unsaturated. 4. Fats are solid at room temperature, those that remain liquid at room temperature are called oils.	1. Due to their low oxygen content, they store and release more energy during oxidation 2. A molecule of fat can yield twice as much energy as from carbohydrate. 3. Phospholipids are important component of cell membranes.

Biomolecules

Biomolecule	Structure	Function
Vitamins	1. Vitamins are organic compounds required in the diet of animals for their healthy growth. 2. Vitamins are classified according to their solubility into two groups : Water soluble vitamin B and ascorbic acid and fat soluble vitamins (viz. A, D, E, K) 3. Plants have the ability to synthesize vitamins from CO_2, NH_3 and H_2S	1. Vitamins (from plant) are essential nutrients in animals diet as animals cannot synthesise such compounds. 2. Their deficiency cause various diseases in animal, like deficiency of vitamin B causes"beri-beri" and that of vitamin C causes scurvy. 3. Vitamin A present in carotene pigment of carrot. Vitamin D can be produced by man with the help of sunlight. Vitamin K produced by bacteria in human intestine.

Biomolecules

Biomolecule	Structure	Function
Hormones	1.Hormones are specific organic substances effective in low concentrations, synthesized by cells in one part of the organism and then transported to another part of the organism, where it produces characteristic physiological responses.	1. In animals hormones are produced in glands called endocrine glands which control all biochemical activities of the organism 2. In animals hormones may be proteins, peptides or steroids. 3.In plants hormones (growth regulators) are generally produced in metabolically active cells and control the vegetitive and reproductive growth of the entire plant.