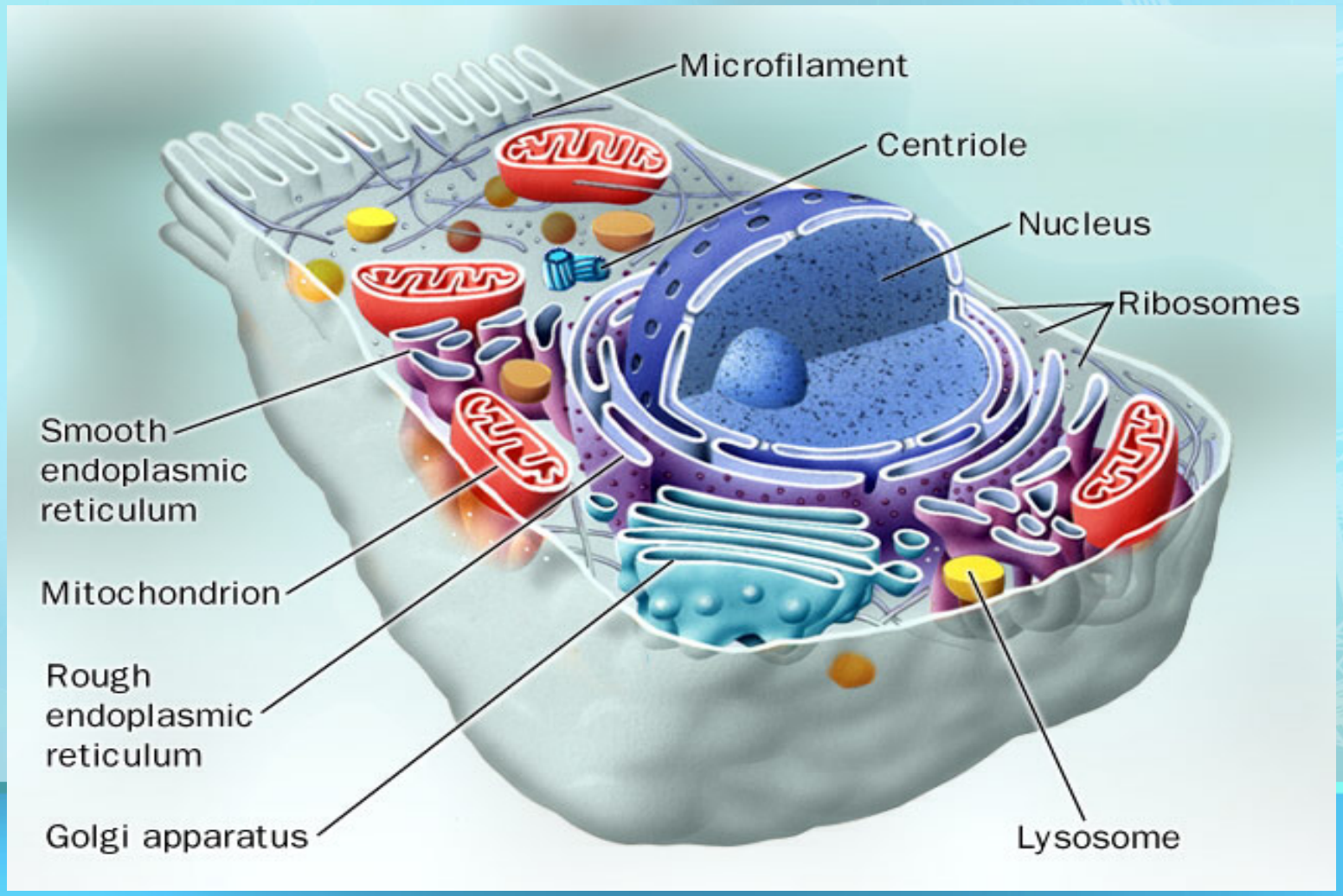
Basic Structure of a Cell



Review Facts About Living Things

What Are the Main Characteristics of organisms?

1. Made of CELLS
2. Require ENERGY (food)
3. REPRODUCE (species)
4. Maintain HOMEOSTASIS
5. ORGANIZED
6. RESPOND to environment
7. GROW and DEVELOP
8. EXCHANGE materials with surroundings (water, wastes, gases)

LEVELS OF ORGANIZATION

Nonliving Levels:

1. ATOM (element)
2. MOLECULE (compounds like carbohydrates & proteins)
3. ORGANELLES (nucleus, ER, Golgi …)

LEVELS OF ORGANIZATION

Living Levels:

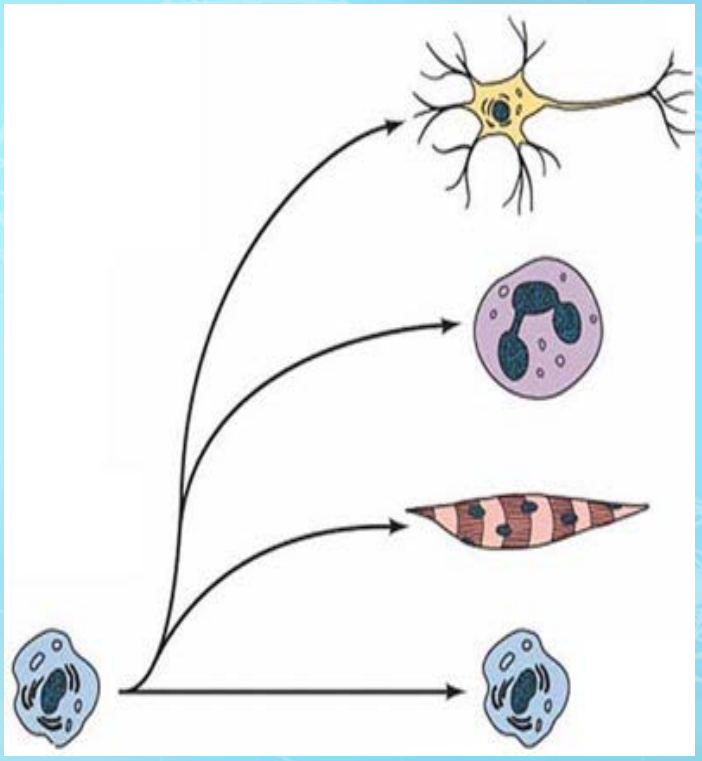
1. CELL (makes up ALL organisms)
2. TISSUE (cells working together
3. ORGAN (heart, brain, stomach …)
4. ORGAN SYSTEMS (respiratory, circulatory …)
5. ORGANISM

LEVELS OF ORGANIZATION

Living Levels continued:

1. POPULATION (one species in an area)
2. COMMUNITY (several populations in an area
3. ECOSYSTEM (forest, prairie …)
4. BIOME (Tundra, Tropical Rain forest…)
5. BIOSPHERE (all living and nonliving things on Earth)

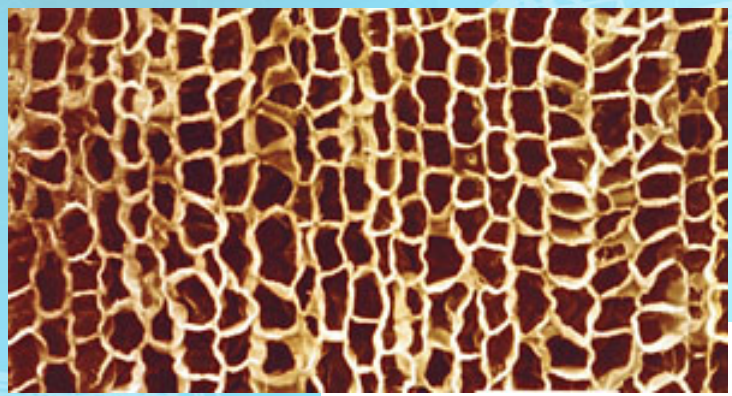
History of Cells & the Cell Theory



Cell Specialization

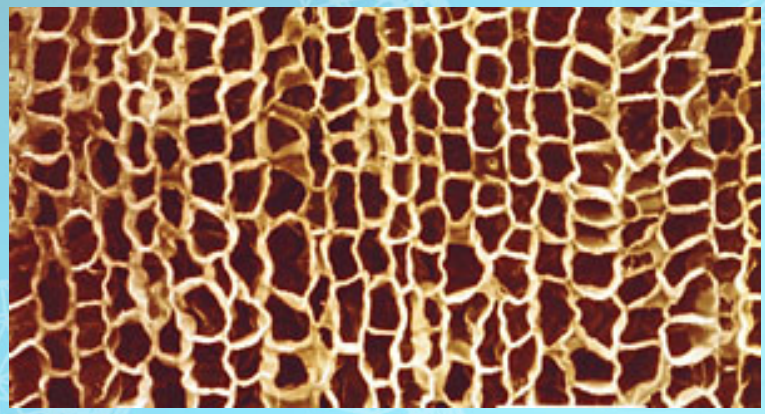
First to View Cells

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



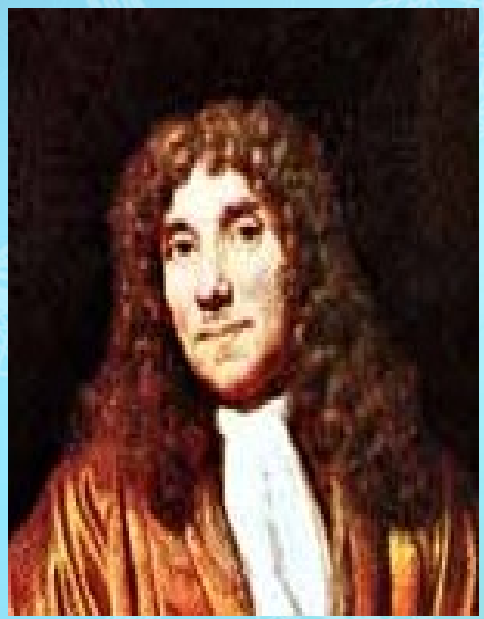
First to View Cells

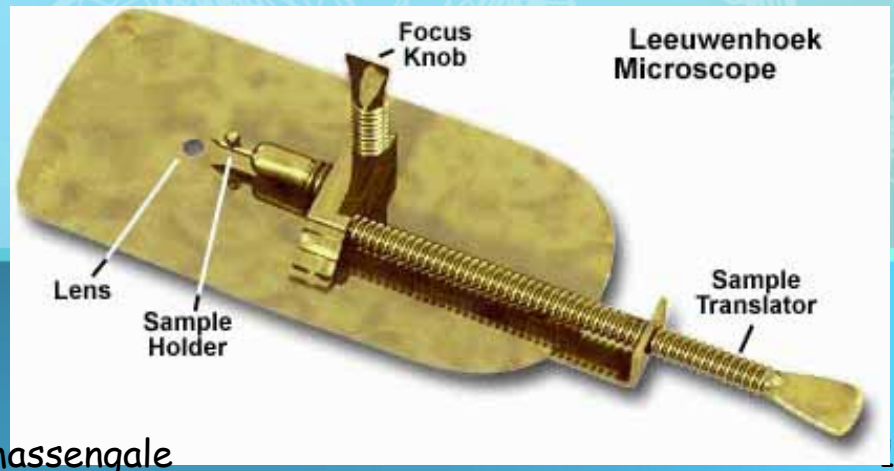
- Hooke is responsible for naming cells
- Hooke called them "CELLS" because they looked like the small rooms that monks lived in called Cells



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





Beginning of the Cell Theory

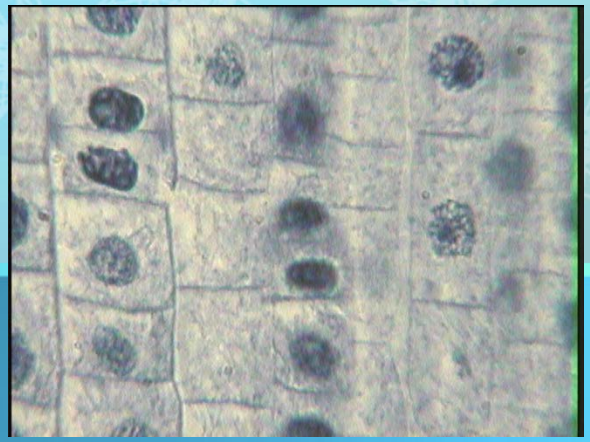
- In 1838, a German botanist named Matthias Schleiden concluded that all plants were made of cells
- Schleiden is a cofounder of the cell theory

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

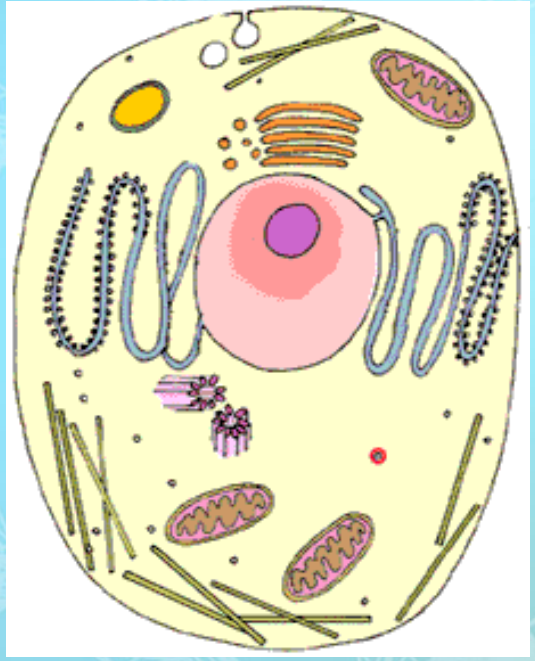
Beginning of the Cell Theory

- 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

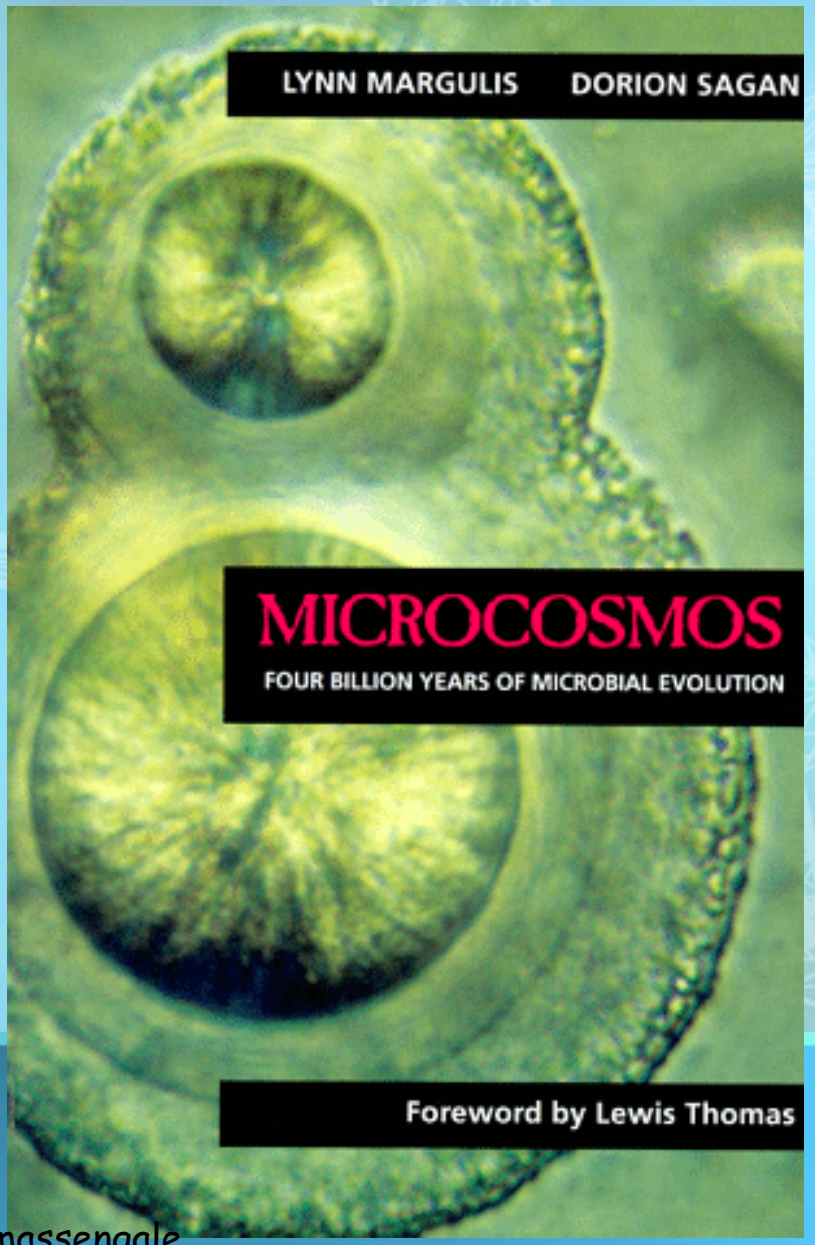


CELL THEORY

- 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)

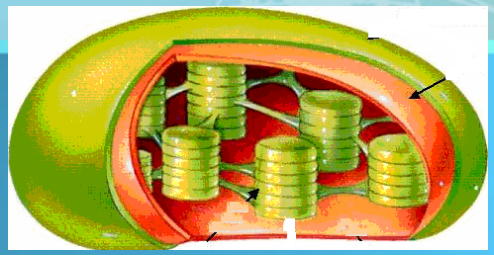


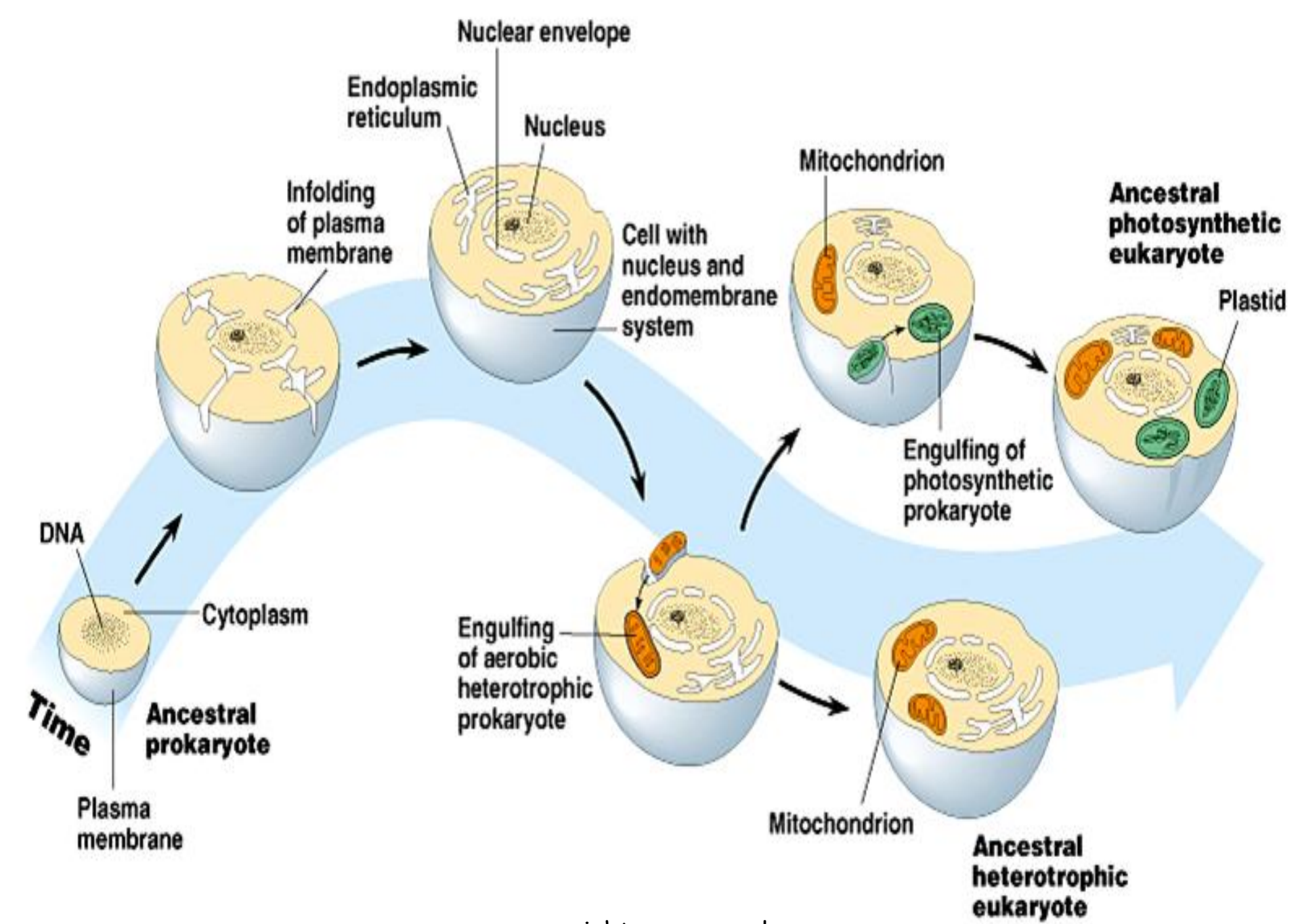
Discoveries Since the Cell Theory



ENDOSYMBIOTIC THEORY

- In 1970, American biologist, Lynn Margulis, provided evidence that some organelles within cells were at one time free living cells themselves
- Supporting evidence included organelles with their own DNA
- Chloroplast and Mitochondria

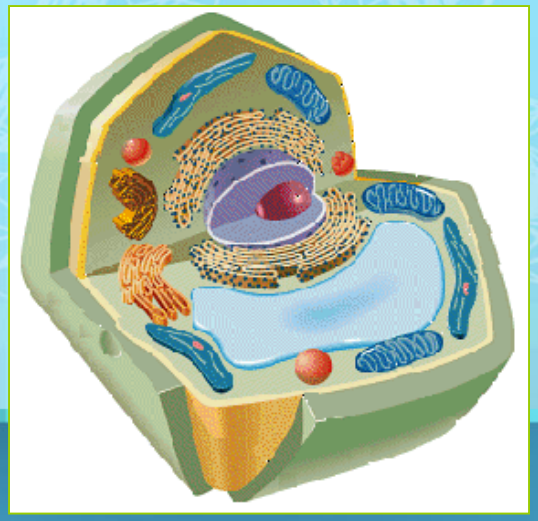




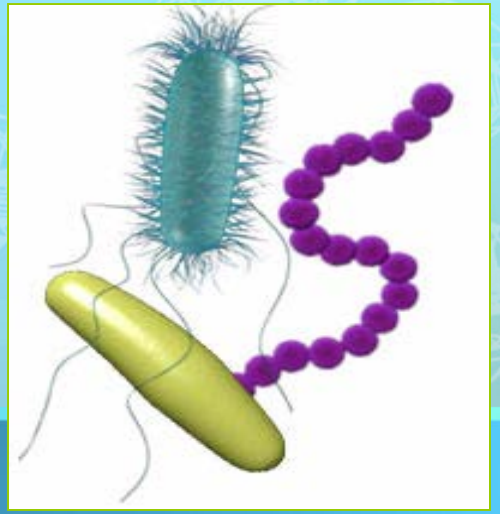
Cell Size and Types

- Cells, the basic units of organisms, can only be observed under microscope
- Three Basic types of cells include:

Animal Cell



Plant Cell



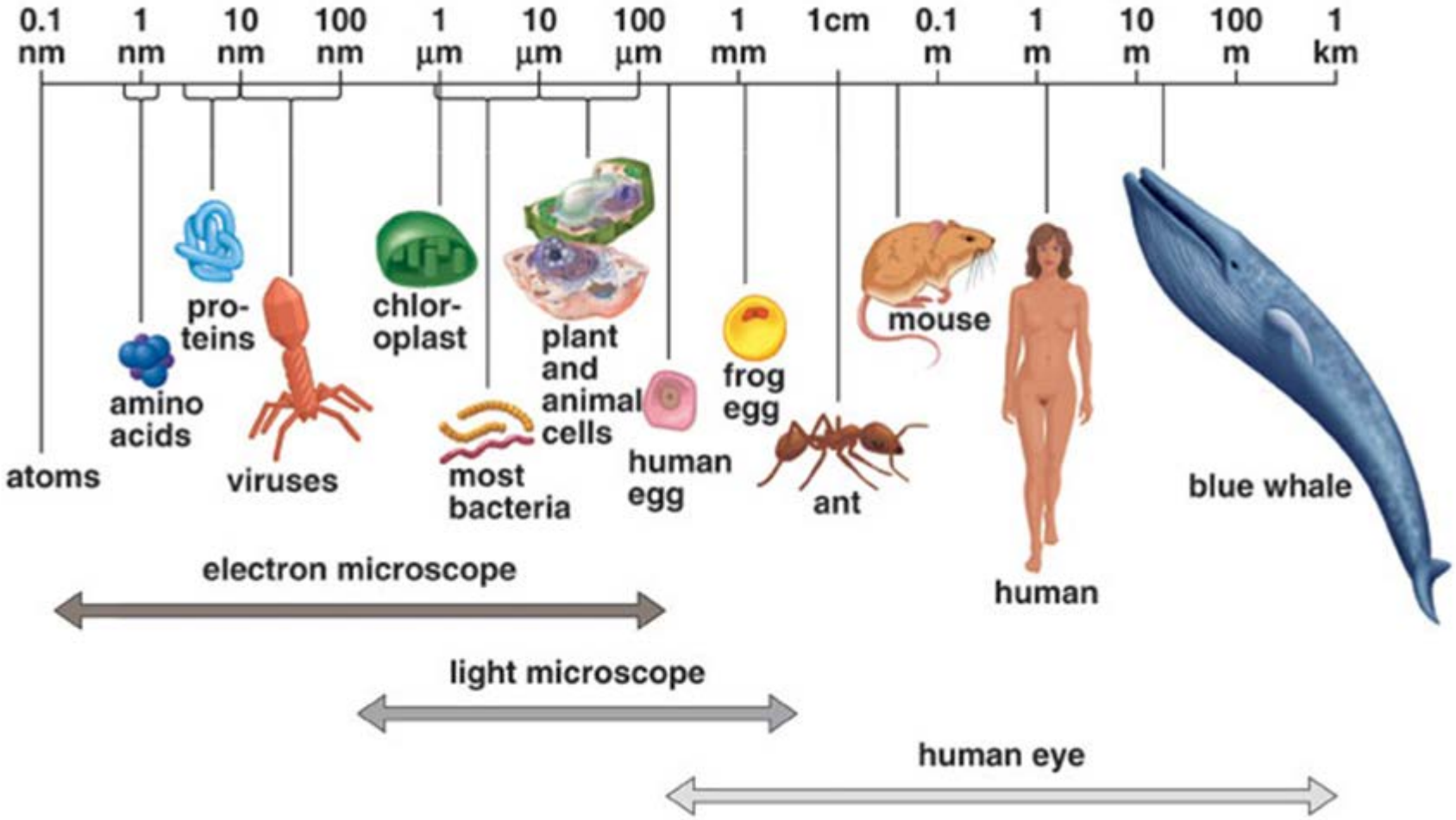
Bacterial Cell

Number of Cells

Although *ALL* living things are made of cells, organisms may be:

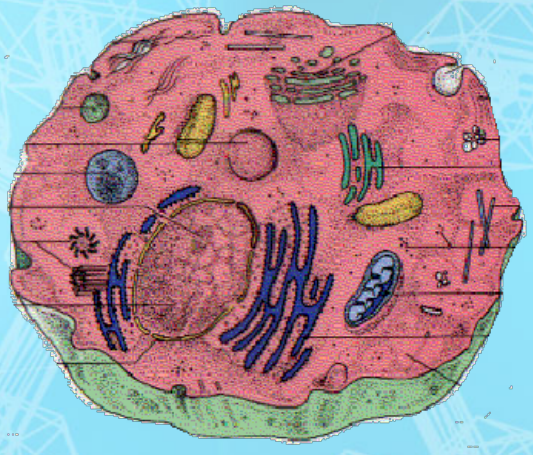
- *Unicellular* – composed of one cell
- *Multicellular*– composed of many cells that may organize into tissues, etc.

CELL SIZE



Typical cells range from 5 – 50 micrometers (microns) in diameter

Which Cell Type is Larger?



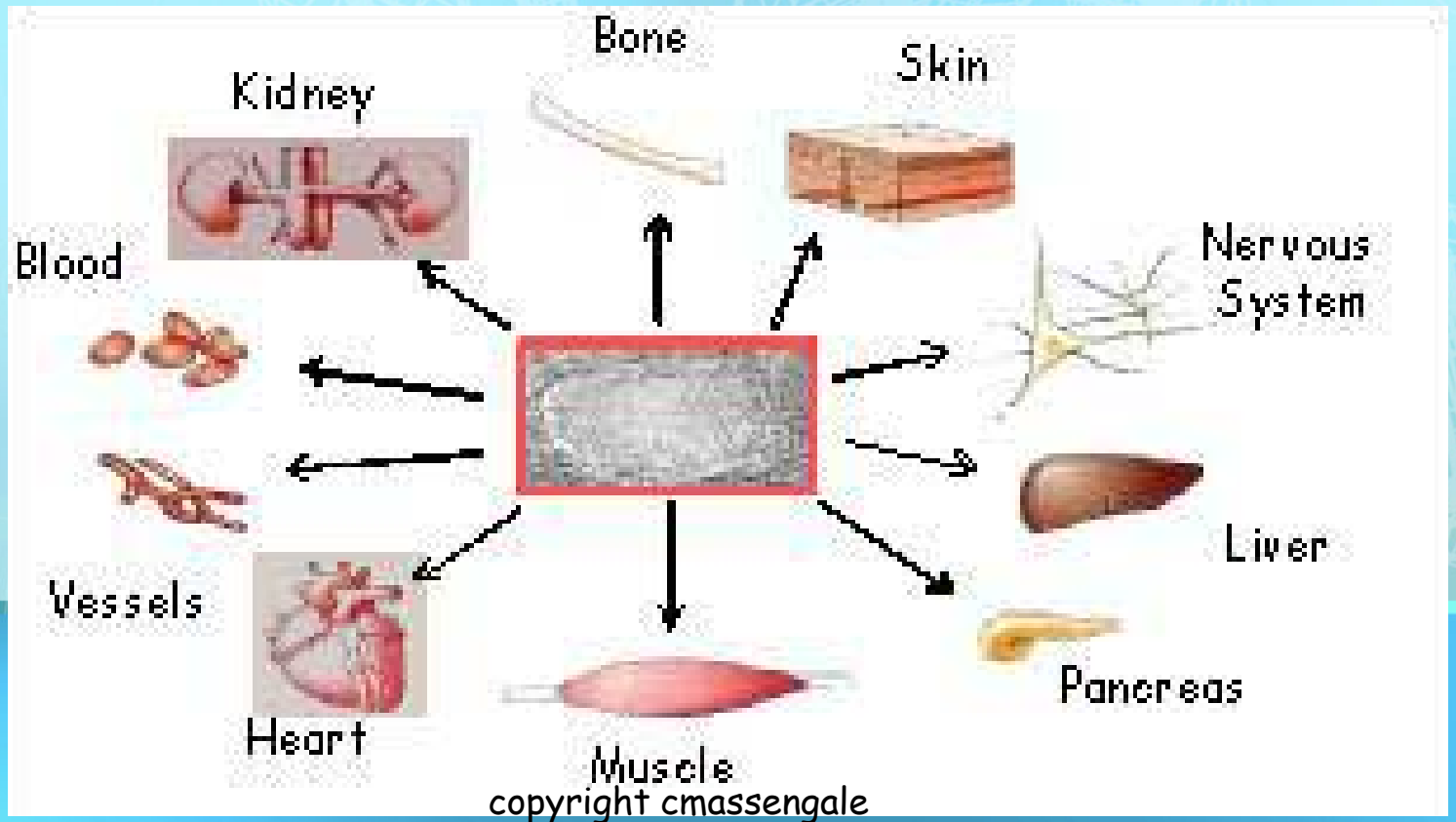
Plant cell > Animal cell > bacteria

How Big is a Micron (μ) ?

1 cm = 10,000 microns 1" = 25,000 microns

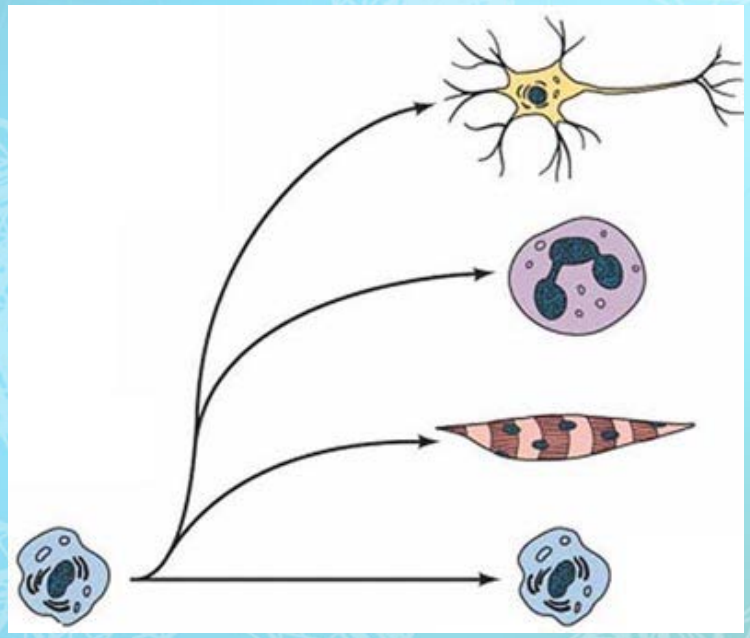
Multicellular Organisms

- Cells in multicellular organisms often **specialize** (take on different shapes & functions)



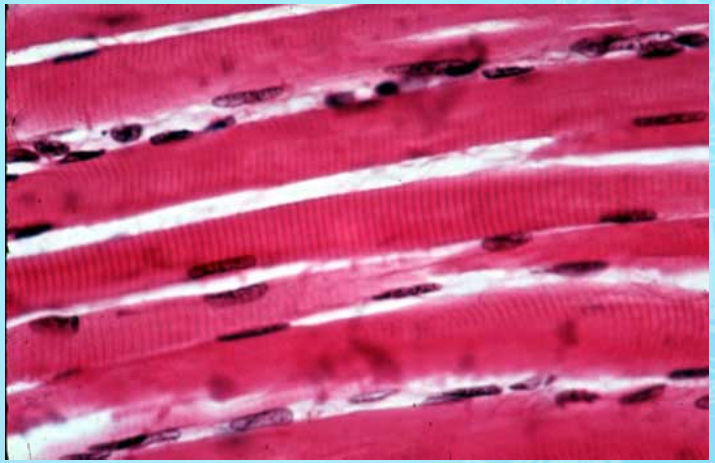
Cell Specialization

- Cells in a multi-cellular organism become specialized by turning different genes on and off
- This is known as DIFFERENTIATION



Specialized Animal Cells

Muscle cells

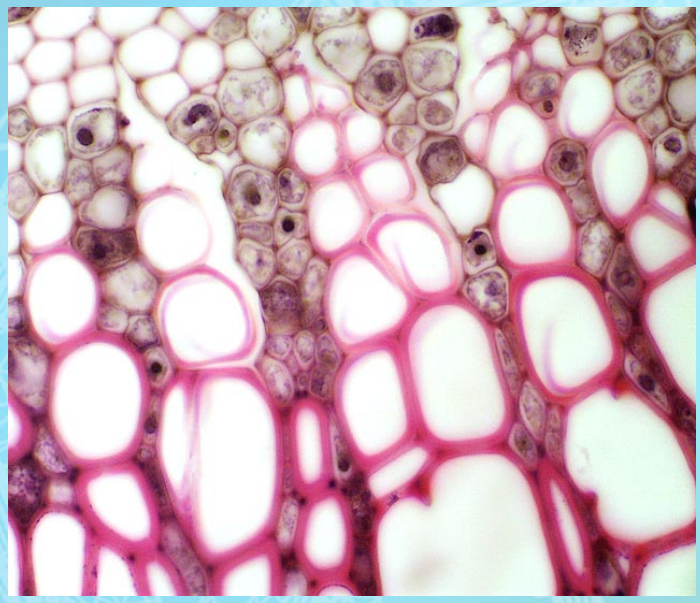


Red blood cells

Cheek cells

Specialized Plant cells

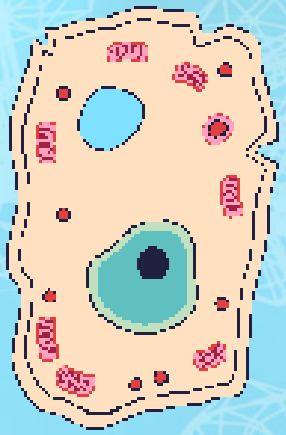
Guard Cells



Pollen

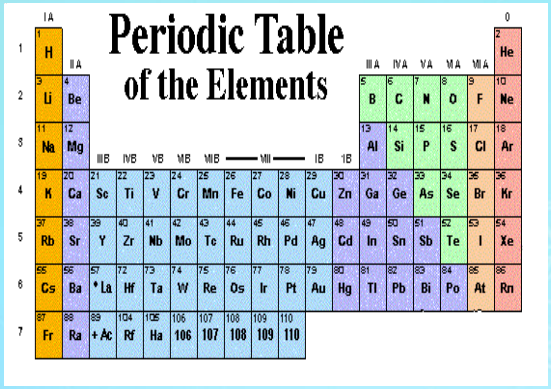
Xylem cells

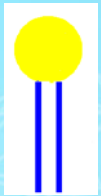
Organization Levels of Life

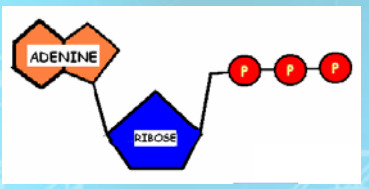


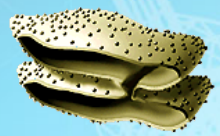
Atoms to Organisms

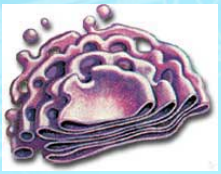
Nonliving Levels

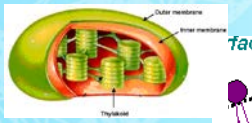


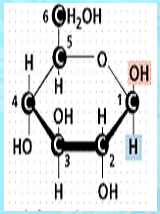


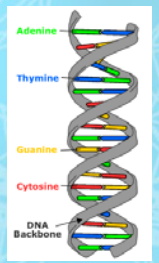


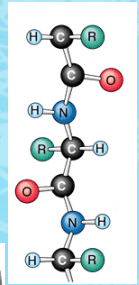


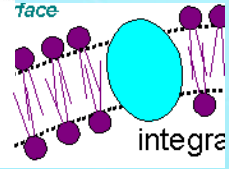


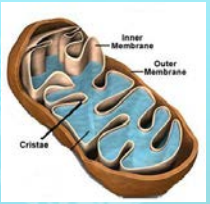


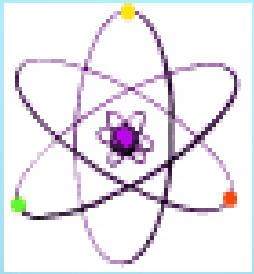


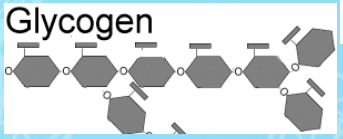






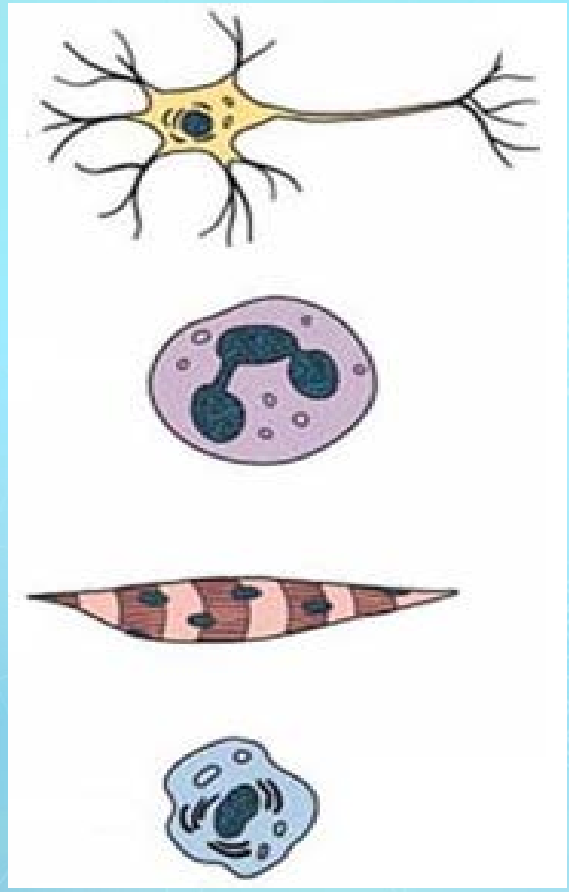






ATOMS → MOLECULES → ORGANELLES

Living Levels



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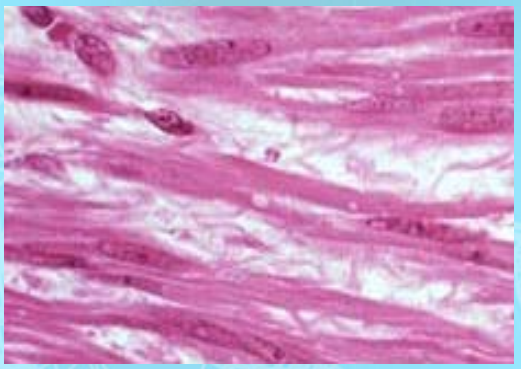
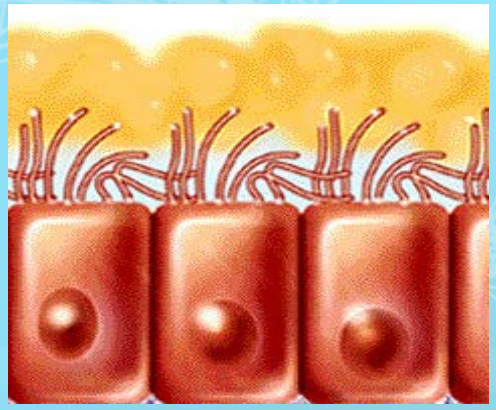
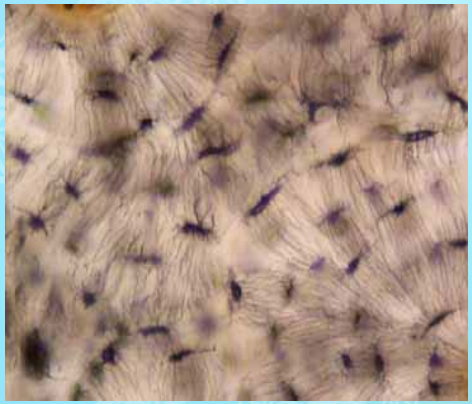
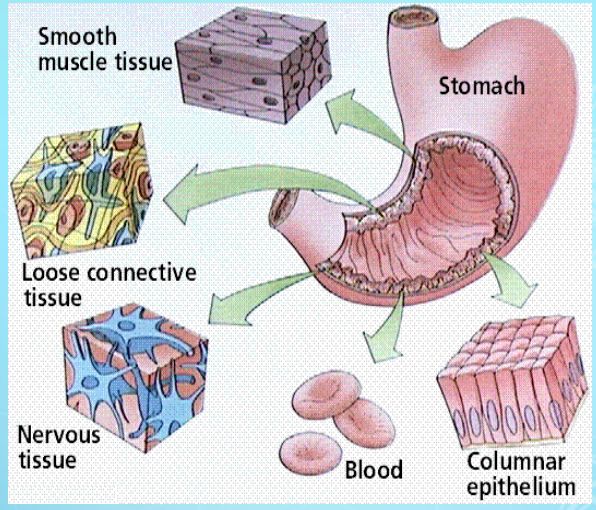


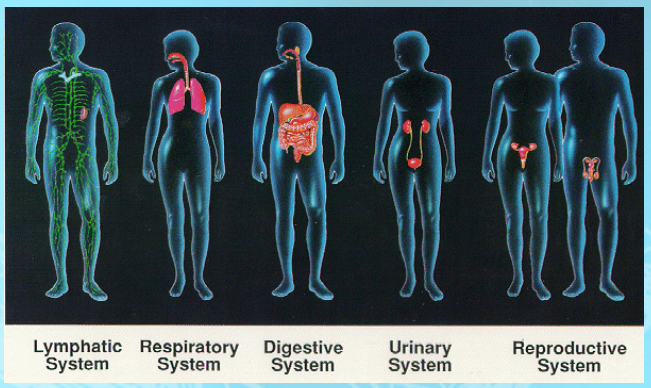


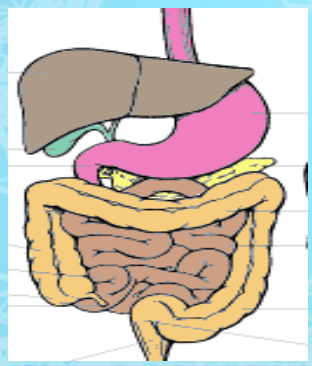


CELLS – life starts here → TISSUES – Similar cells working together

More Living Levels





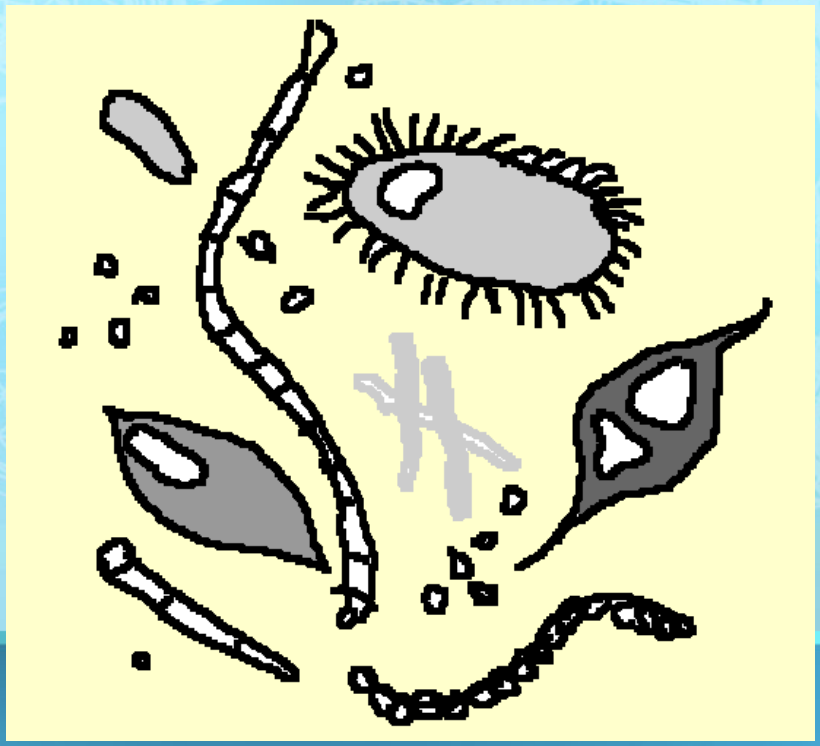


ORGANS → ORGAN SYSTEMS → ORGANISM

Different tissues working together

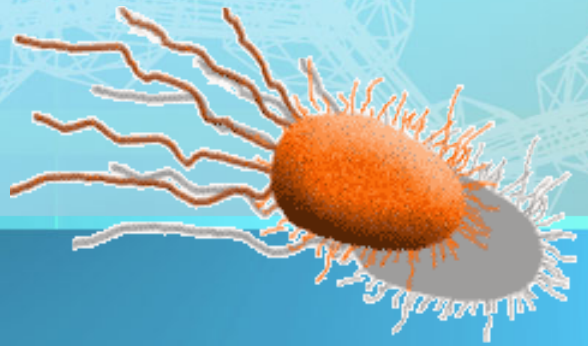
Different organs working together

Simple or Complex Cells



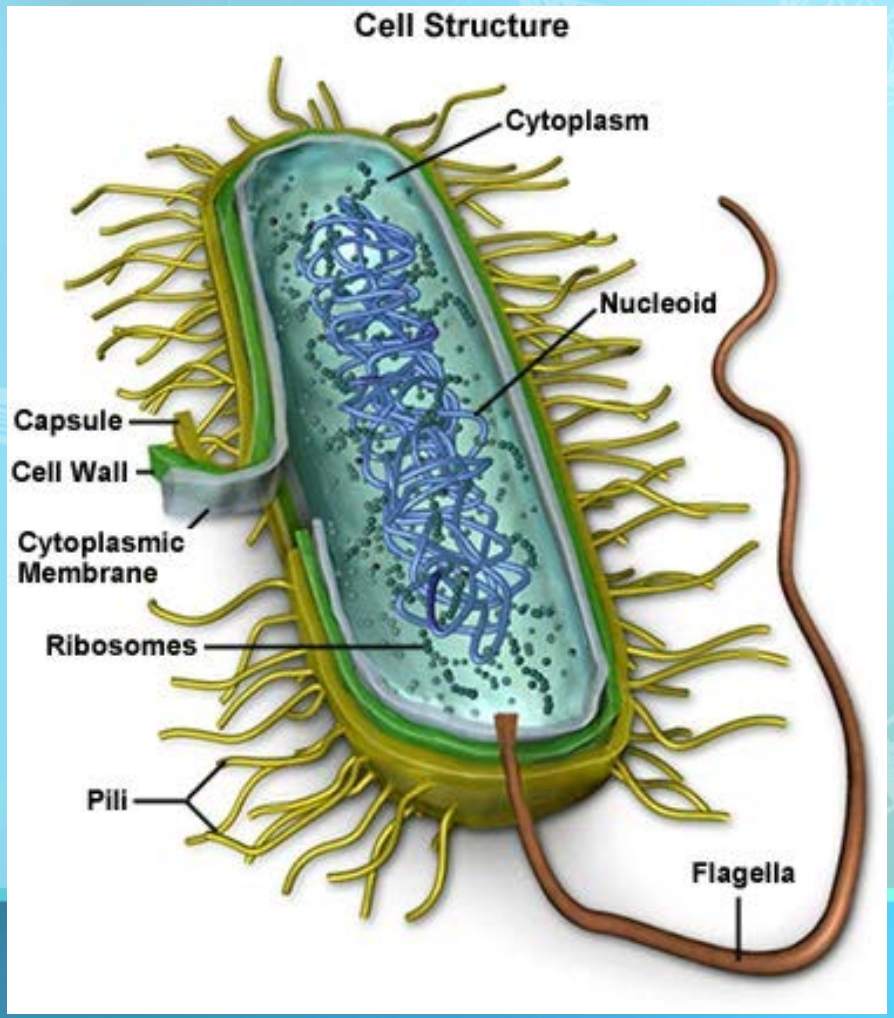
Prokaryotes – The first Cells

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



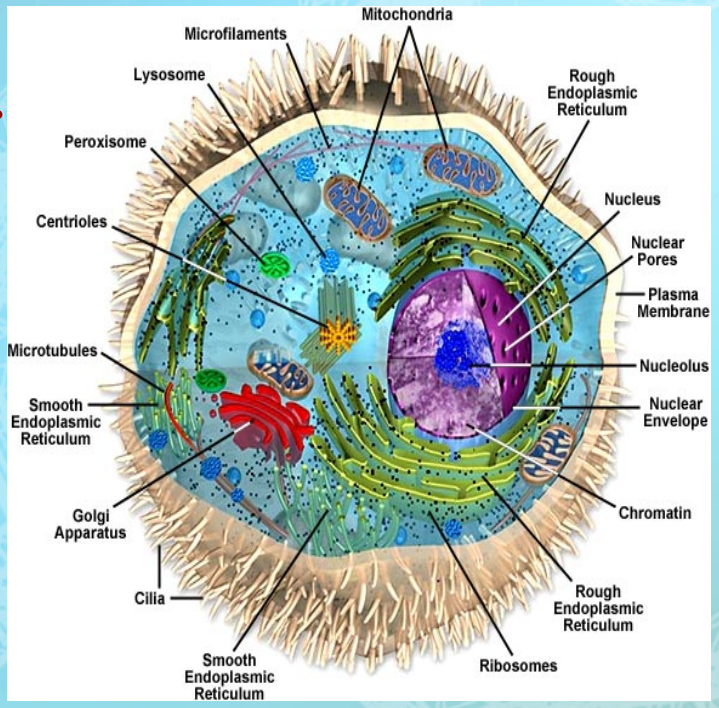
Prokaryotes

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



Eukaryotes

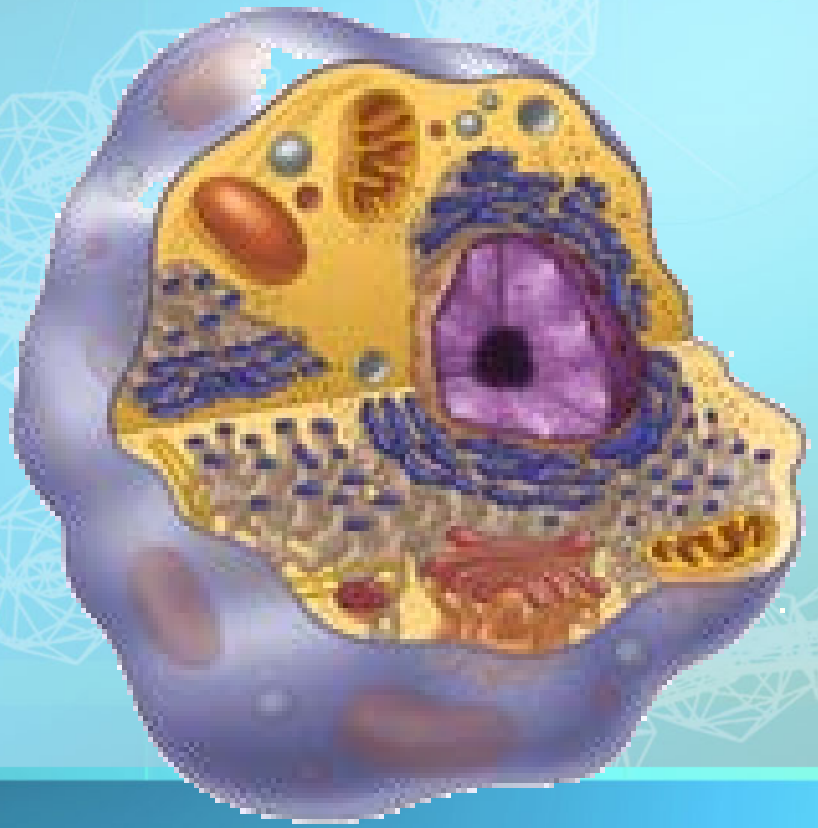
- Cells that HAVE a nucleus and membrane-bound organelles
- Includes protists, fungi, plants, and animals
- More complex type of cells



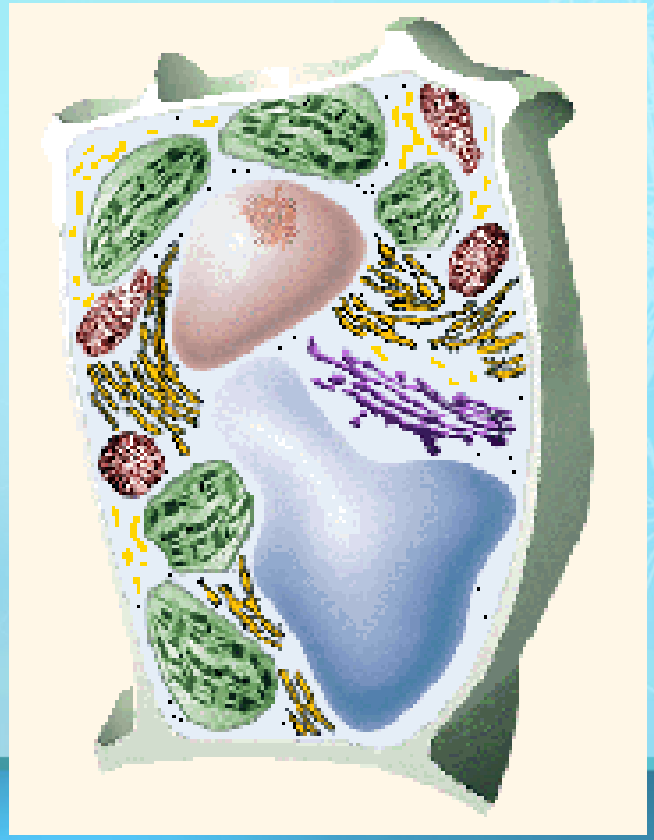
Eukaryotic Cell

Contain 3 basic cell structures:

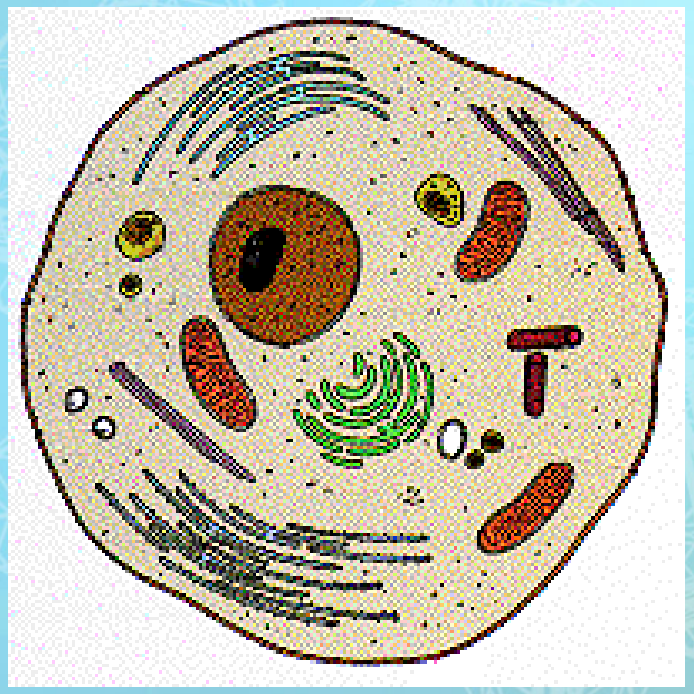
- Nucleus
- Cell Membrane
- Cytoplasm with organelles



Two Main Types of Eukaryotic Cells

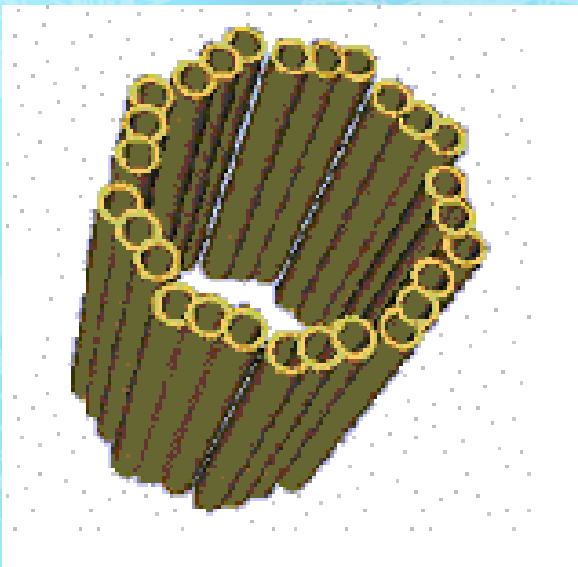


Plant Cell



Animal Cell

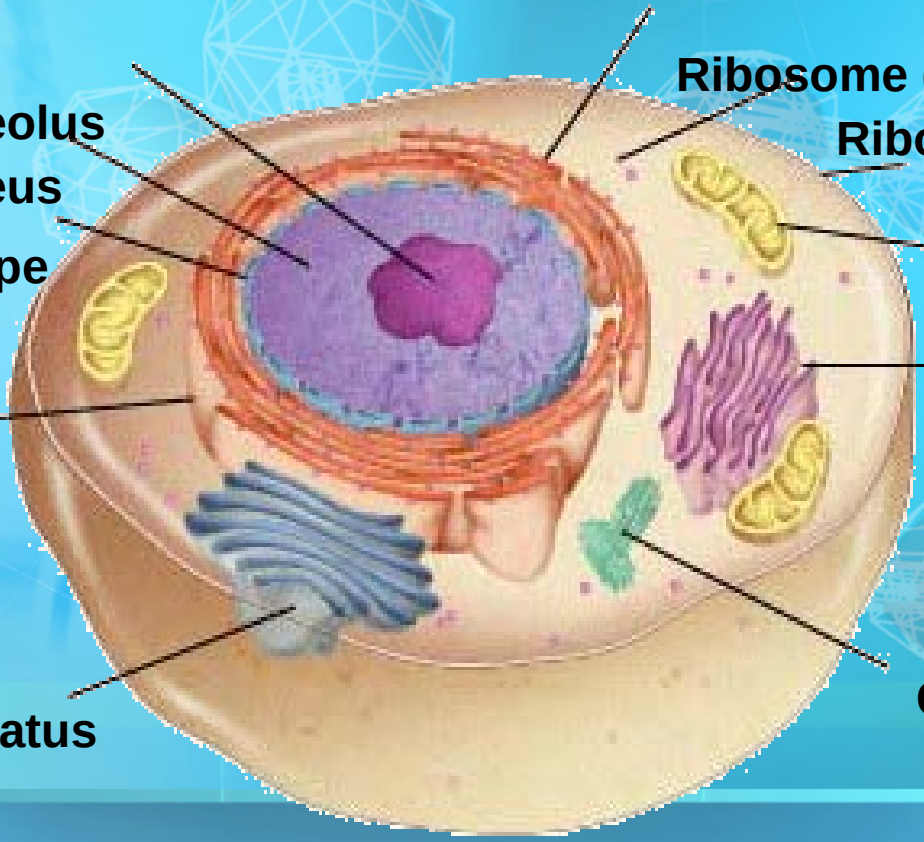
Organelles



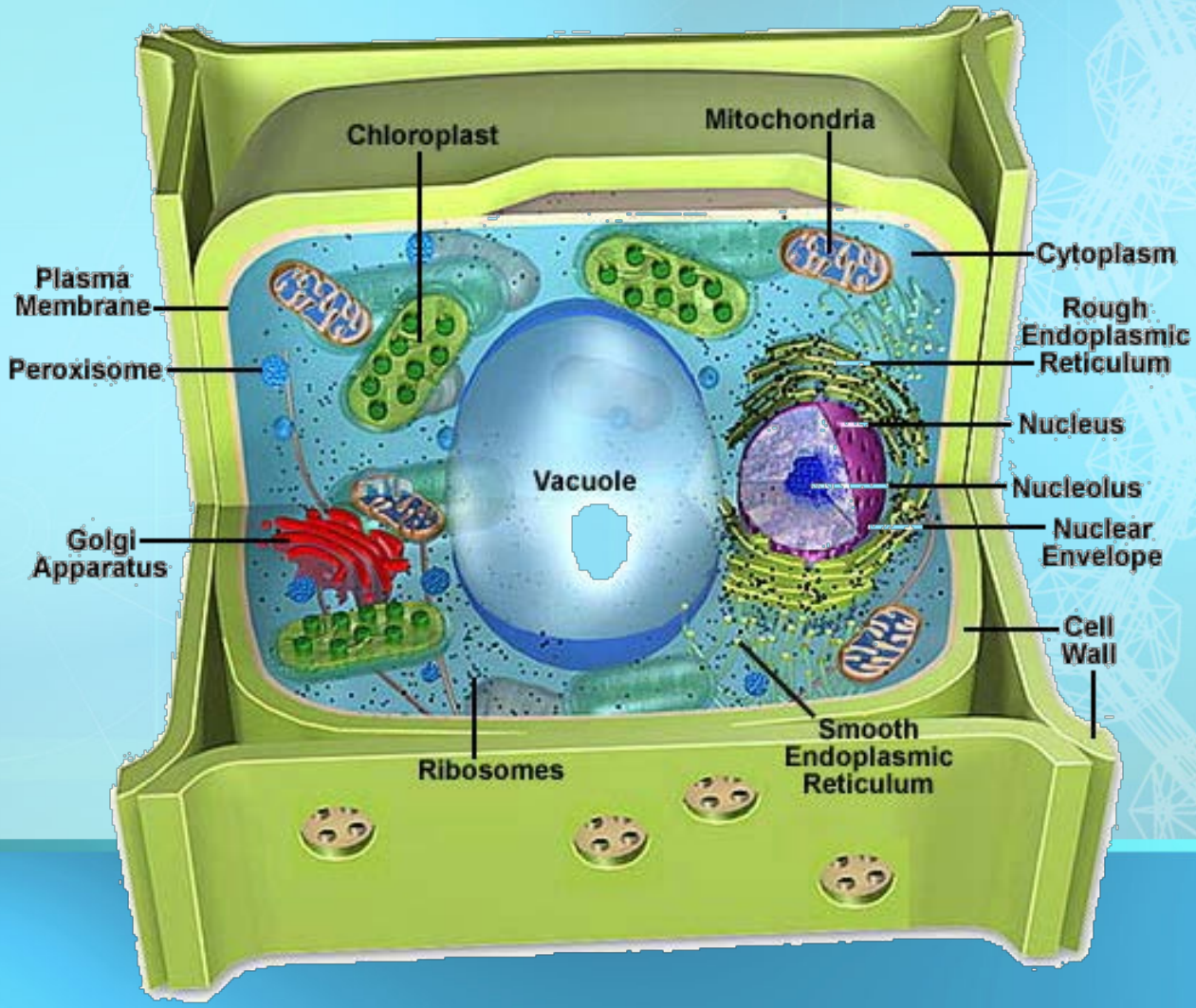
Organelles

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

Animal Cell Organelles

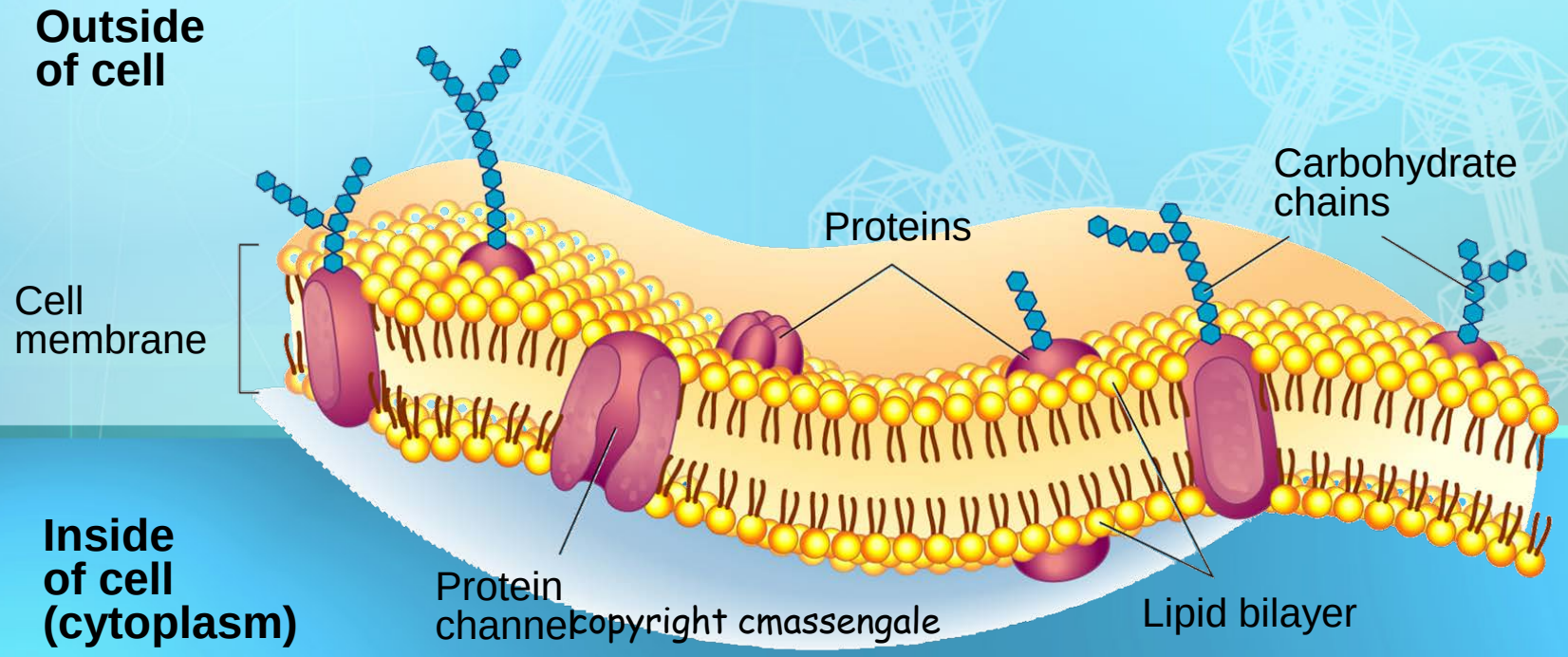


Plant Cell Organelles



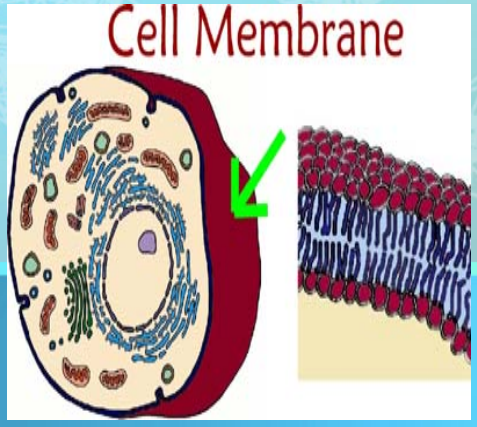
Cell or Plasma Membrane

- Composed of double layer of phospholipids and proteins
- Surrounds outside of ALL cells
- Controls what enters or leaves the cell
- Living layer

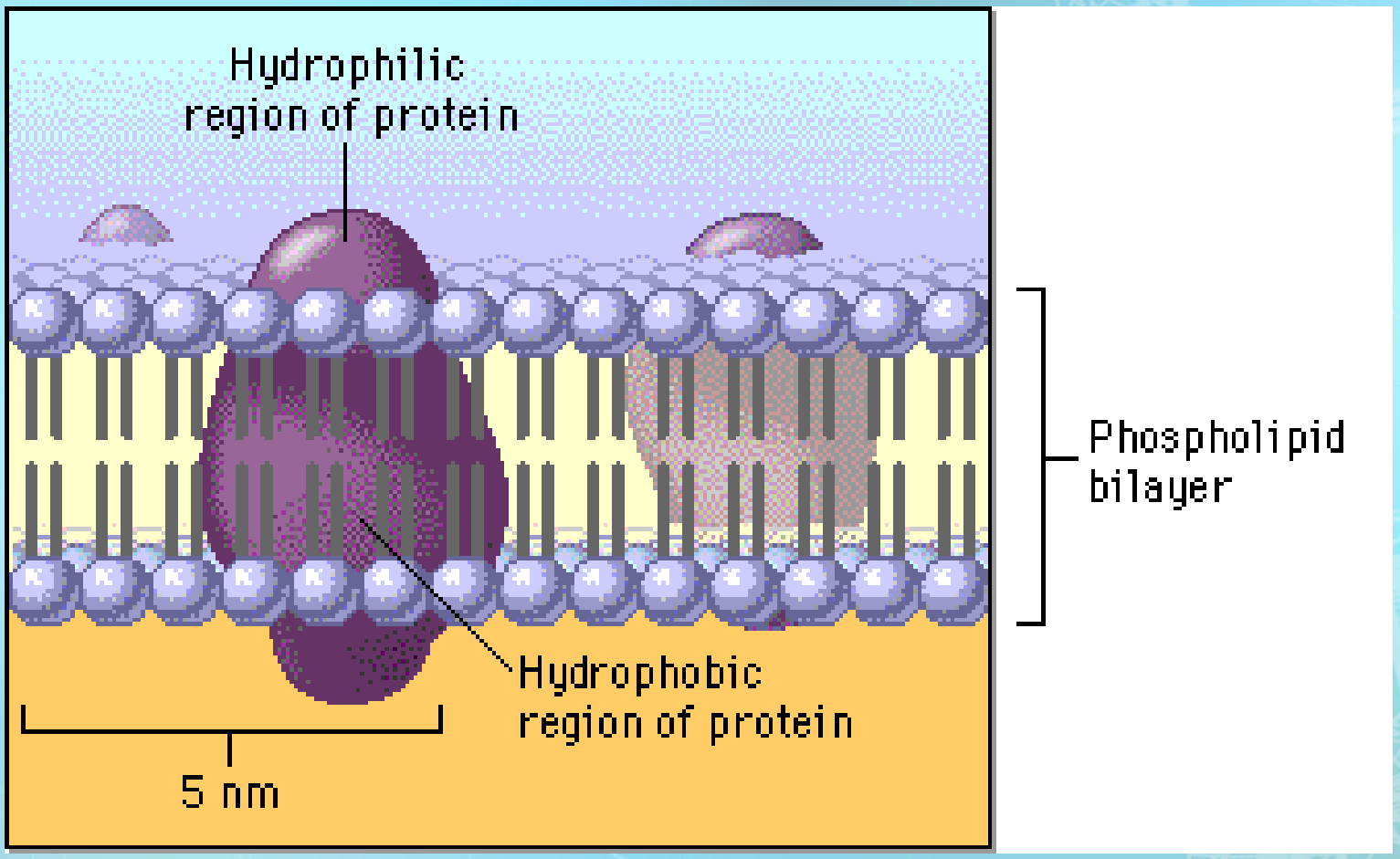


Phospholipids

- 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)



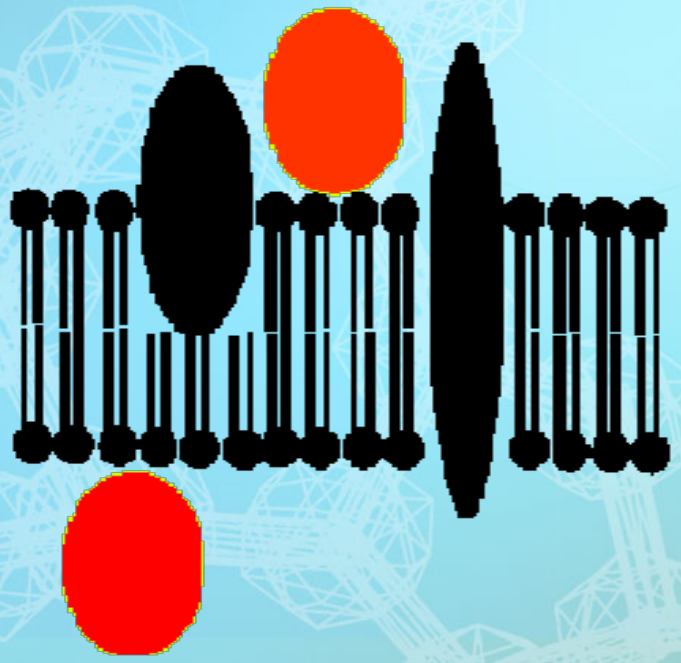
The Cell Membrane is Fluid



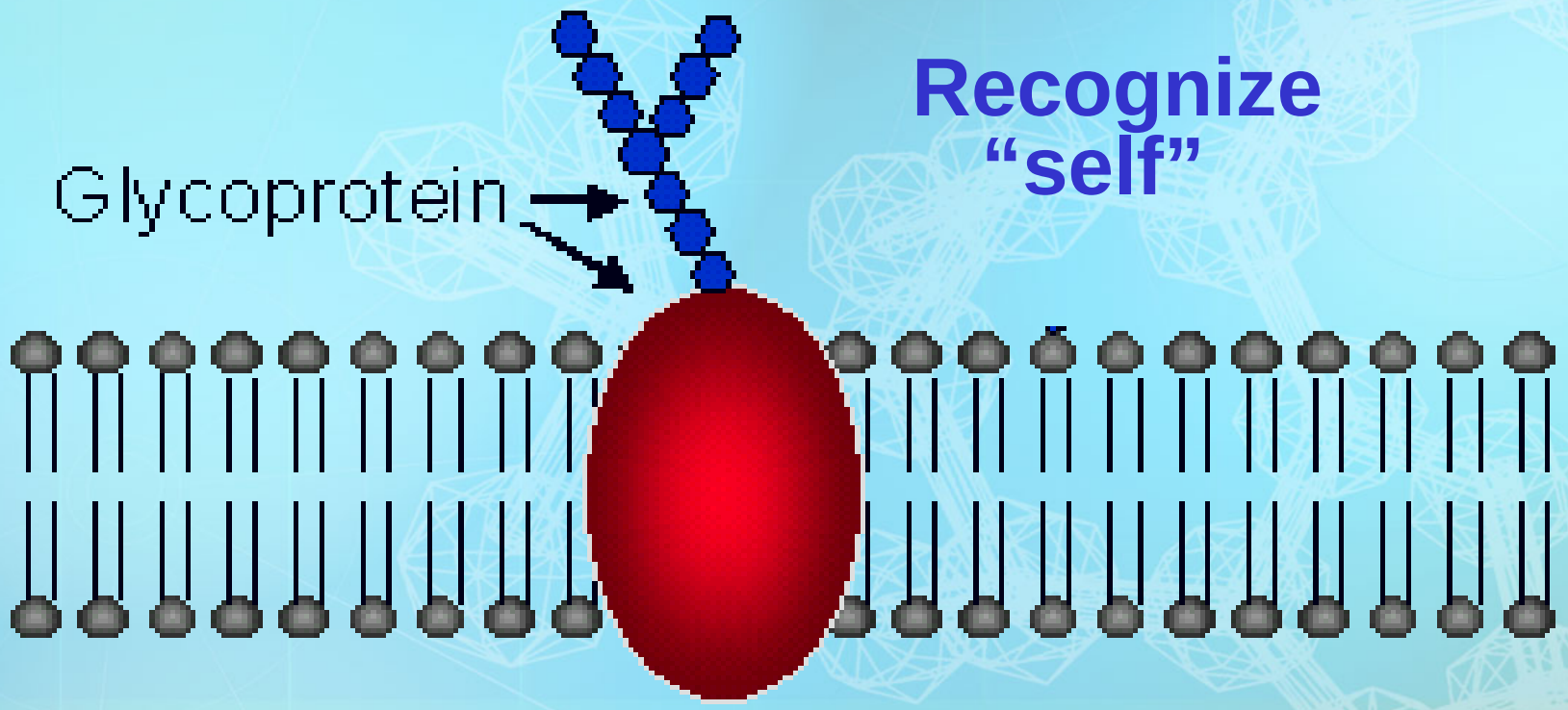
Molecules in cell membranes are constantly moving and changing

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



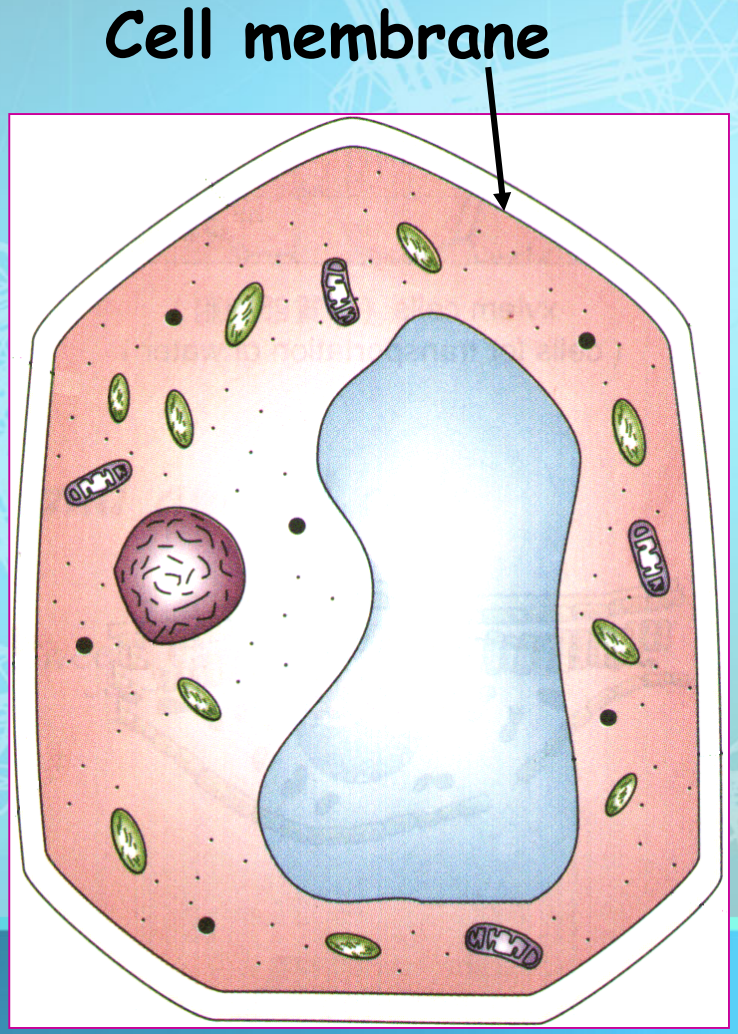
GLYCOPROTEINS



Glycoproteins have carbohydrate tails to act as markers for cell recognition

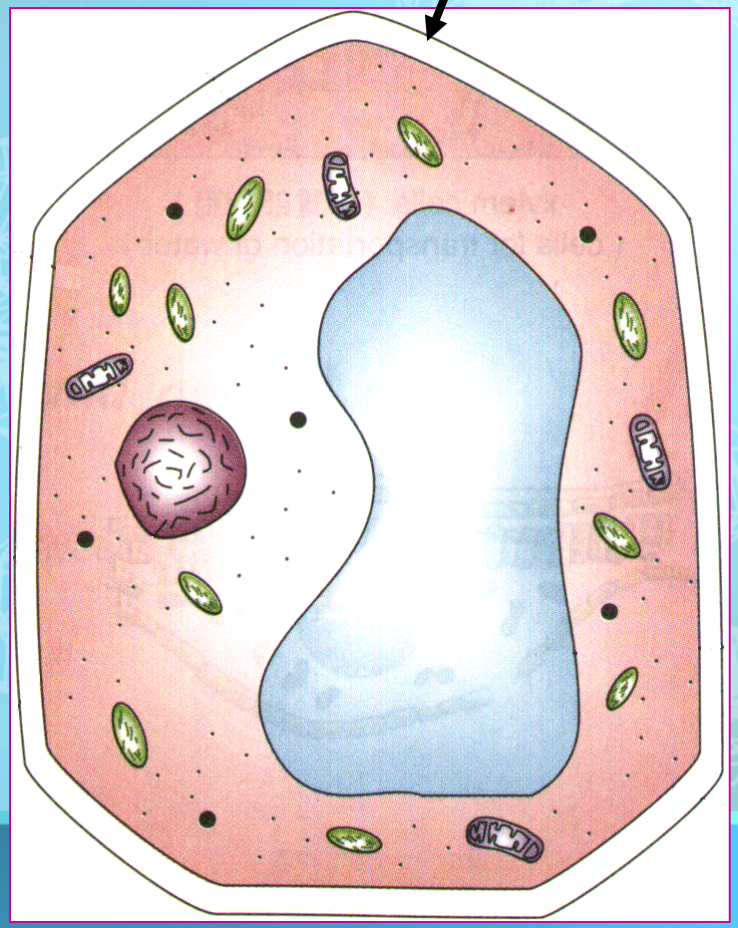
Cell Membrane in Plants

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



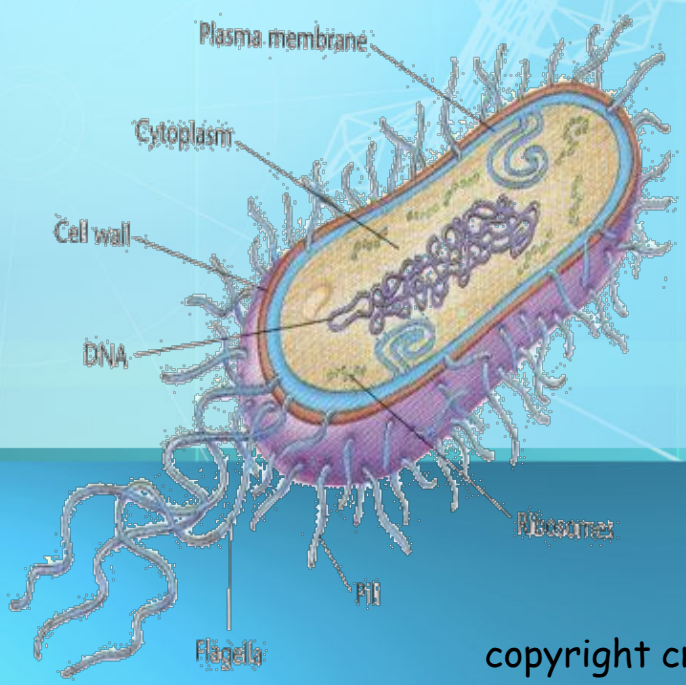
Cell Wall

- Nonliving layer
- Found in plants, fungi, & bacteria
- Made of cellulose in plants
- Made of peptidoglycan in bacteria
- Made of chitin in Fungi



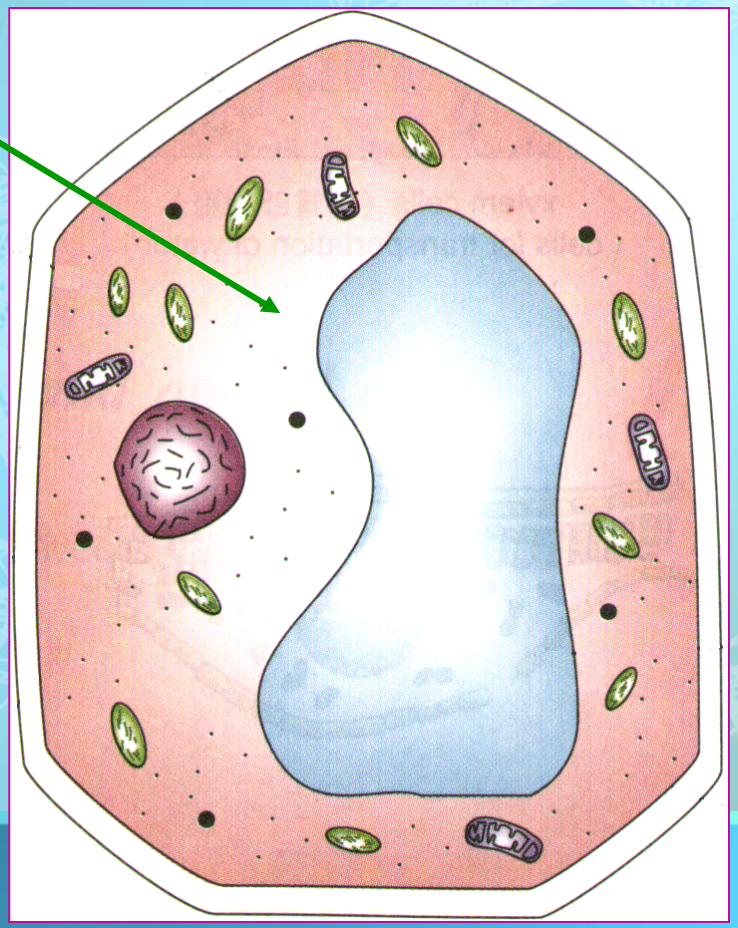
Cell Wall

- **Supports** and **protects** cell
- Found **outside of the cell membrane**



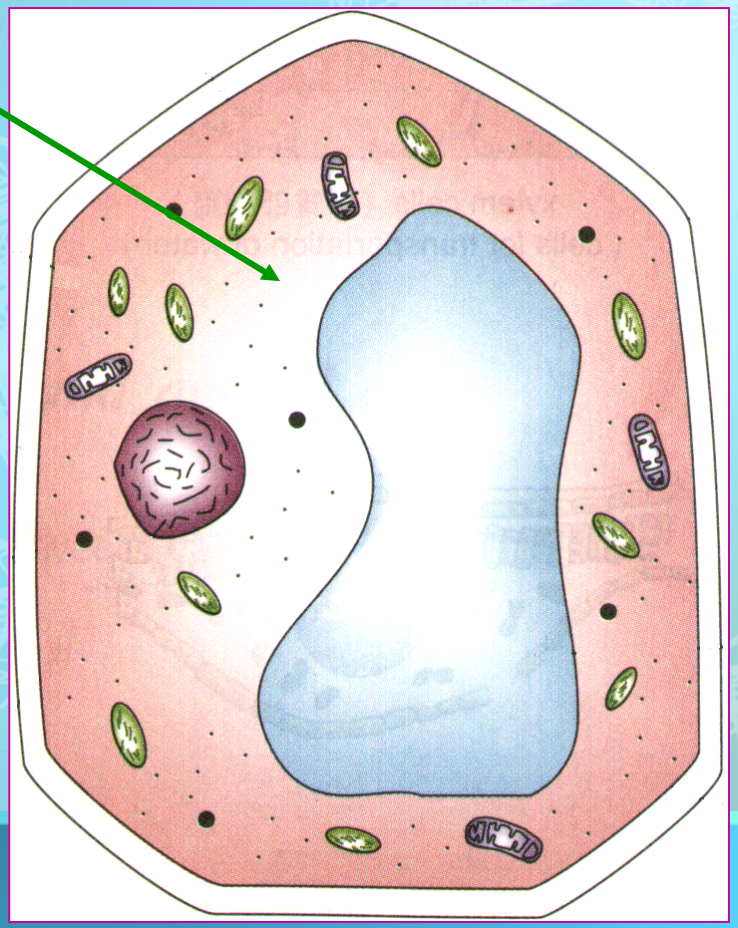
Cytoplasm of a Cell

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



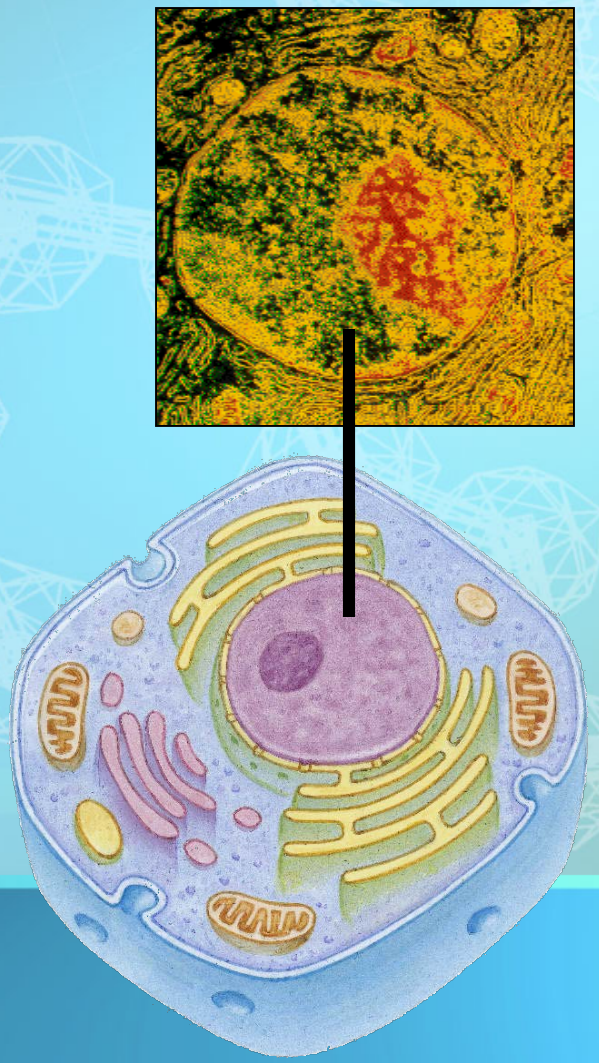
More on Cytoplasm

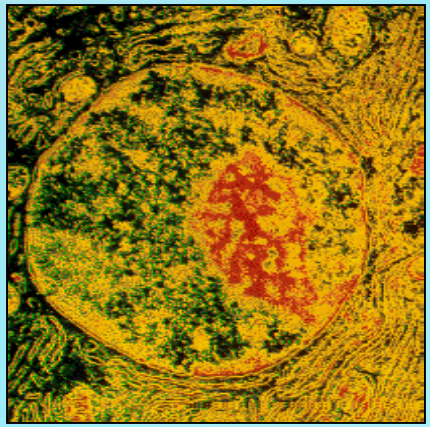
- Contains organelles to carry out specific jobs
- Found in ALL cells



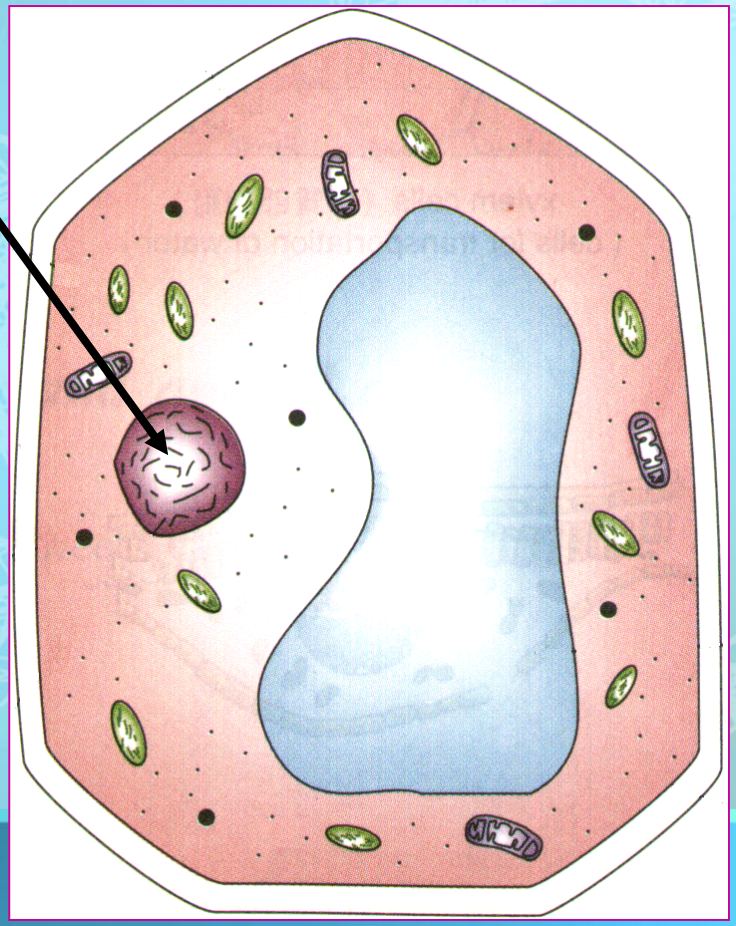
The Control Organelle - Nucleus

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





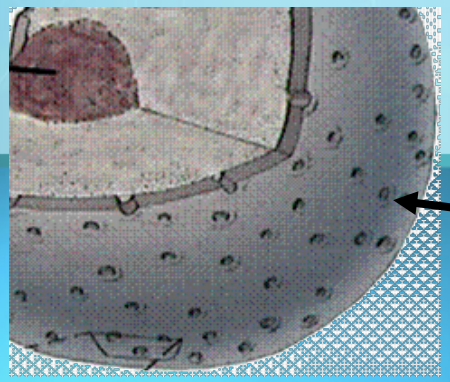
More on the Nucleus



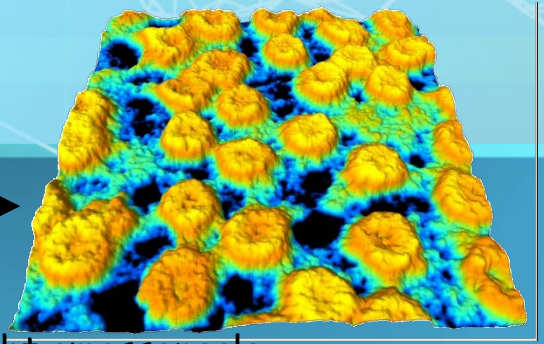
- Each cell has fixed number of chromosomes that carry **genes**
- Genes control cell characteristics

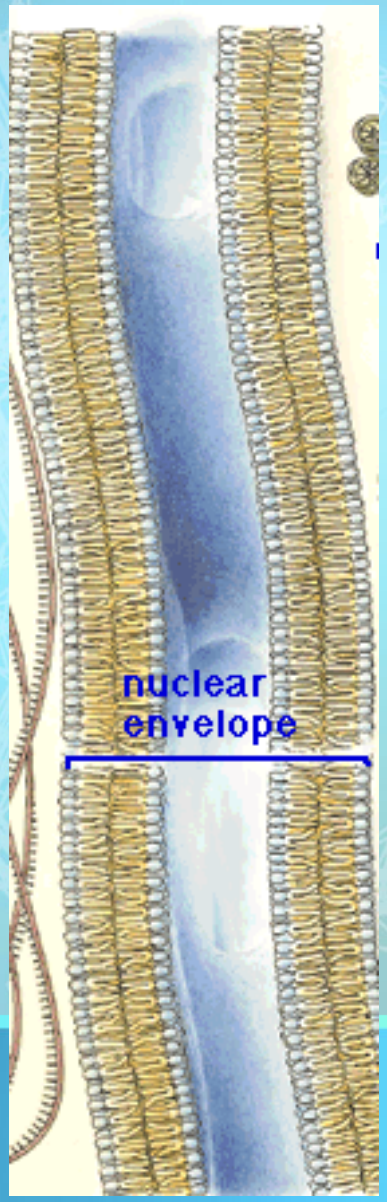
Nuclear Envelope

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



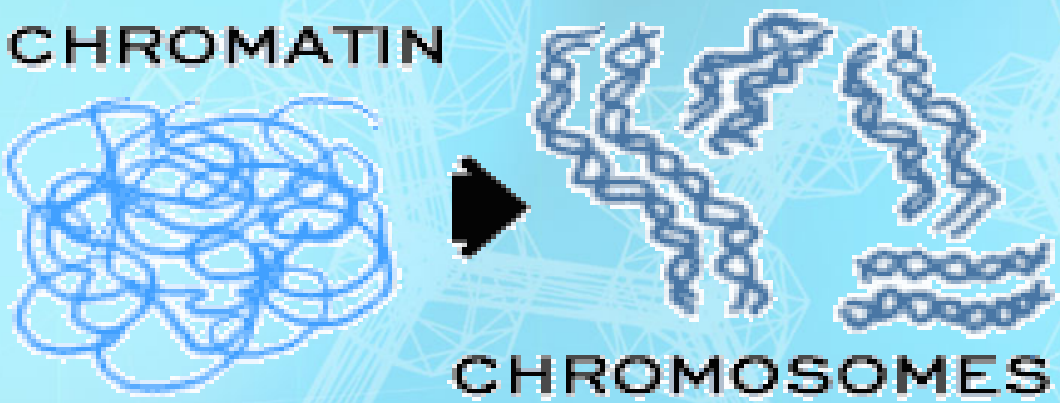
Nuclear pores





Inside the Nucleus -

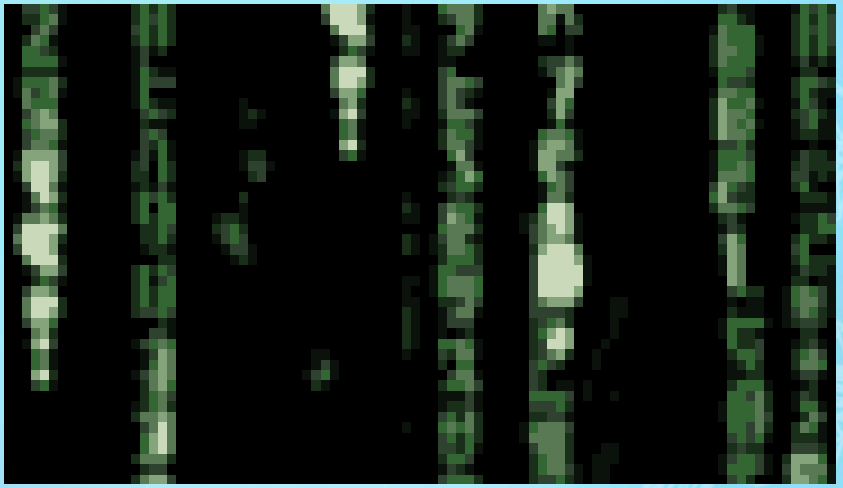
The genetic material (DNA) is found



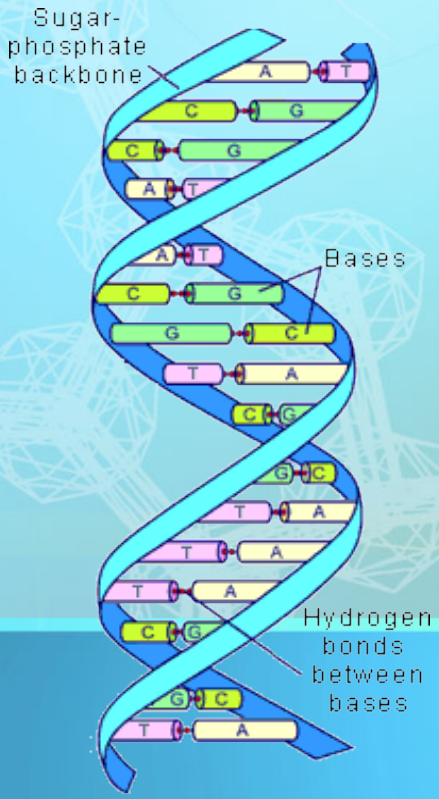
DNA is spread out
And appears as
CHROMATIN
in non-dividing cells

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

What Does DNA do?



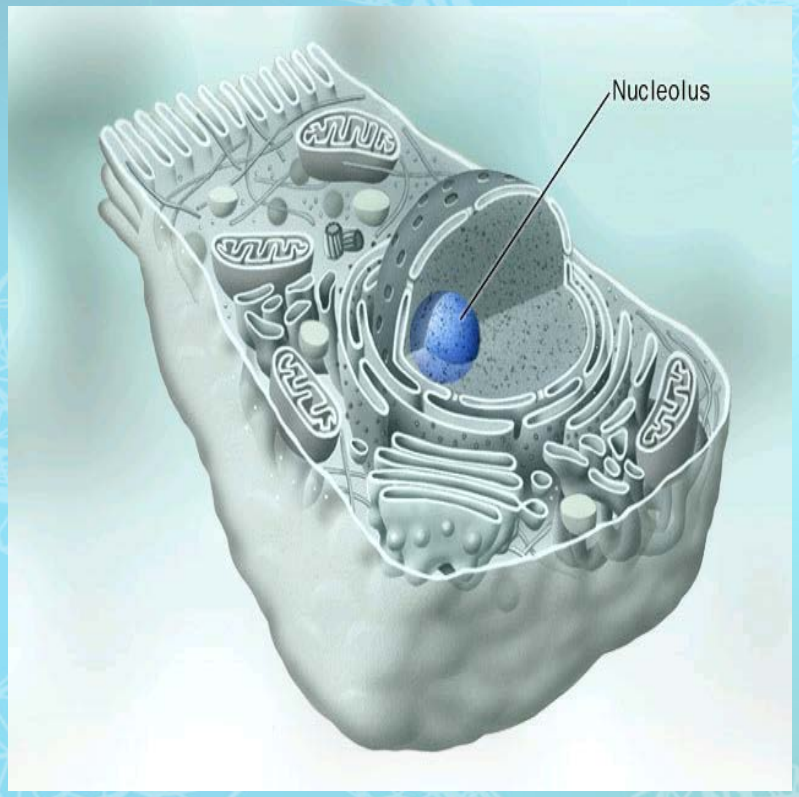
DNA is the **hereditary material** of the cell

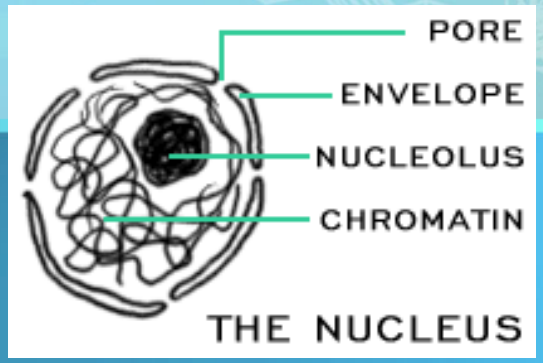


Genes that make up the DNA molecule code for different **proteins**

Nucleolus

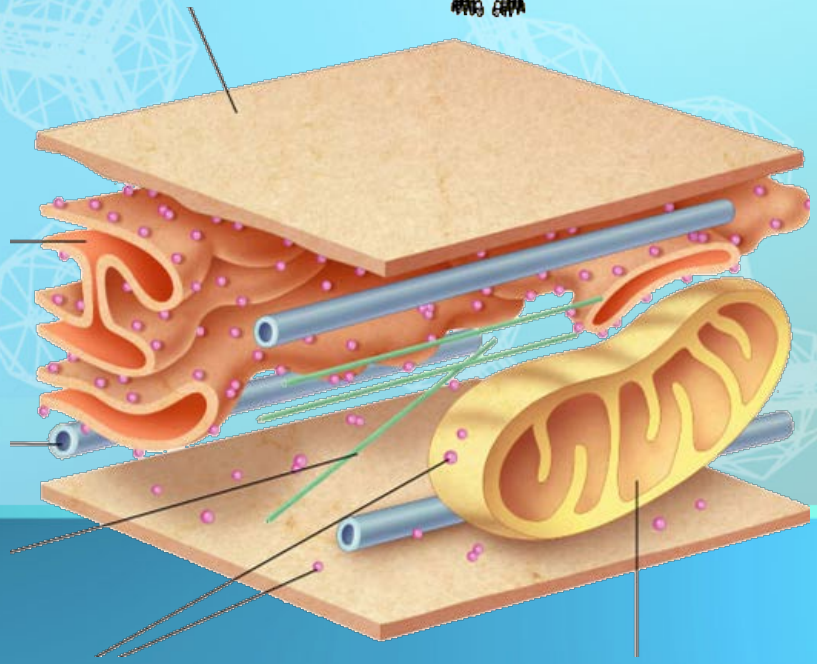
- Inside nucleus
- Cell may have 1 to 3 nucleoli
- Disappears when cell divides
- Makes ribosomes that make proteins



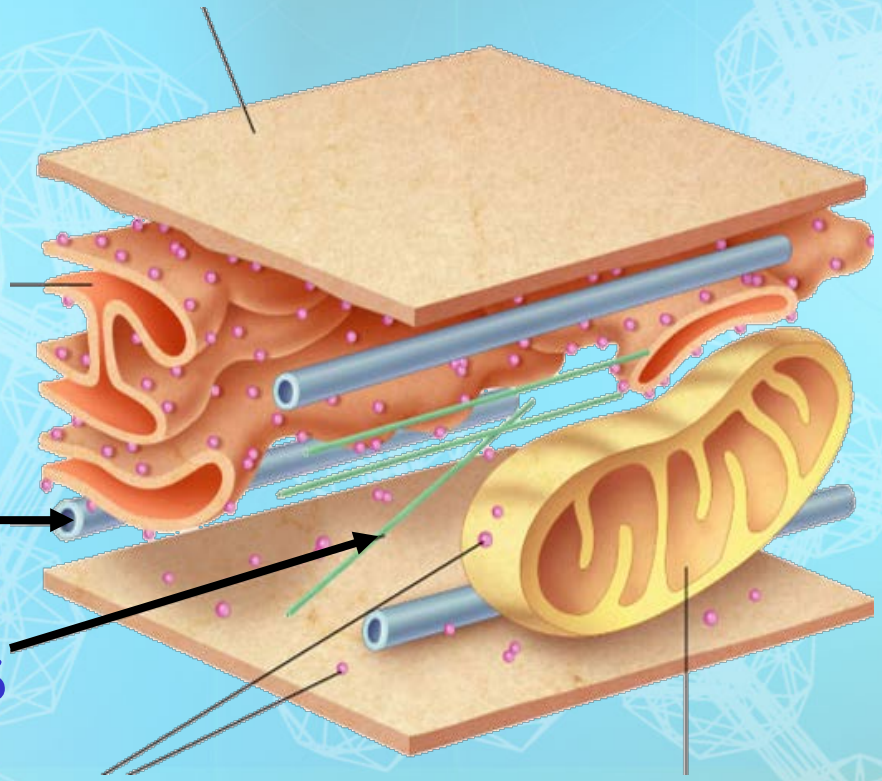


Cytoskeleton

- 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



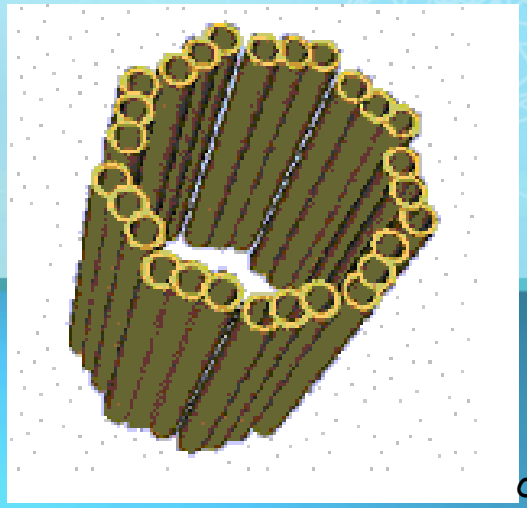
Cytoskeleton



MICROTUBULES

MICROFILAMENTS

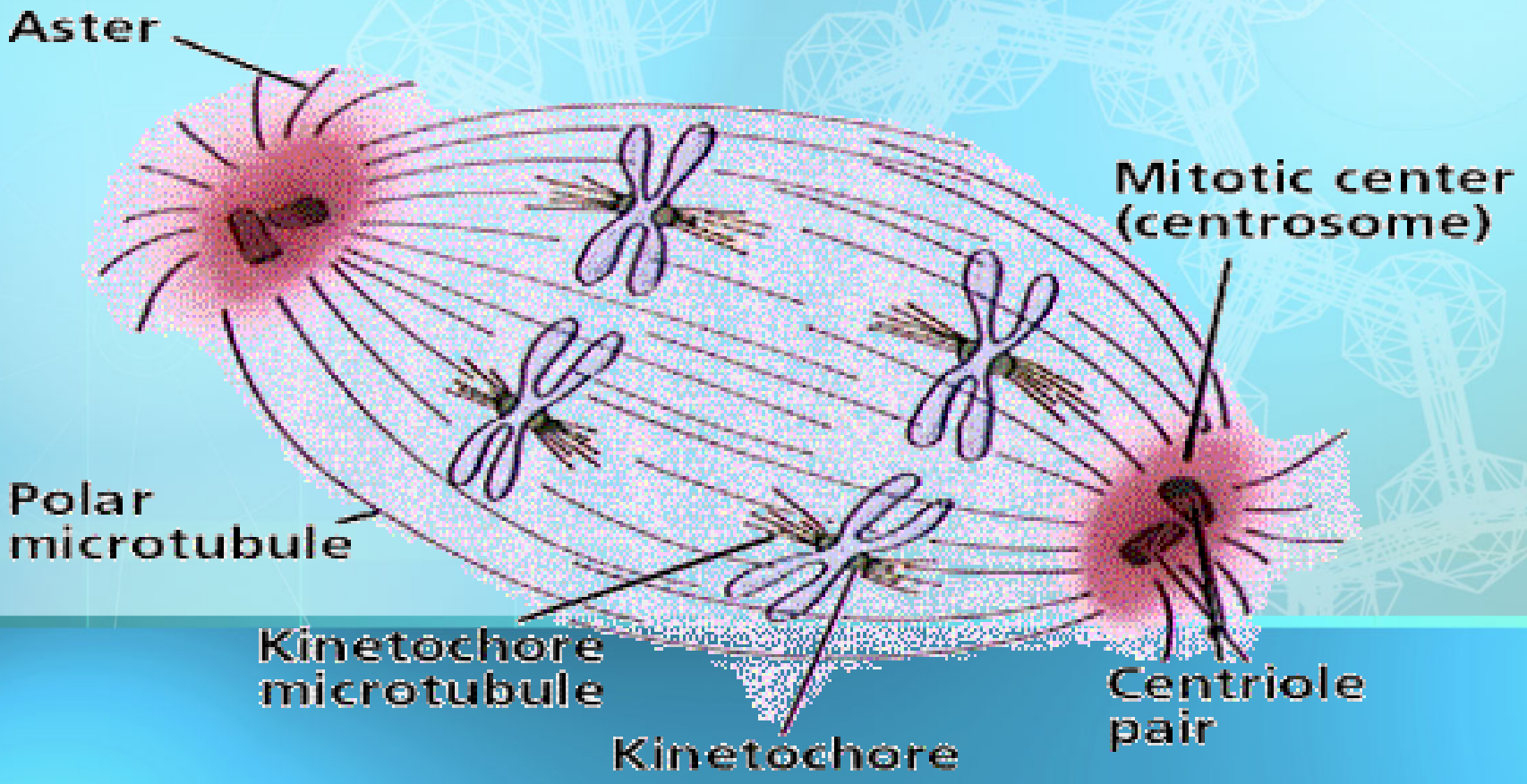
Centrioles



- 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

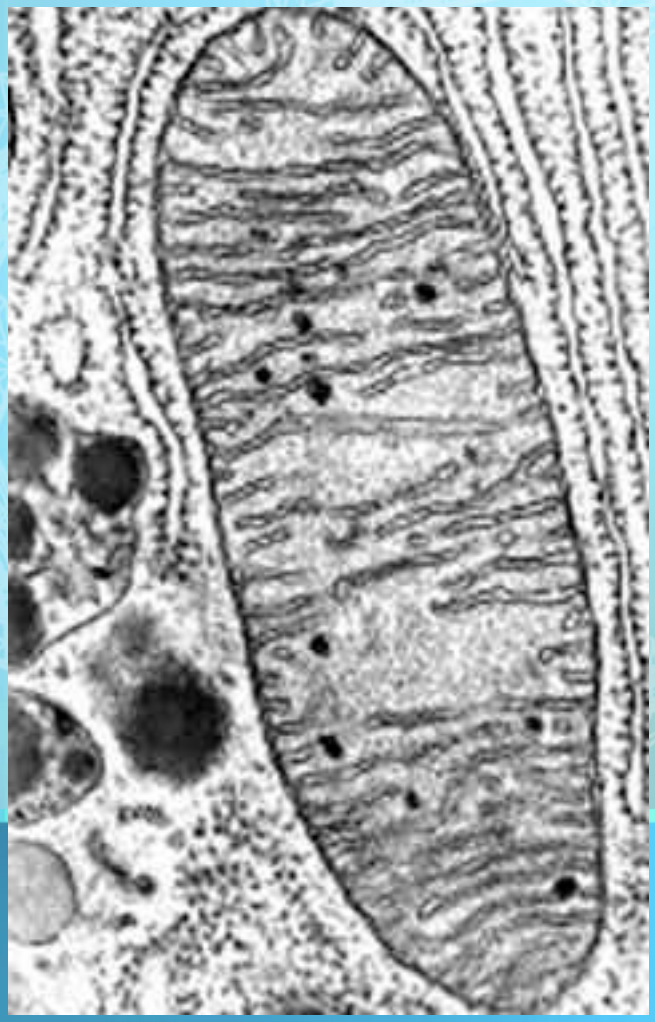
Centrioles & the Mitotic Spindle

Made of MICROTUBULES (Tubulin)



Mitochondrion (plural = mitochondria)

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



MITOCHONDRIA

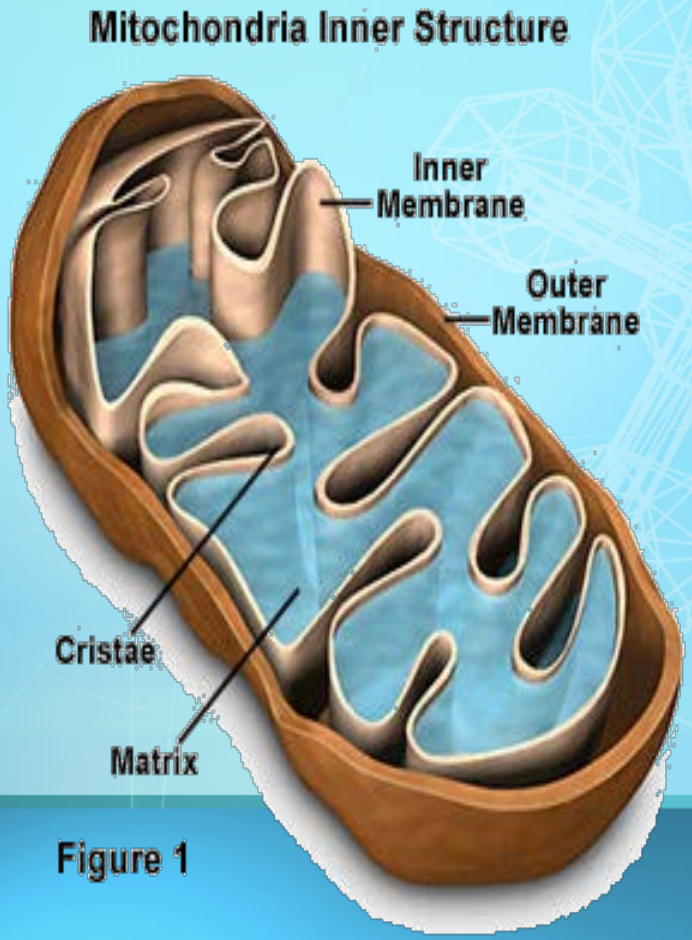


Figure 1

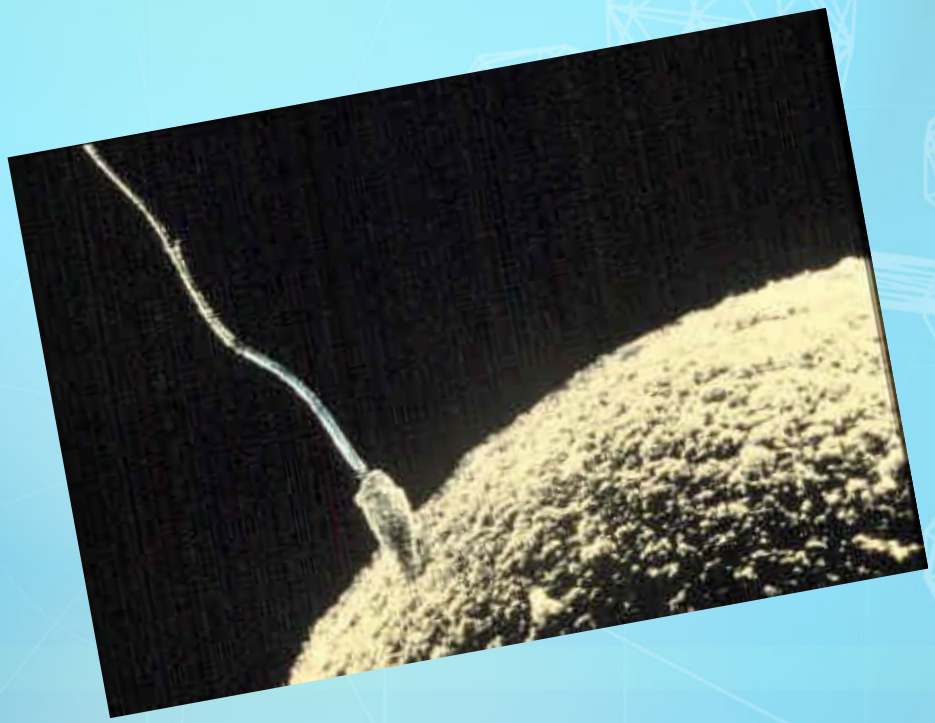
Surrounded by a DOUBLE membrane

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

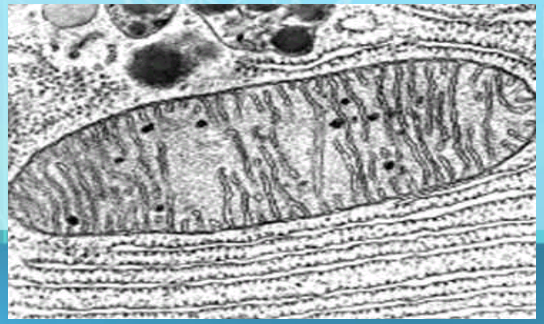
Therefore …

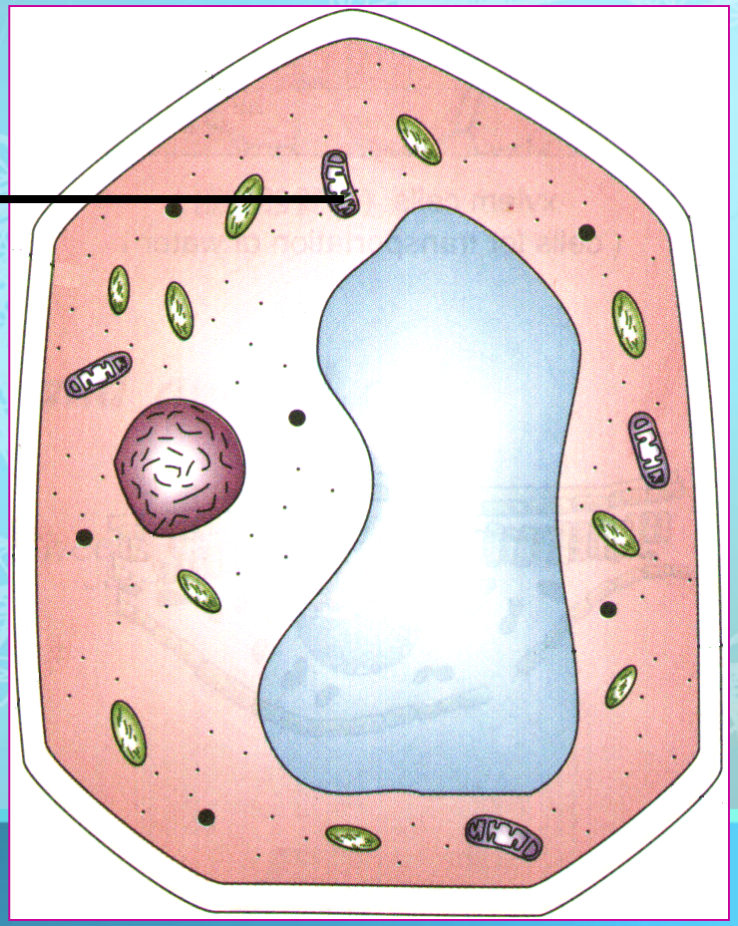
- You inherit your mitochondria from your mother!

Cell Powerhouse

Mitochondrion
(mitochondria)

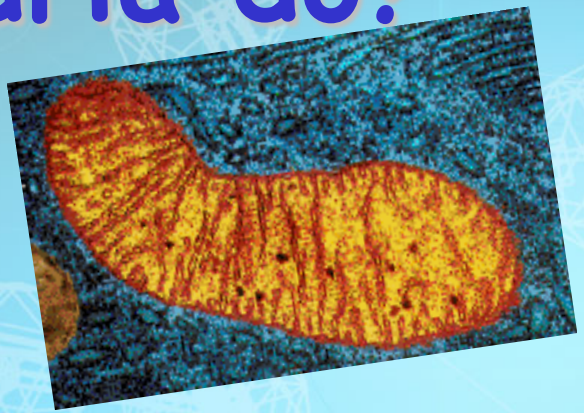
Rod shape



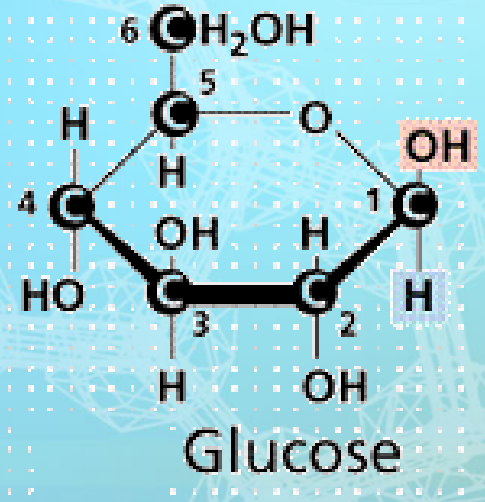


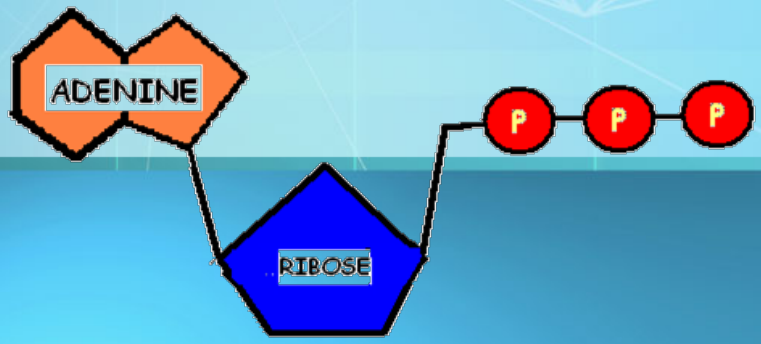
What do mitochondria do?

"Power plant" of the cell



Burns glucose to release energy (ATP)





Stores energy as ATP

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)

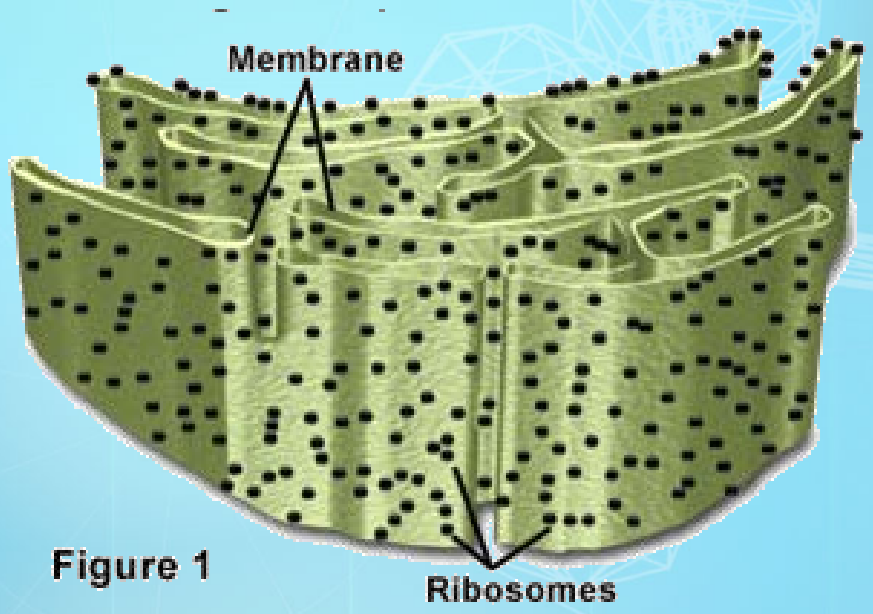
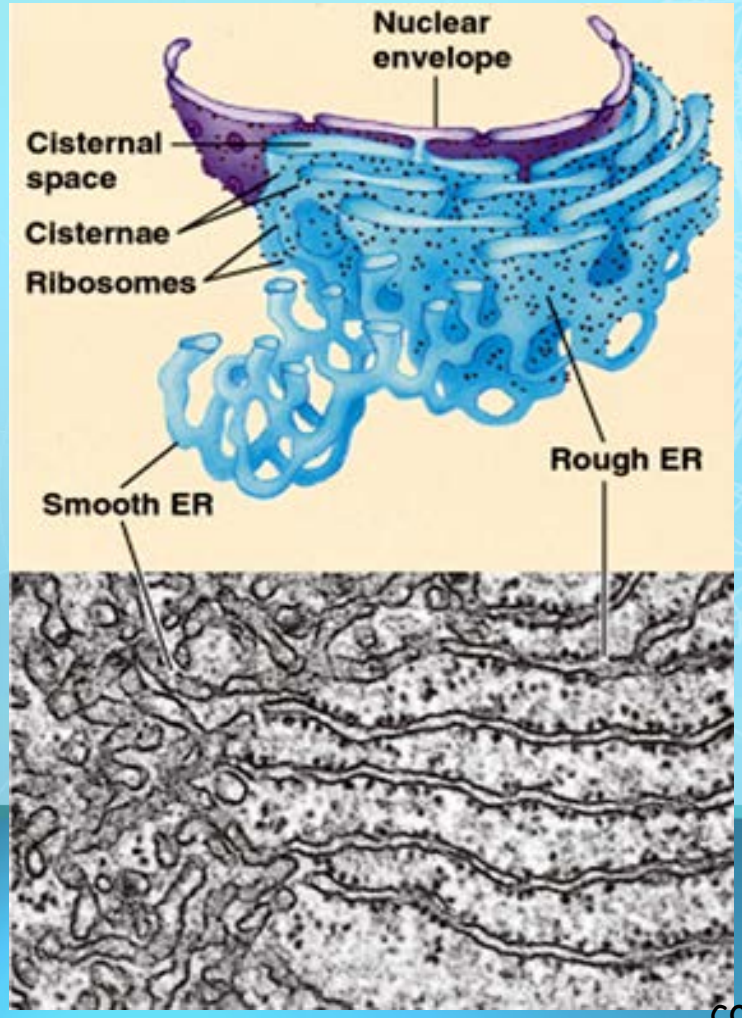


Figure 1

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

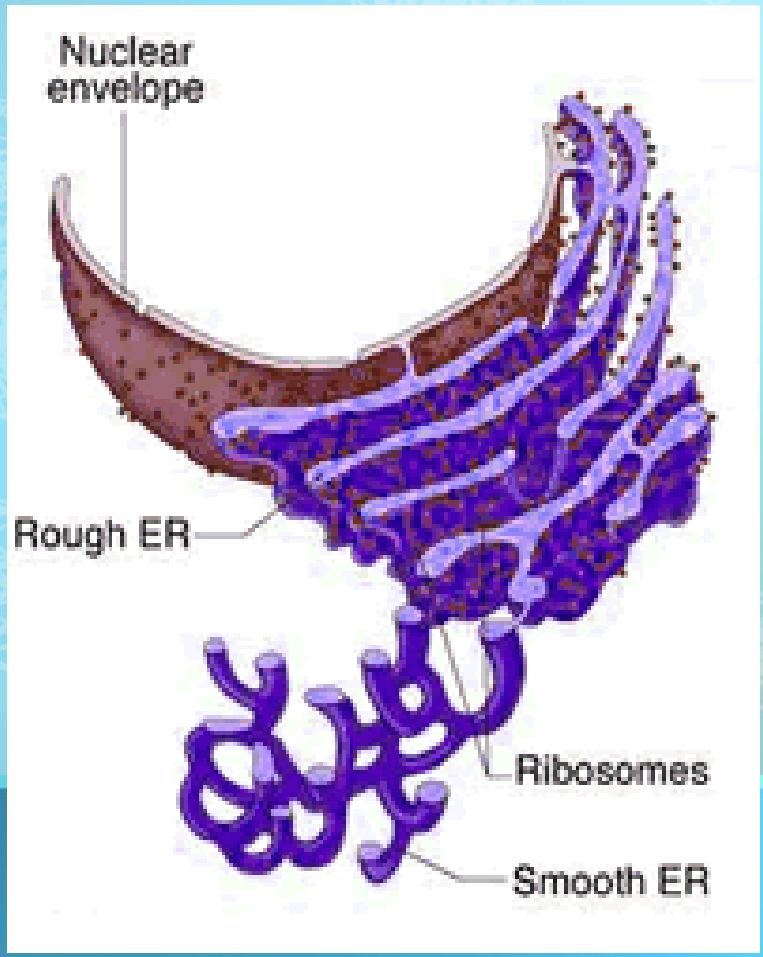
Rough Endoplasmic Reticulum (Rough ER)



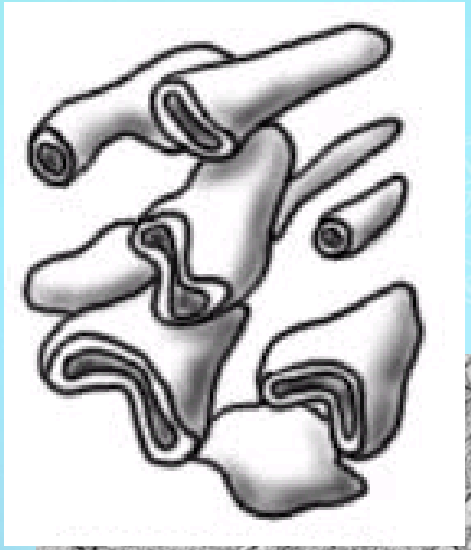
- Proteins are made by ribosomes on ER surface
- They are then threaded into the interior of the Rough ER to be modified and transported

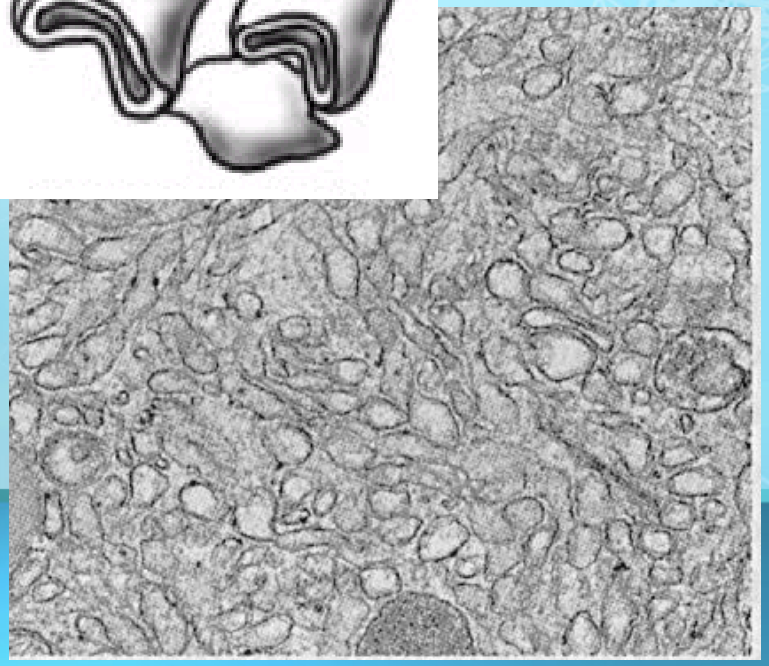
Smooth Endoplasmic Reticulum

- *Smooth ER* lacks ribosomes on its surface
- Is attached to the ends of rough ER
- Makes cell products that are USED INSIDE the cell



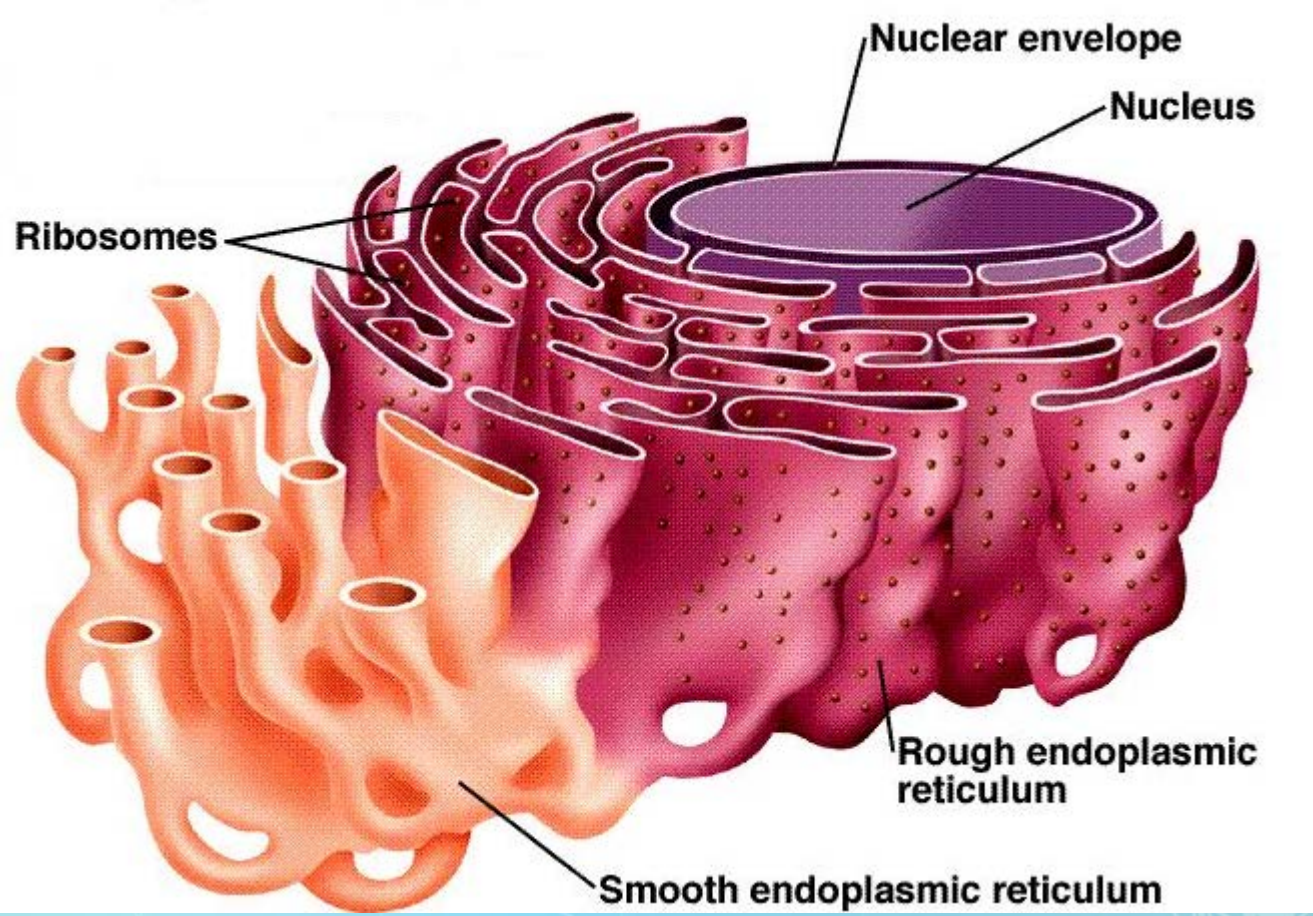
Functions of the Smooth ER





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

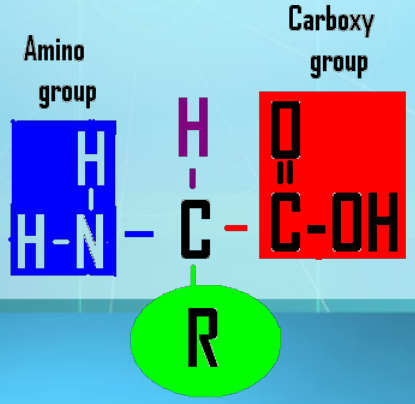
Endomembrane System

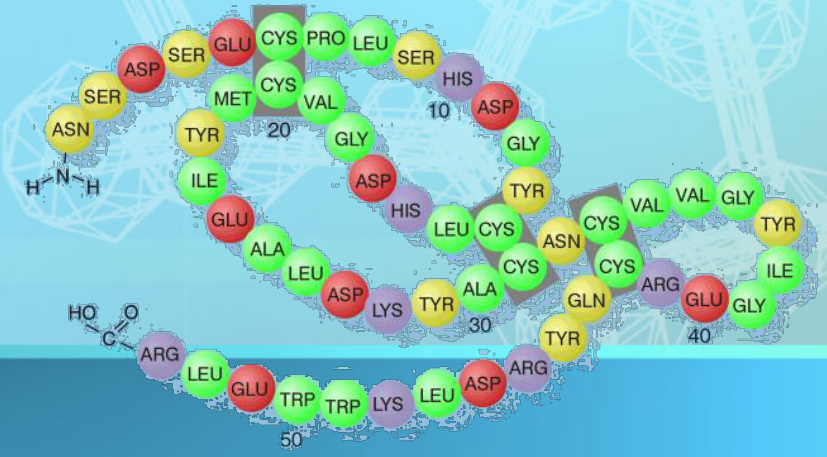


Includes nuclear membrane connected to ER connected to cell membrane (transport)

Ribosomes

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





Ribosomes

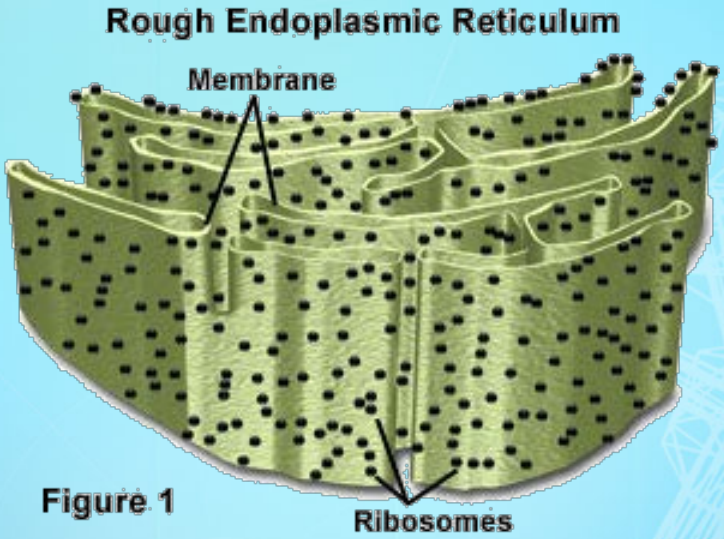
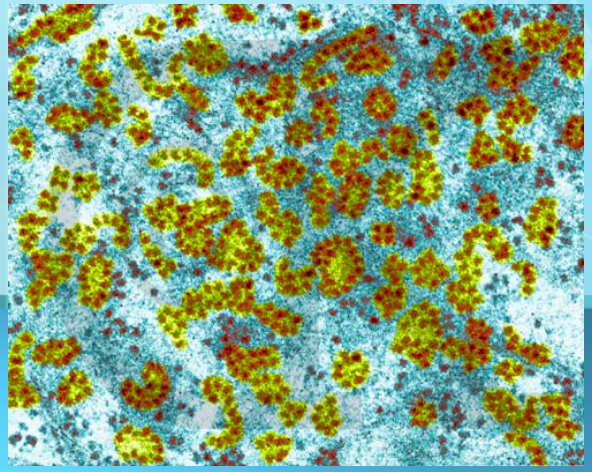


Figure 1



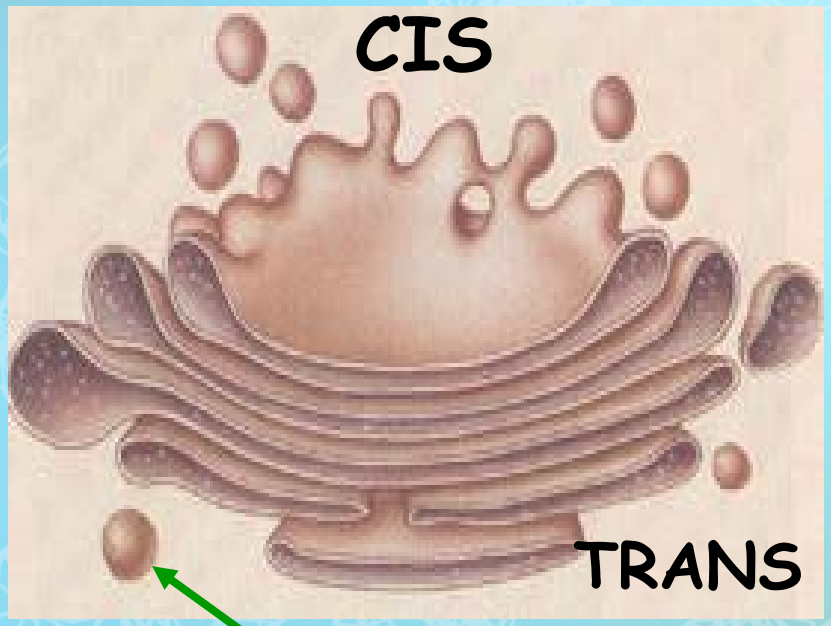
Can be attached to Rough ER

OR

Be free (unattached) in the cytoplasm

Golgi Bodies

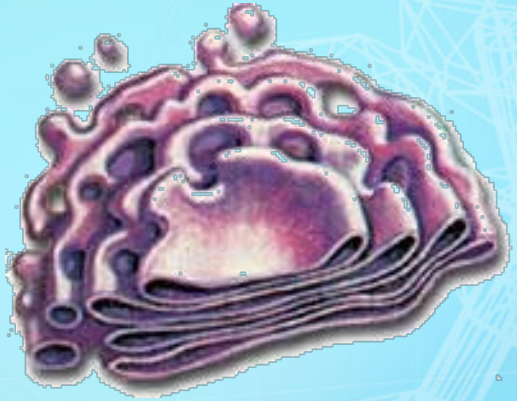
- Stacks of flattened sacs
- Have a shipping side (trans face) and receiving side (cis face)
- Receive proteins made by ER
- Transport vesicles with modified proteins pinch off the ends



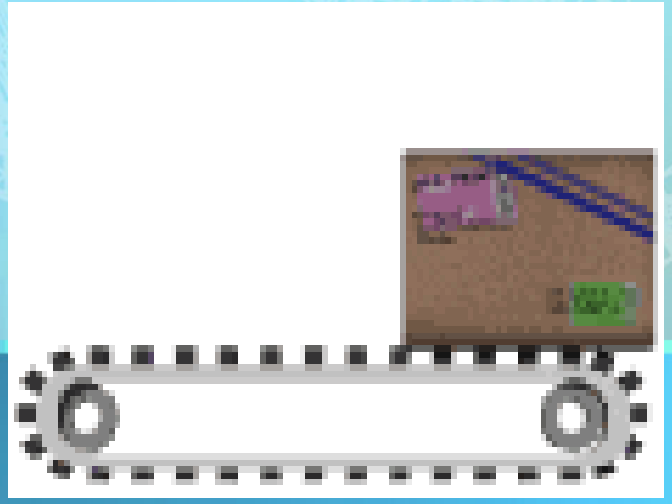
Transport vesicle

Golgi Bodies

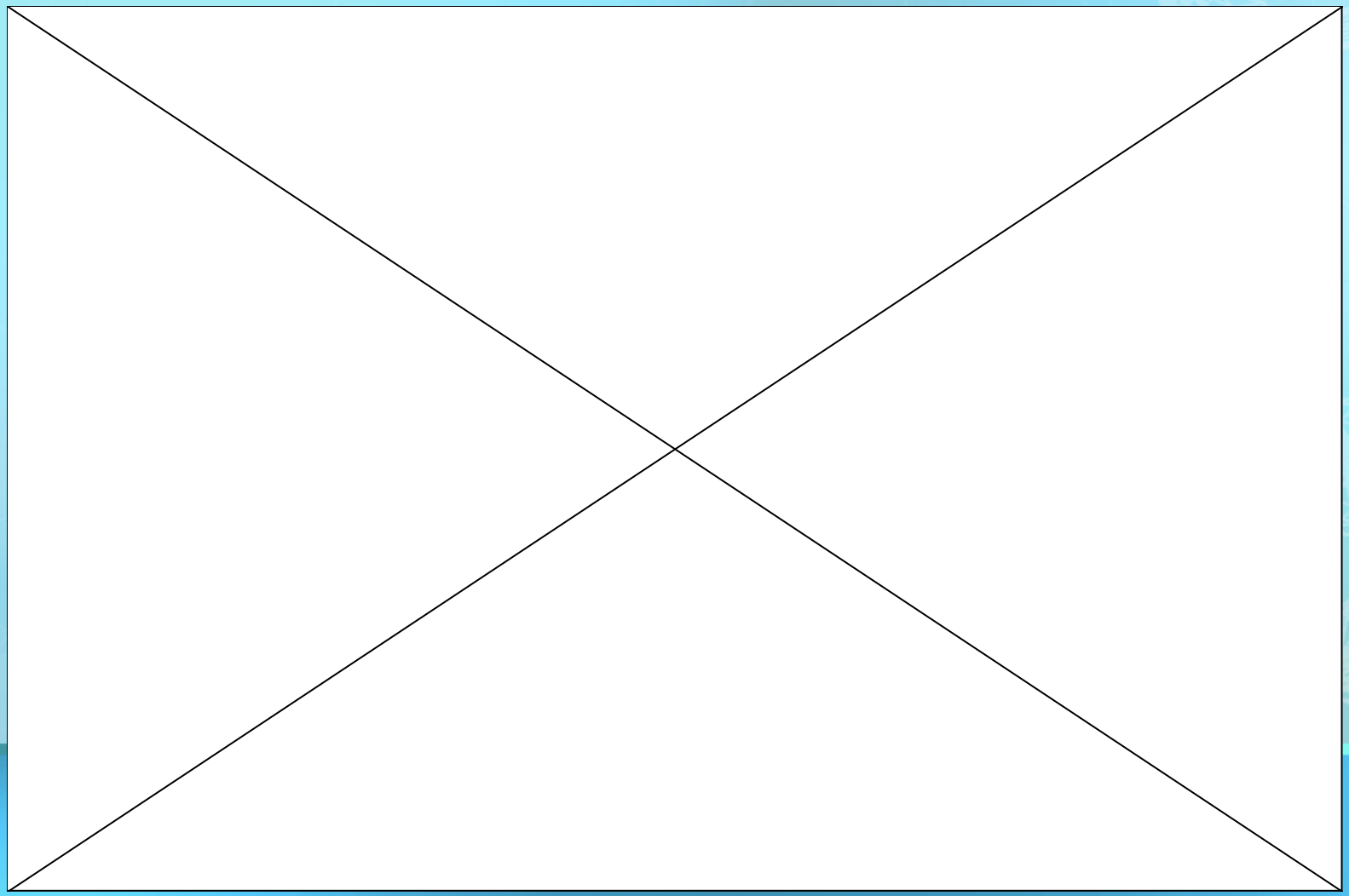
Look like a stack of pancakes



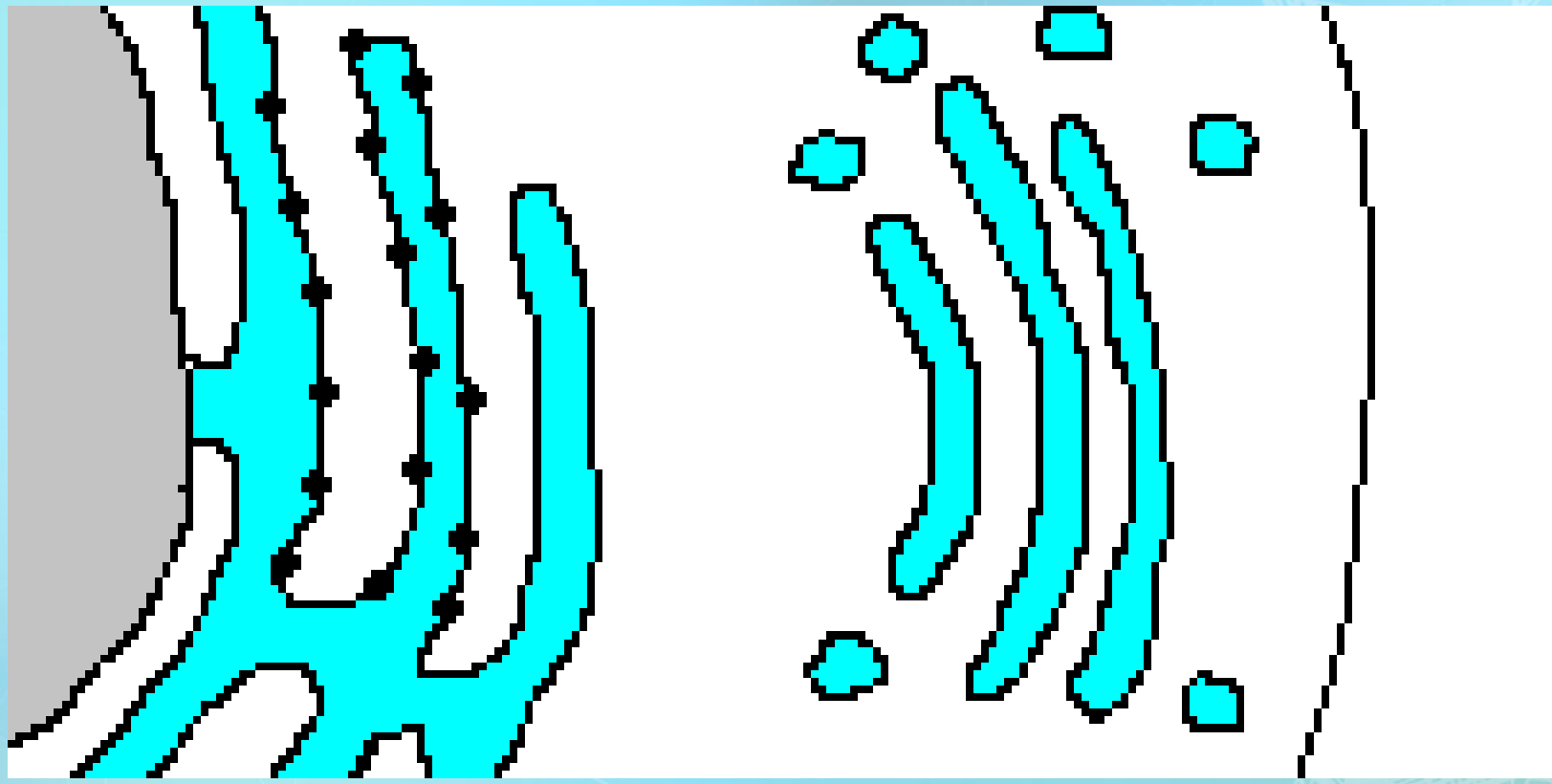
Modify, sort, & package molecules from ER for **storage** OR **transport** out of cell



Golgi



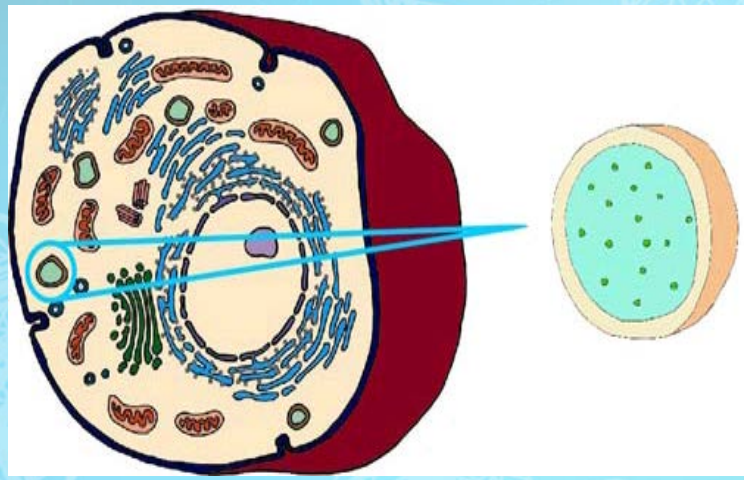
Golgi Animation

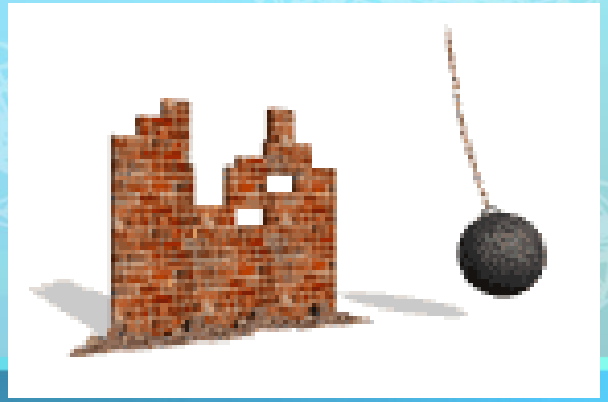


Materials are transported from Rough ER to Golgi to the cell membrane by VESICLES

Lysosomes

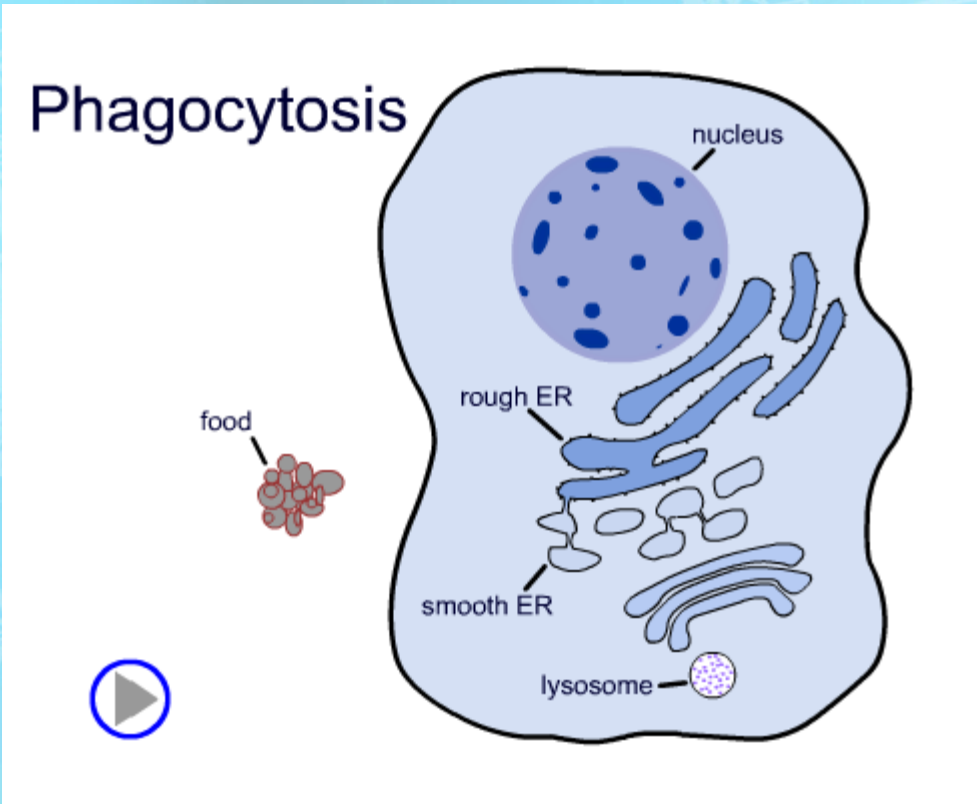
- Contain digestive enzymes
- Break down food, bacteria, and worn out cell parts for cells
- Programmed for cell death (AUTOLYSIS)
- Lyse (break open) & release enzymes to break down & recycle cell parts)





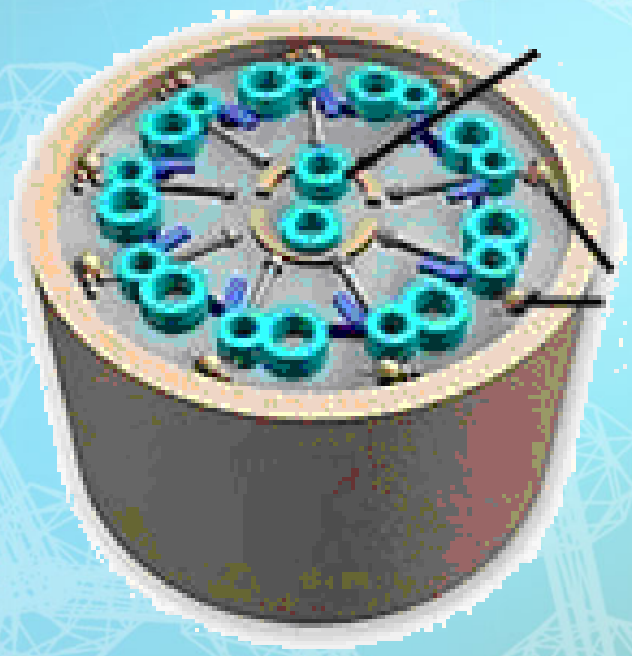
Lysosome Digestion

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



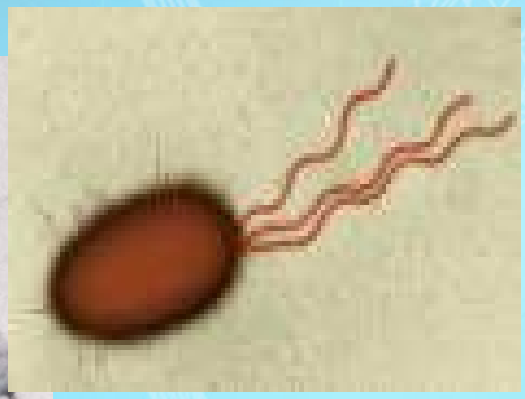
Cilia & Flagella

- Made of protein tubes called microtubules
- Microtubules arranged (9 + 2 arrangement)
- Function in moving cells, in moving fluids, or in small particles across the cell surface

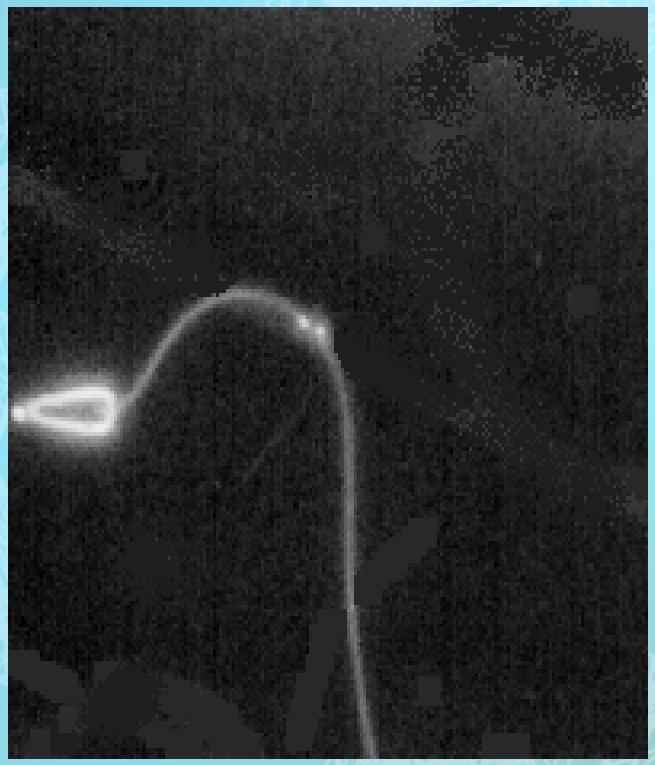


Cilia & Flagella

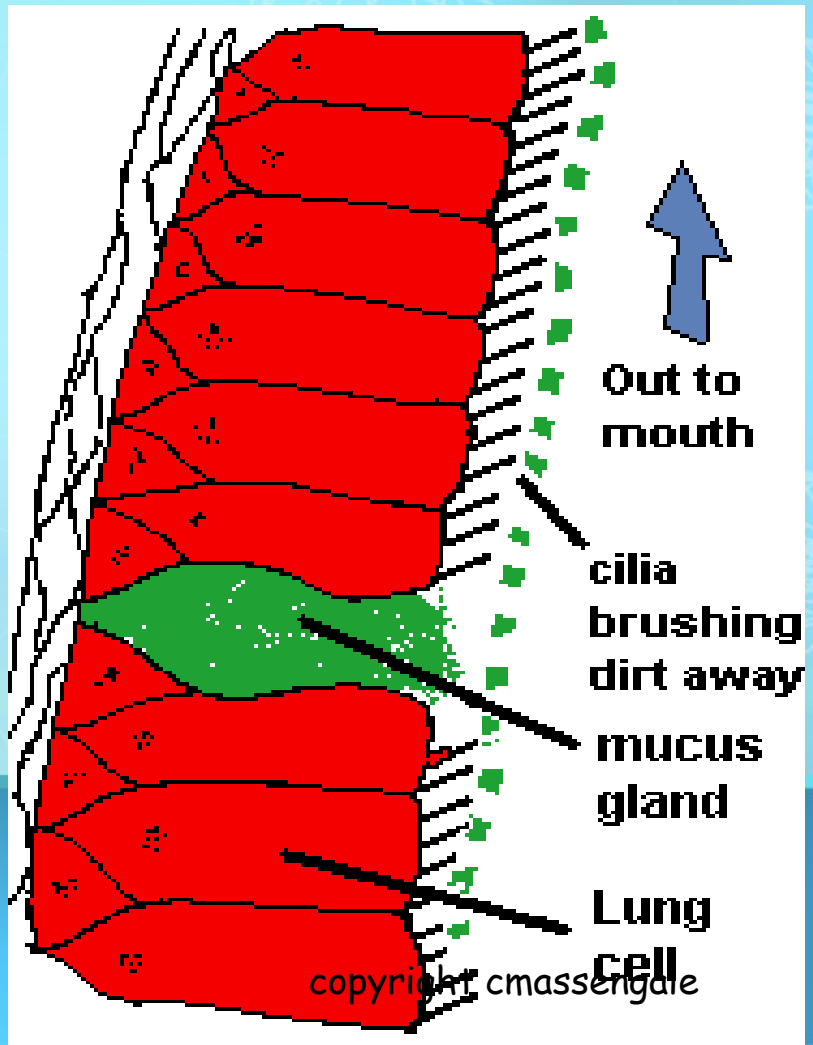
- **Cilia** are shorter and more numerous on cells
- **Flagella** are longer and fewer (usually 1-3) on cells



Cell Movement with Cilia & Flagella

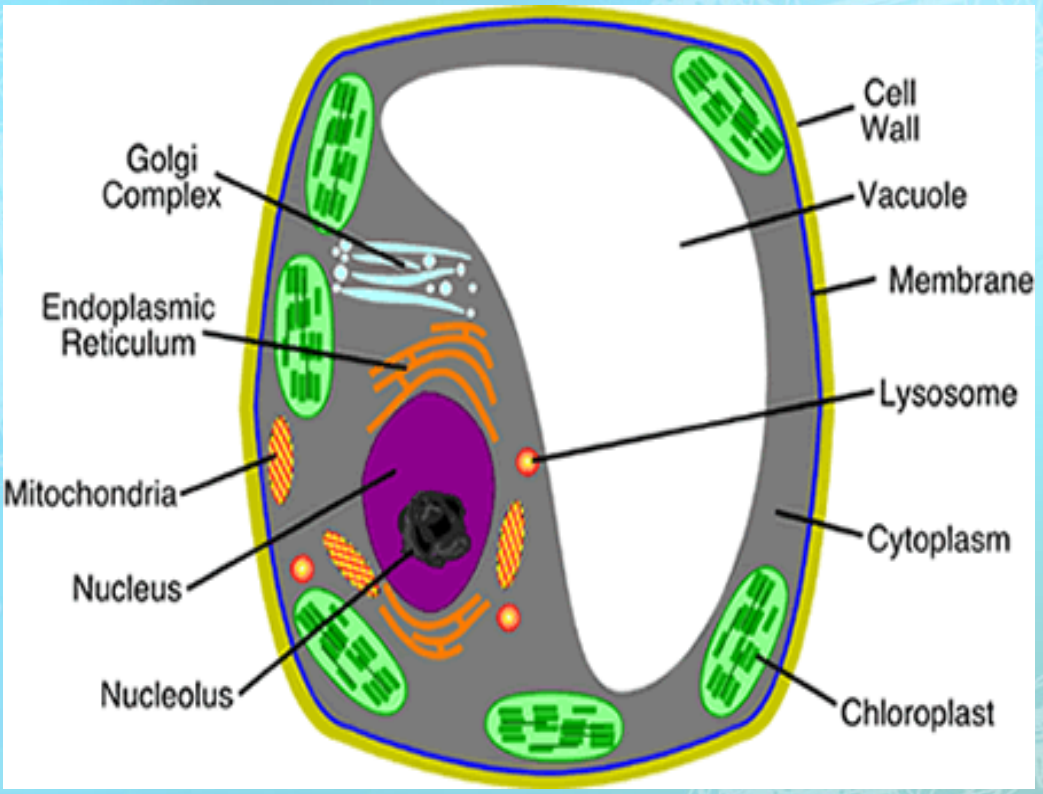


Cilia Moving Away Dust Particles from the Lungs Respiratory System



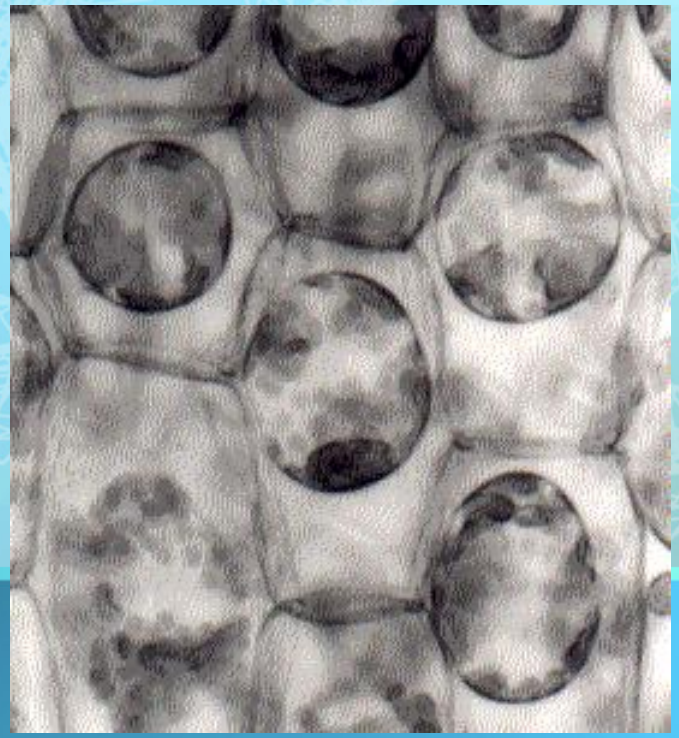
Vacuoles

- **Fluid filled** sacks for **storage**
- **Small or absent** in *animal* cells
- *Plant* cells have a **large Central Vacuole**
- **No vacuoles** in *bacterial* cells



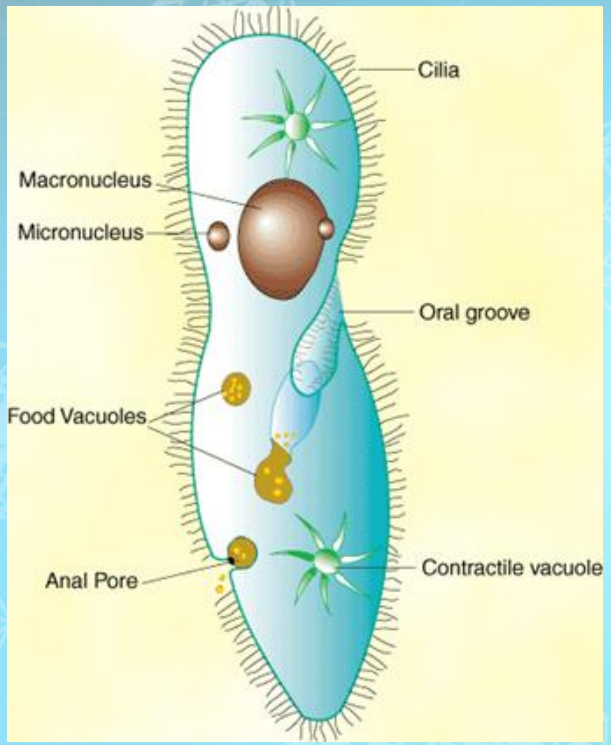
Vacuoles

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

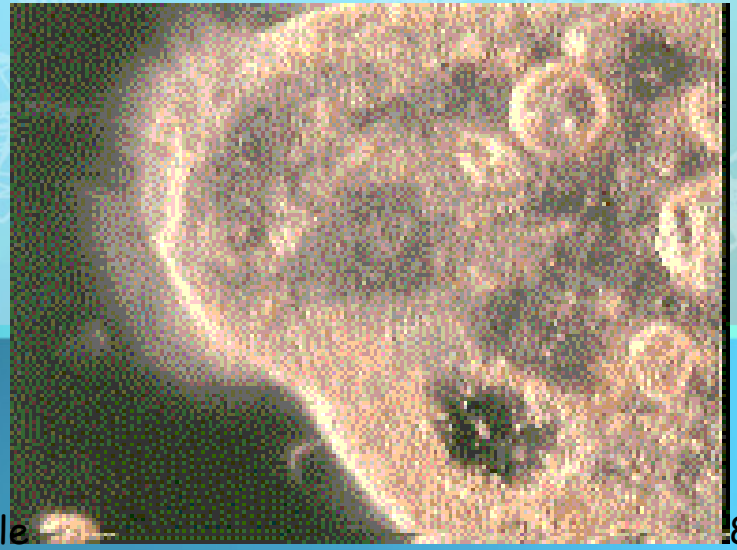


Contractile Vacuole

- Found in unicellular protists like paramecia
- Regulate water intake by pumping out excess (homeostasis)
- Keeps the cell from lysing (bursting)



Contractile vacuole animation

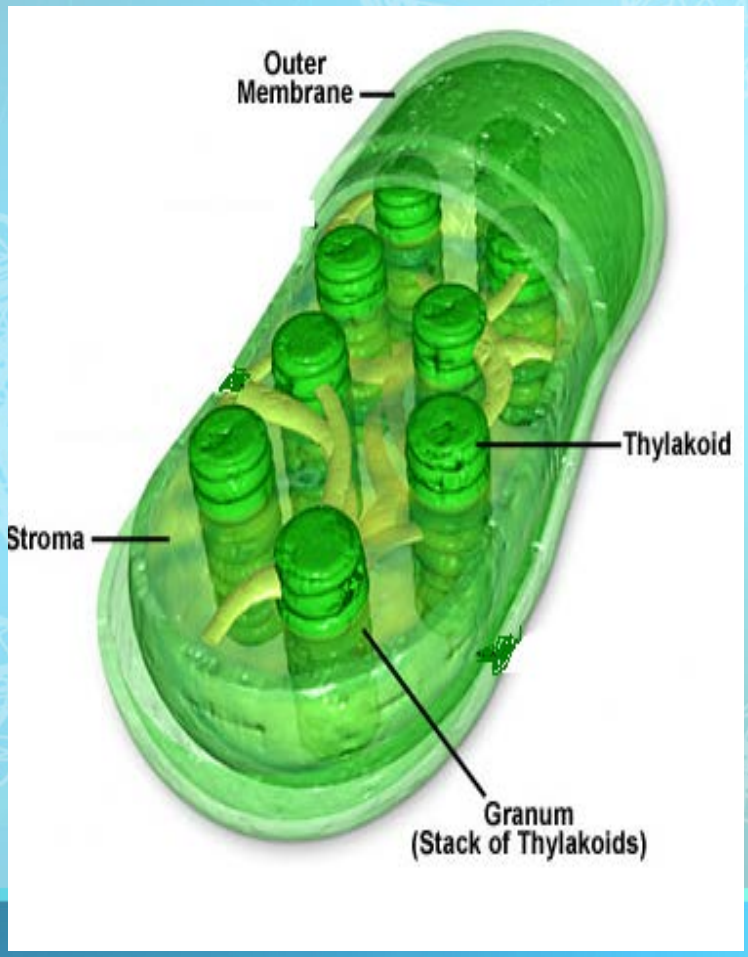


Chloroplasts

- 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

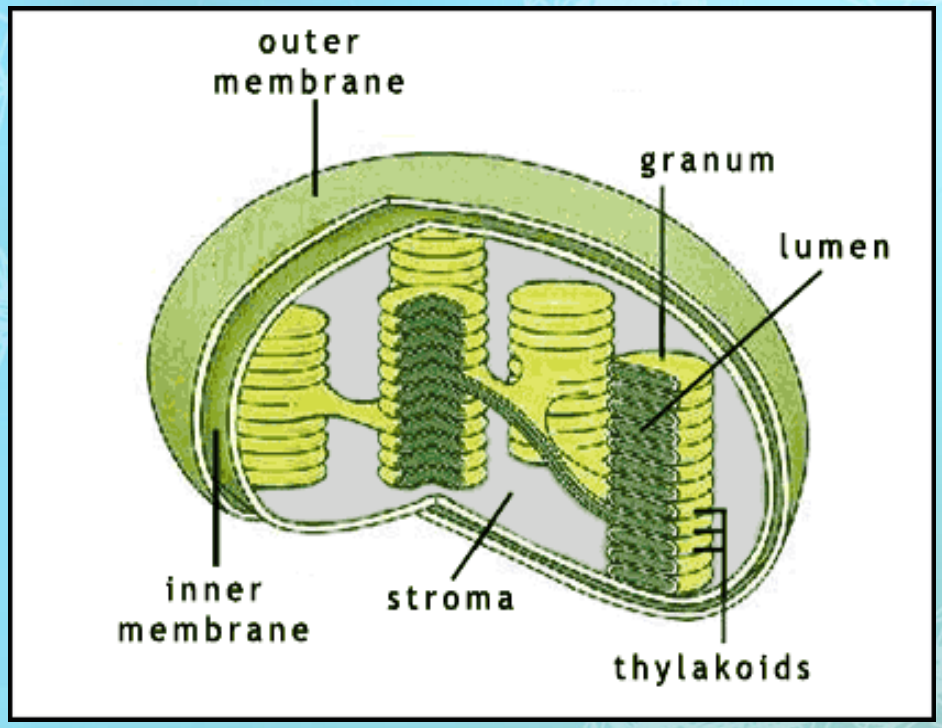
Chloroplasts

- 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



Chloroplasts

- Contains its own DNA
- Contains enzymes & pigments for Photosynthesis
- Never in animal or bacterial cells
- Photosynthesis – food making process



Cell Size

Question:

Are the cells in an elephant bigger, smaller, or about the same size as those in a mouse?

Factors Affecting Cell Size

- Surface area (plasma membrane surface) is determined by multiplying length times width (L x W)
- Volume of a cell is determined by multiplying length times width times height (L x W x H)
- Therefore, Volume increases FASTER than the surface area

Cell Size

- When the surface area is no longer great enough to get rid of all the wastes and to get in enough food and water, then the cell must divide
- Therefore, the cells of an organism are close in size

Cell Size

Question:

Are the cells in an elephant bigger, smaller, or about the same size as those in a mouse?

About the same size, but …

The elephant has MANY MORE cells than a mouse!