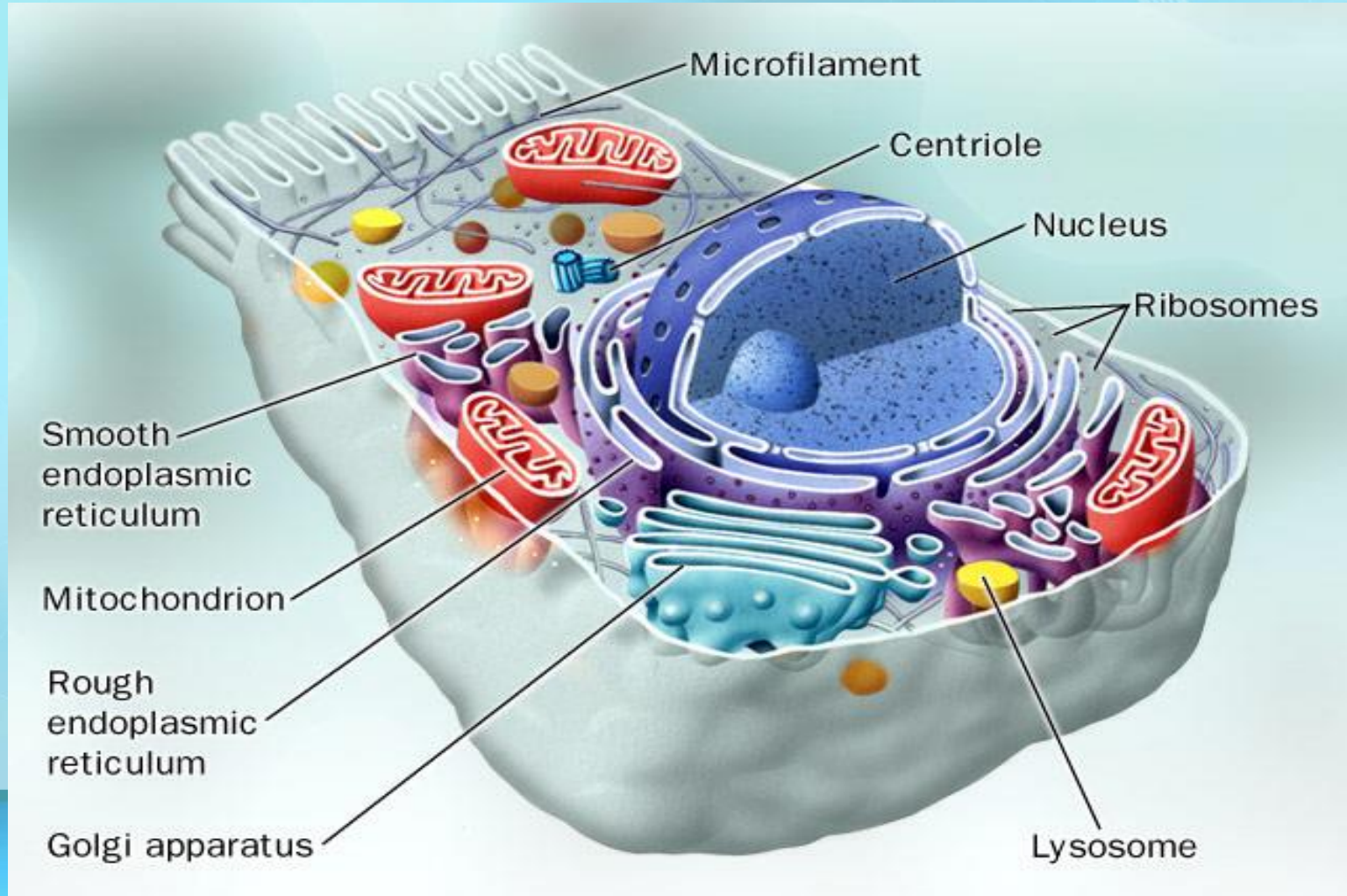


Basic Structure of a Cell





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:

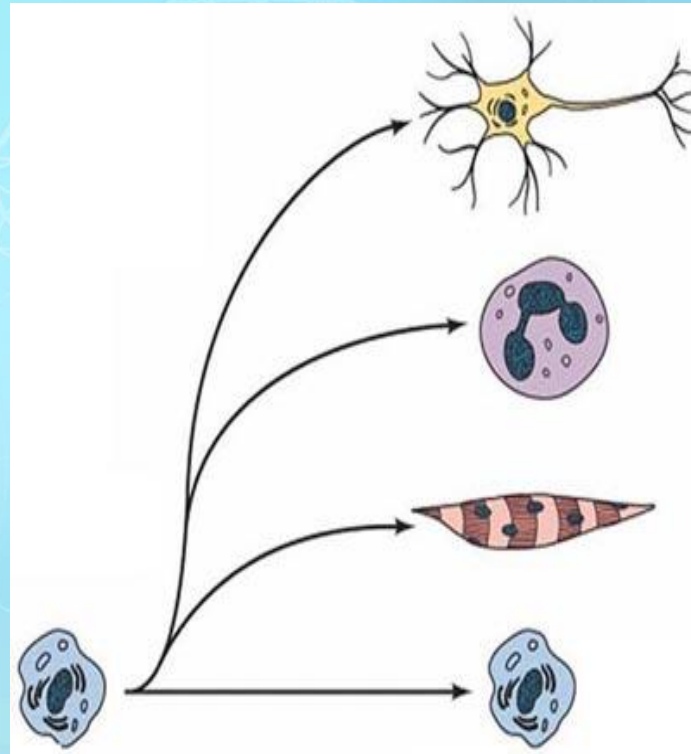
1. **CELL** (makes up ALL organisms)
2. **TISSUE** (cells working together)
3. **ORGAN** (heart, brain, stomach ...)
4. **ORGAN SYSTEMS** (respiratory, circulatory ...)
5. **ORGANISM**

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

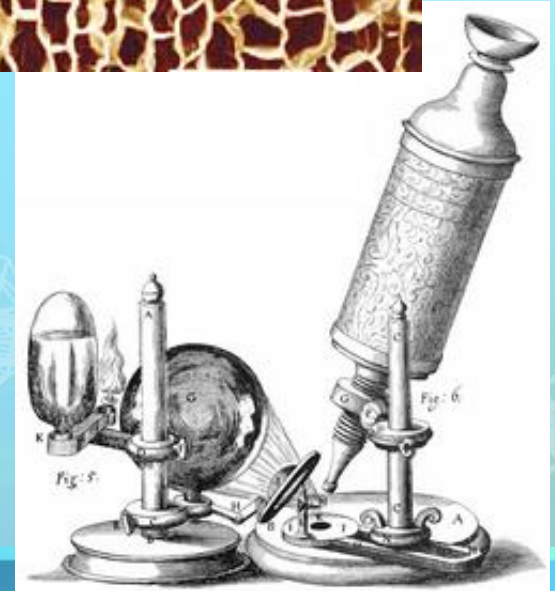
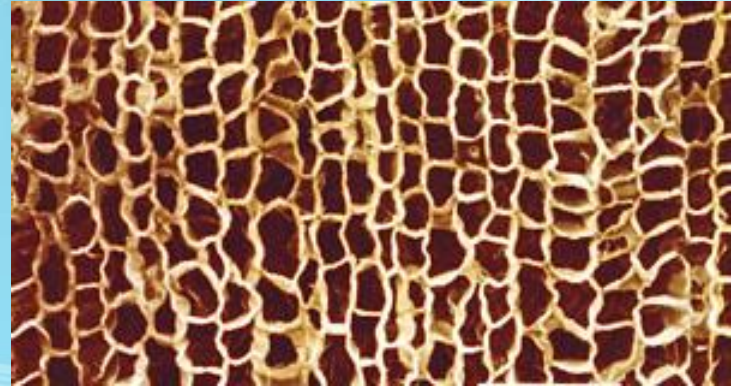


Cell
Specialization

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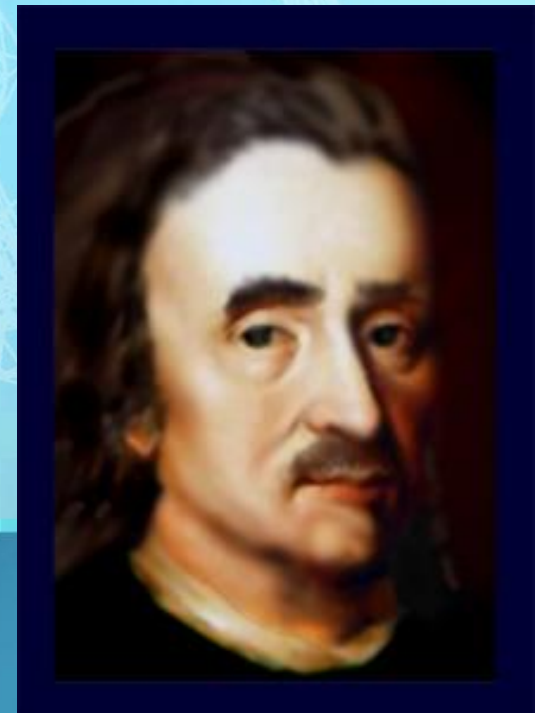
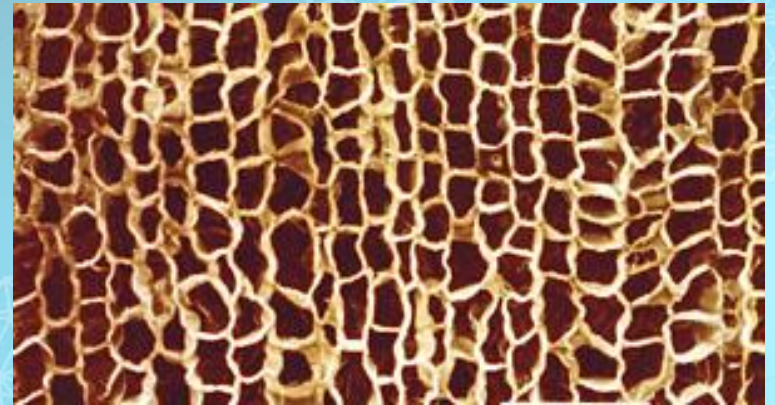
First to View Cells

- 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



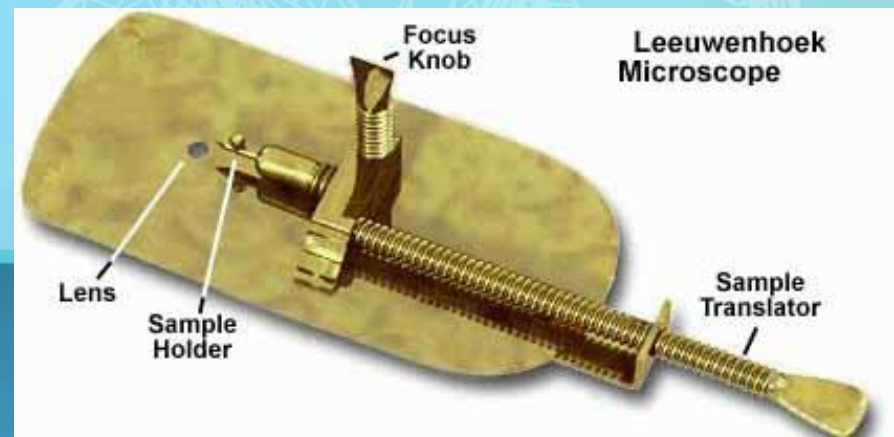
First to View Cells

- 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**



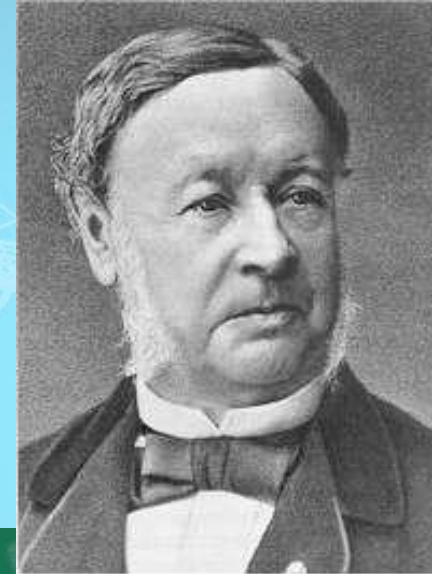
Beginning of the Cell Theory

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



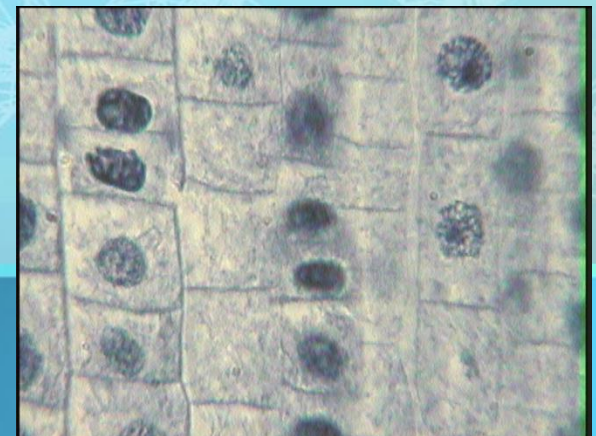
Beginning of the Cell Theory

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



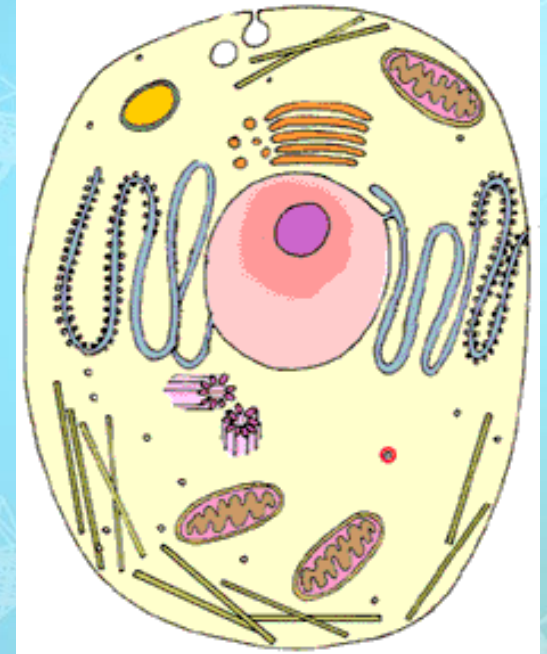
Beginning of the Cell Theory

- 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

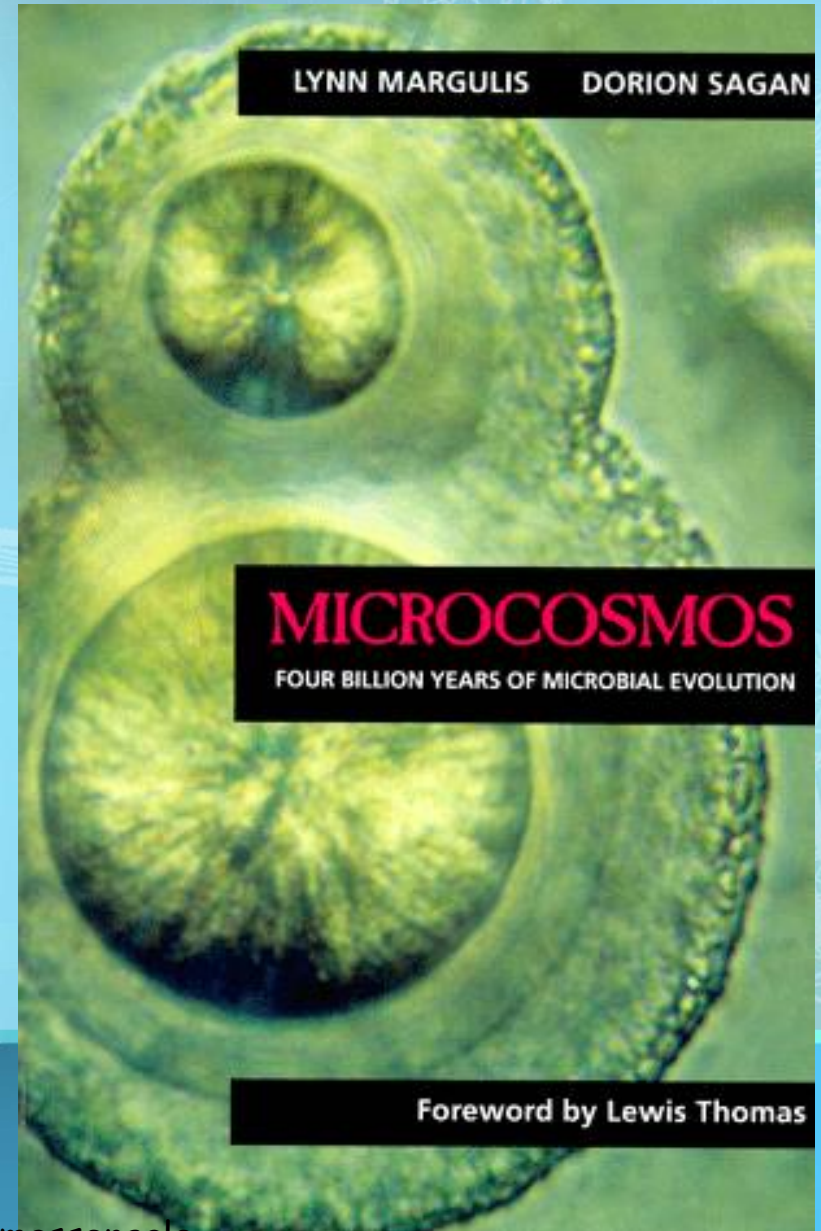


CELL THEORY

- 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)

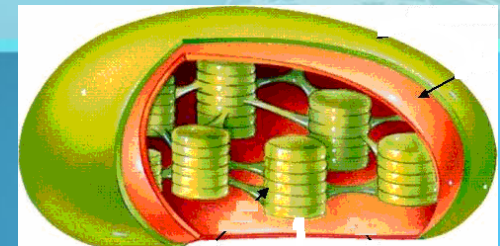


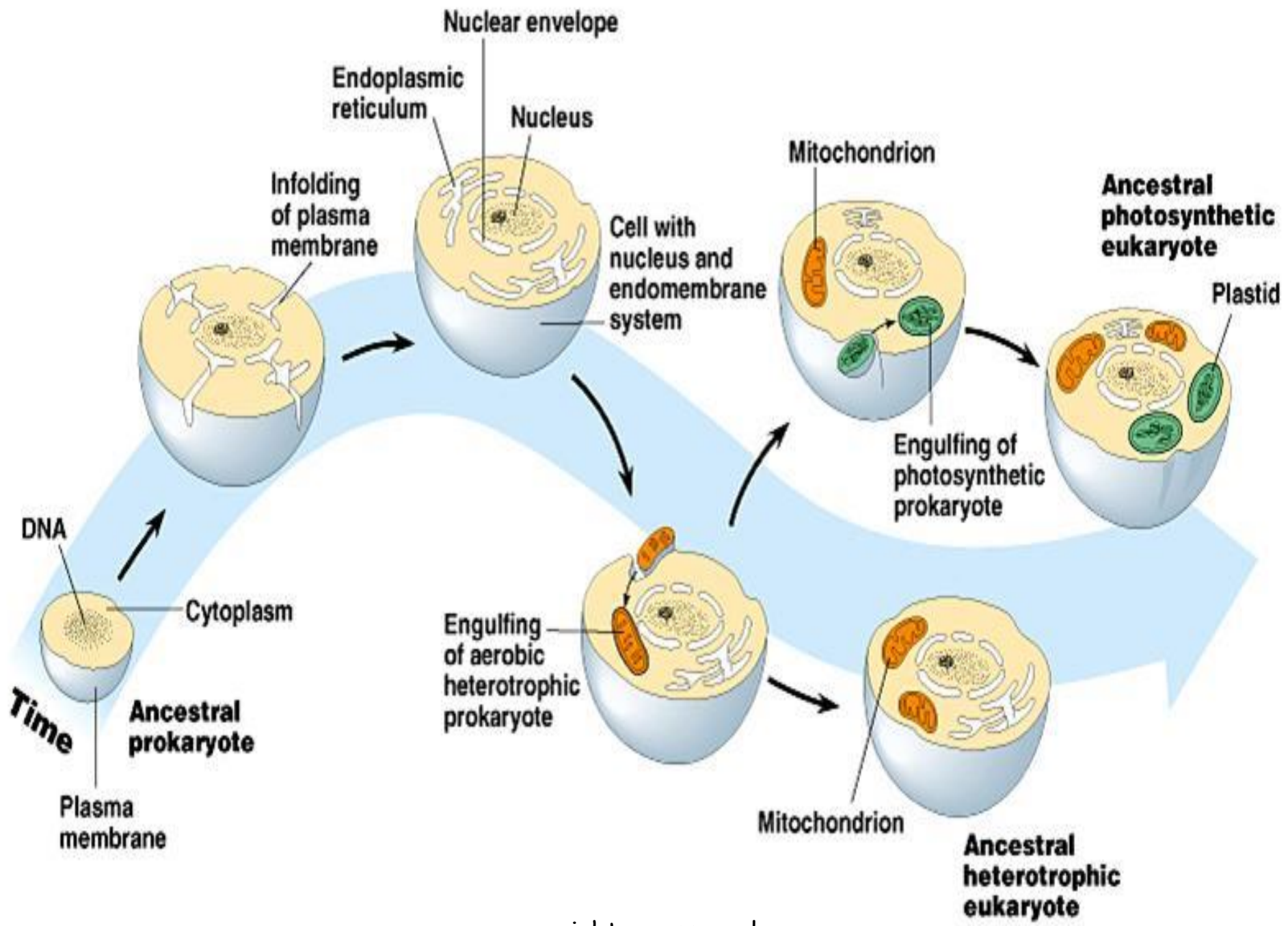
Discoveries Since the Cell Theory



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**





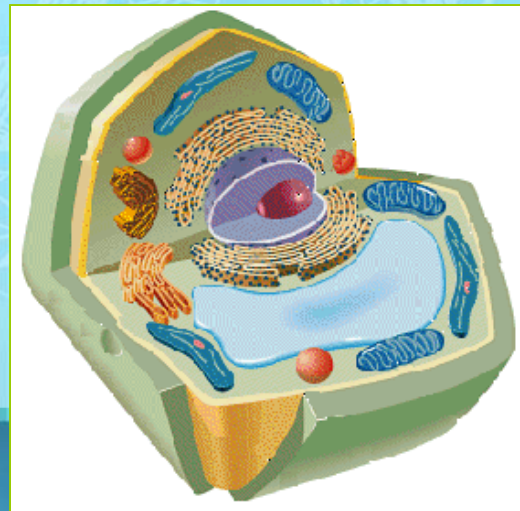
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Cell Size and Types

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

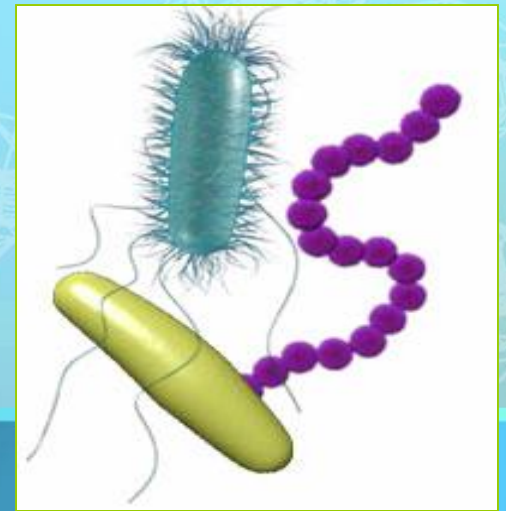


Animal Cell



Plant Cell

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Bacterial Cell

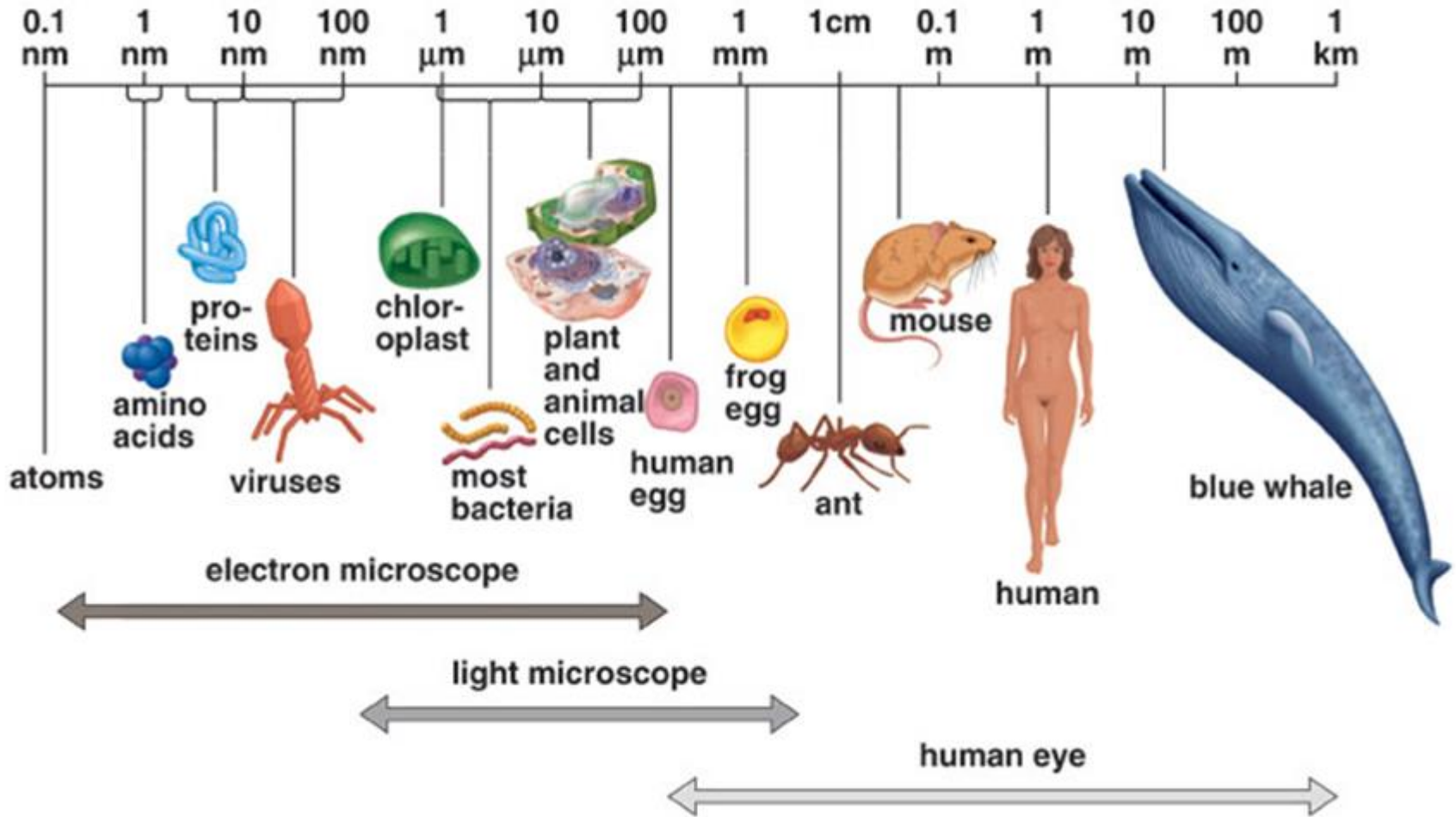
Number of Cells

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.

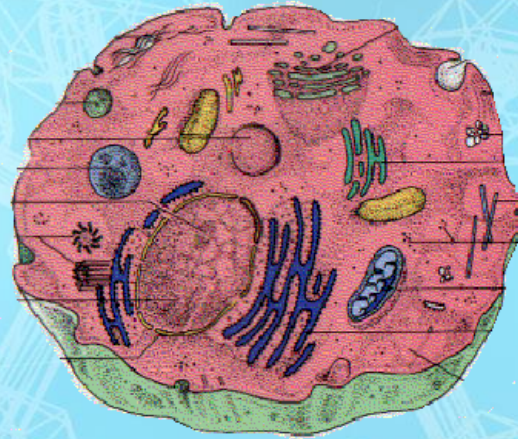


CELL SIZE



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) ?

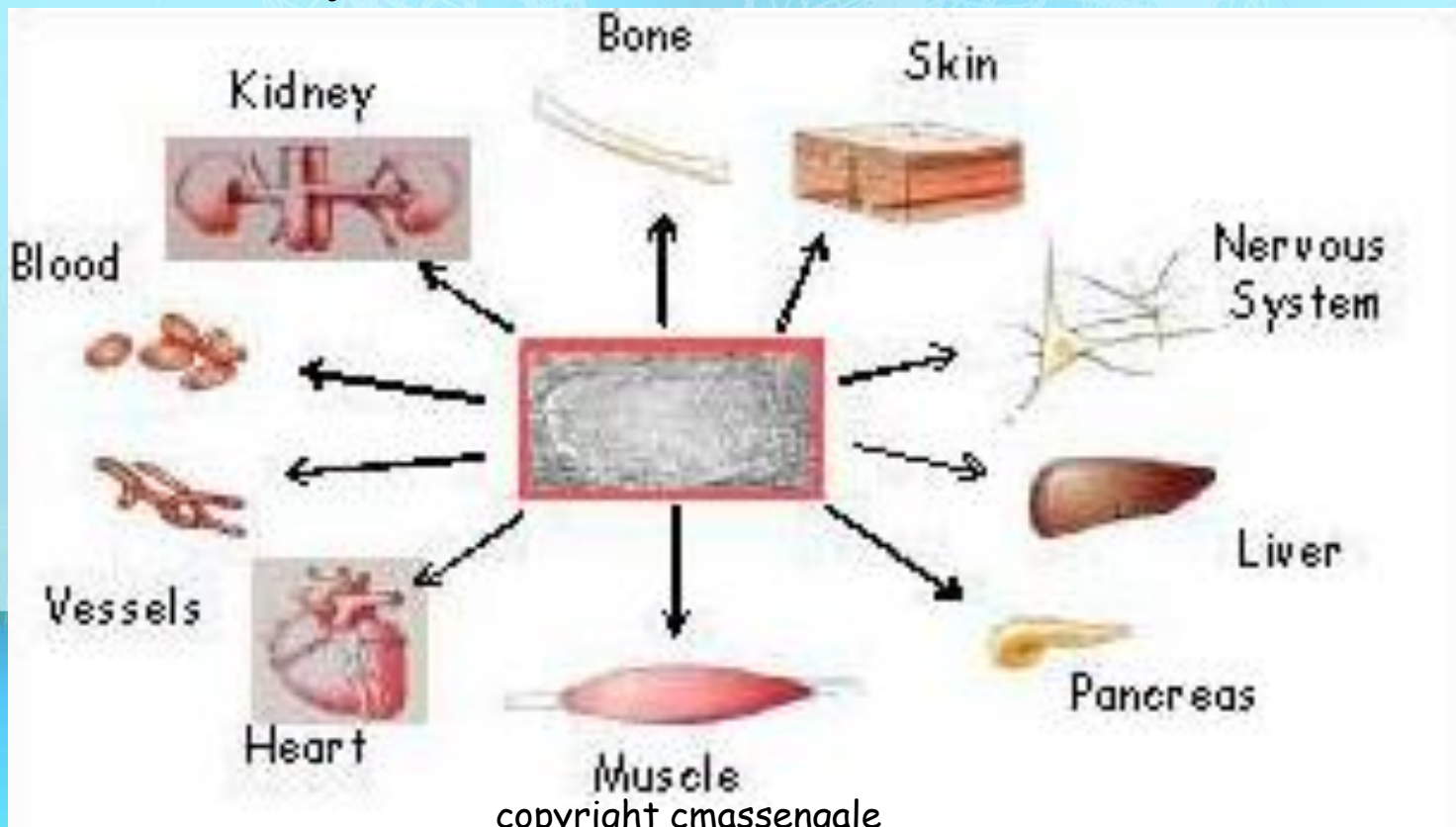


1 cm = 10,000 microns

1" = 25,000 microns

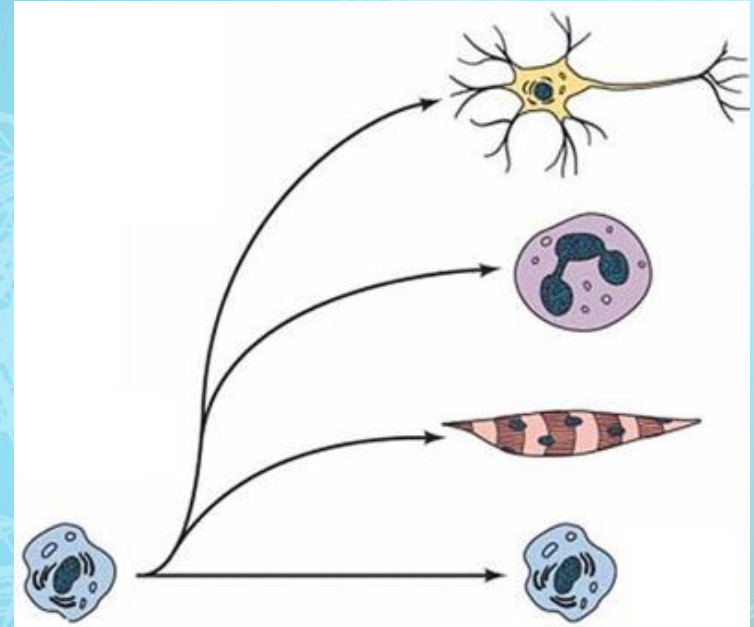
Multicellular Organisms

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



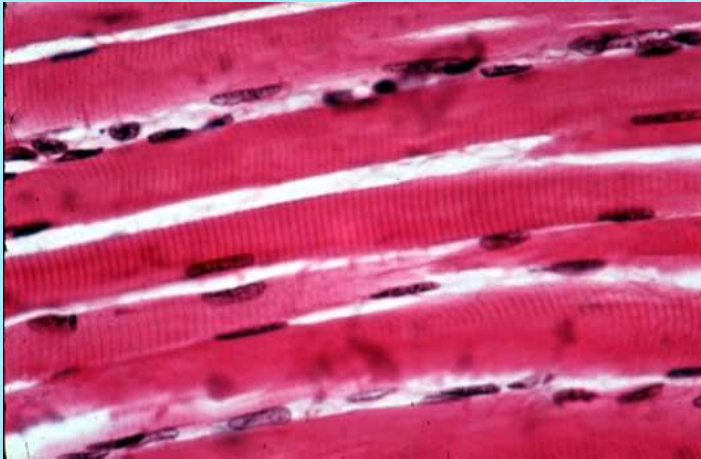
Cell Specialization

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

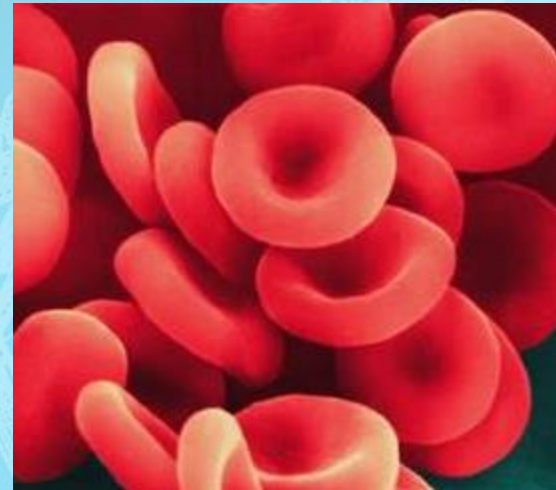


Specialized Animal Cells

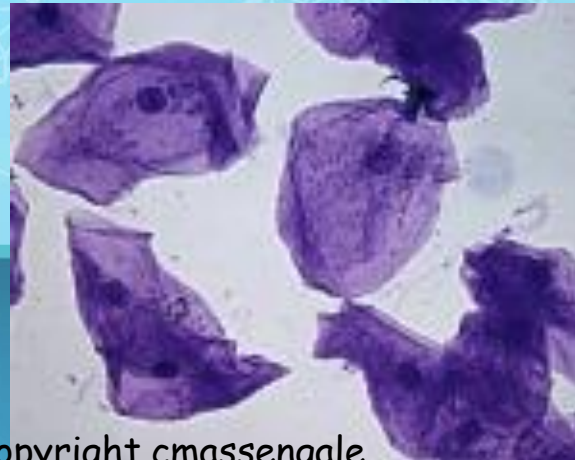
Muscle cells



Red blood cells

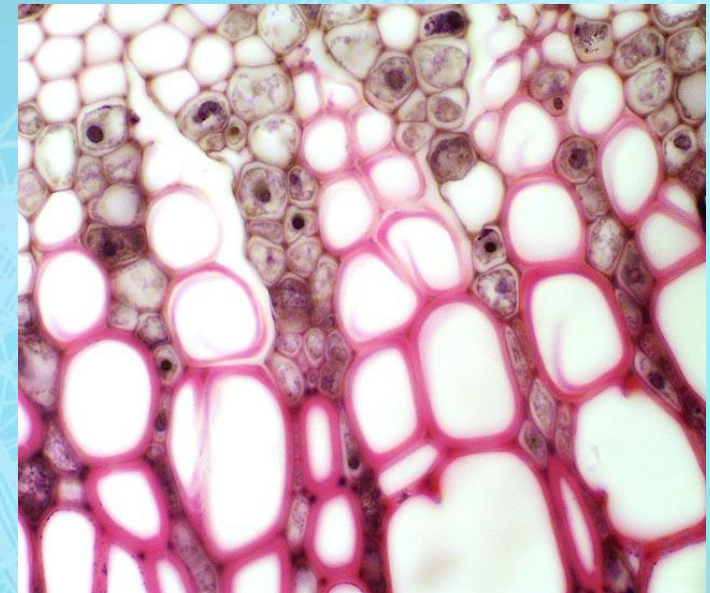
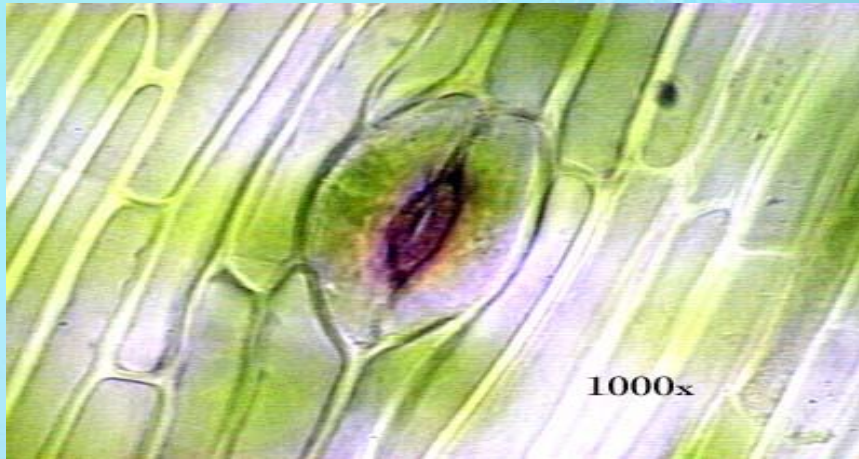


Cheek cells



Specialized Plant cells

Guard Cells

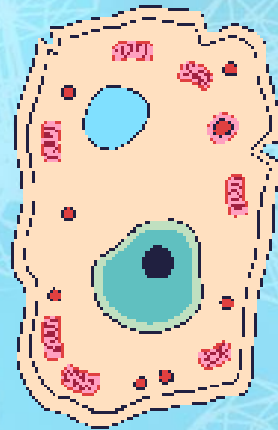


Pollen



Xylem cells

Organization Levels of Life

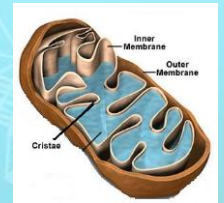
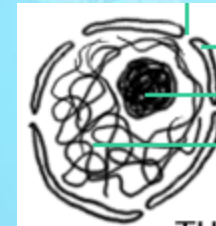
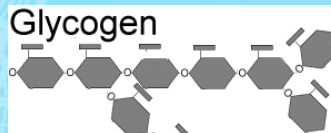
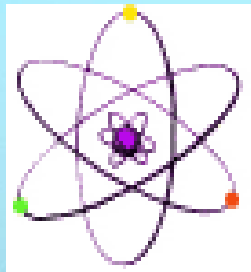
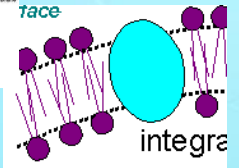
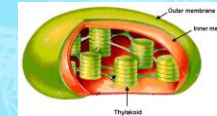
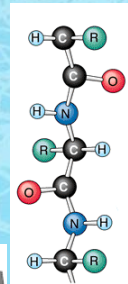
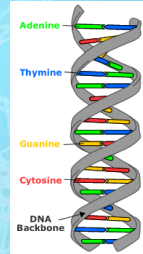
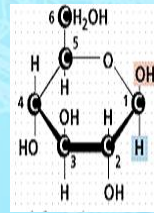
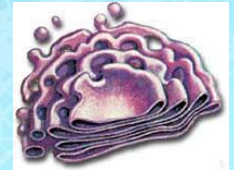
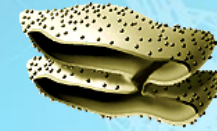
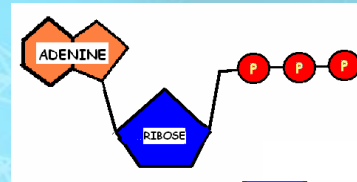
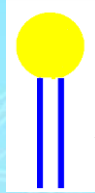


Atoms to Organisms

Nonliving Levels

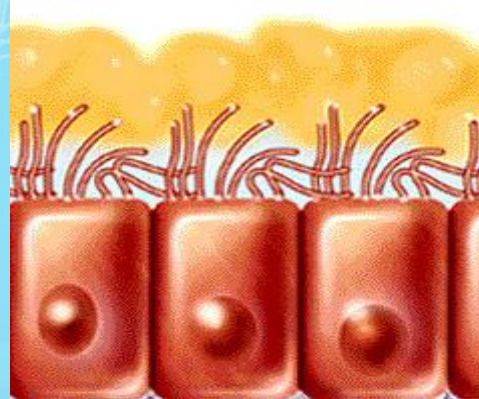
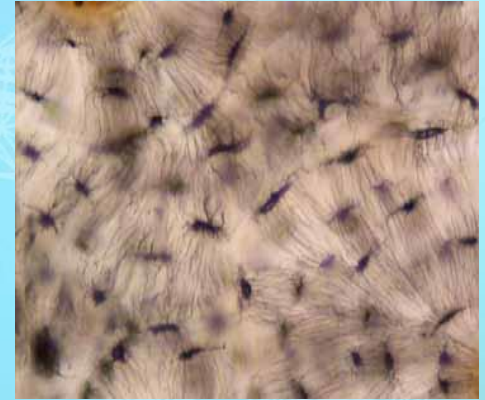
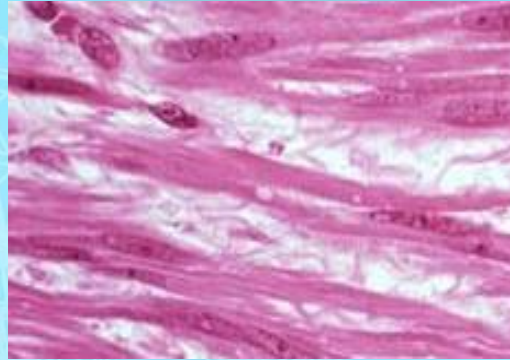
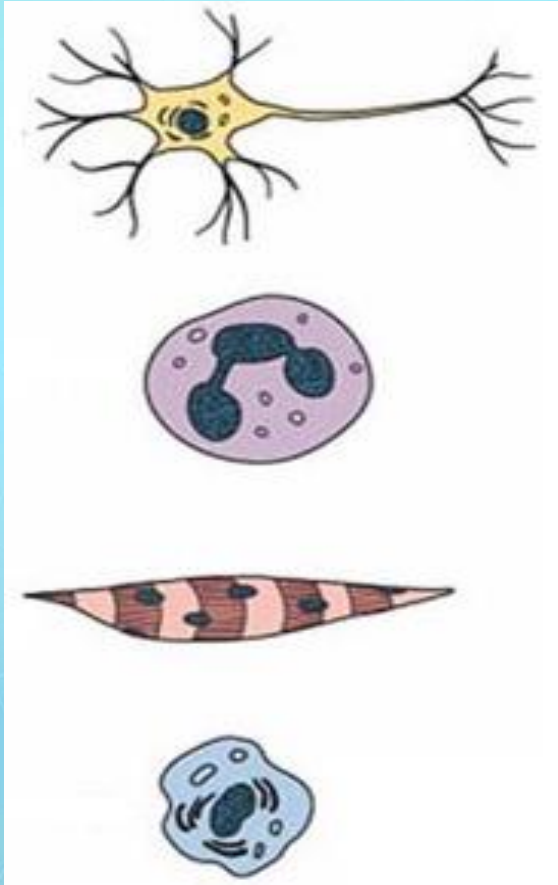
Periodic Table of the Elements

1	IA																2	0		
1	H	IIA																He		
2	Li	Be											B	C	N	O	F	Ne		
3	Na	Mg	IIIB										IVB	VB	VI	VII	VIII	IX	X	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	Fr	Ra	+Ac	Rf	Ha	106	107	108	109	110										



ATOMS → MOLECULES → ORGANELLES

Living Levels

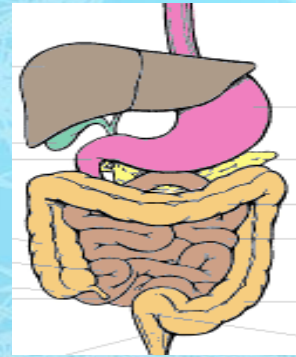
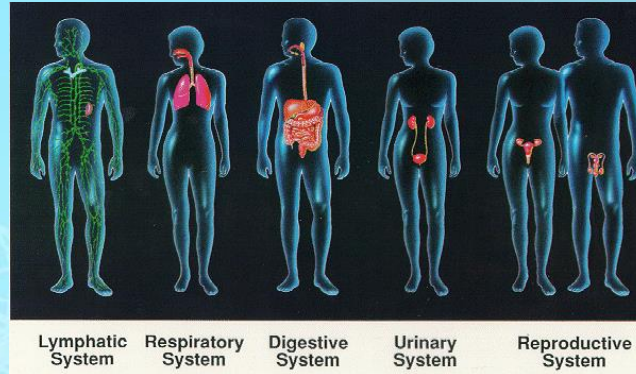
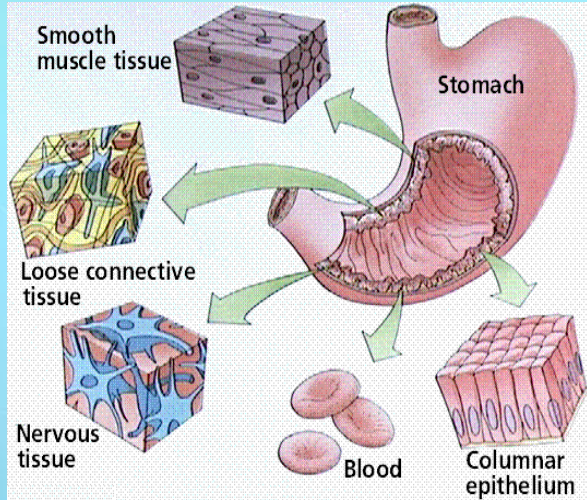


CELLS - life starts here



TISSUES - Similar cells working together

More Living Levels



ORGANS



ORGAN SYSTEMS



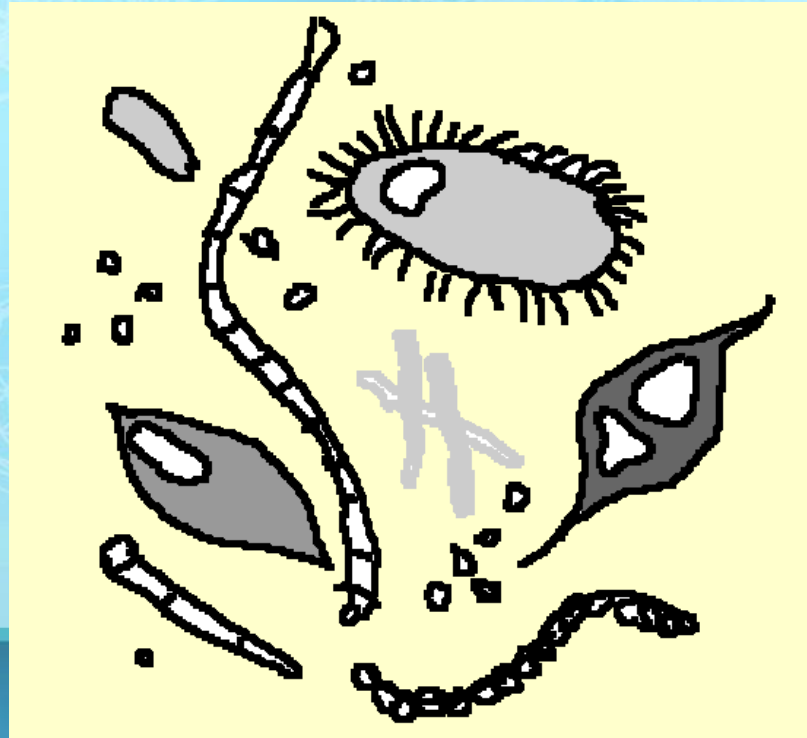
ORGANISM

Different tissues working together

Different organs working together

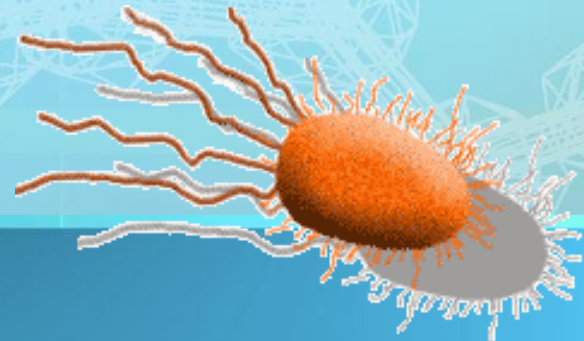
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Simple or Complex Cells



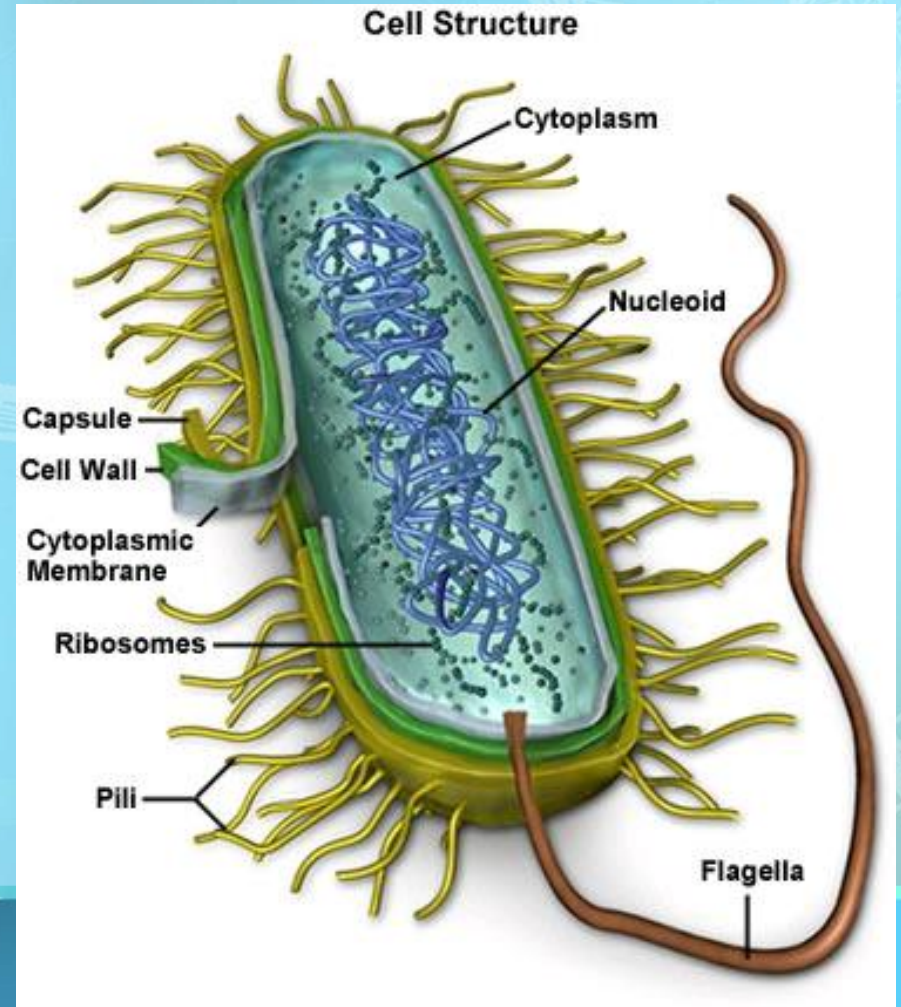
Prokaryotes - The first Cells

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



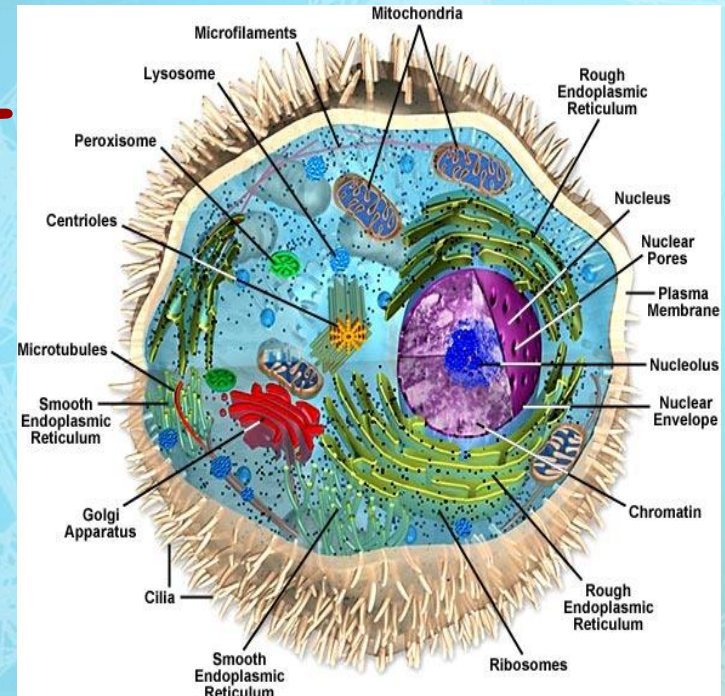
Prokaryotes

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



Eukaryotes

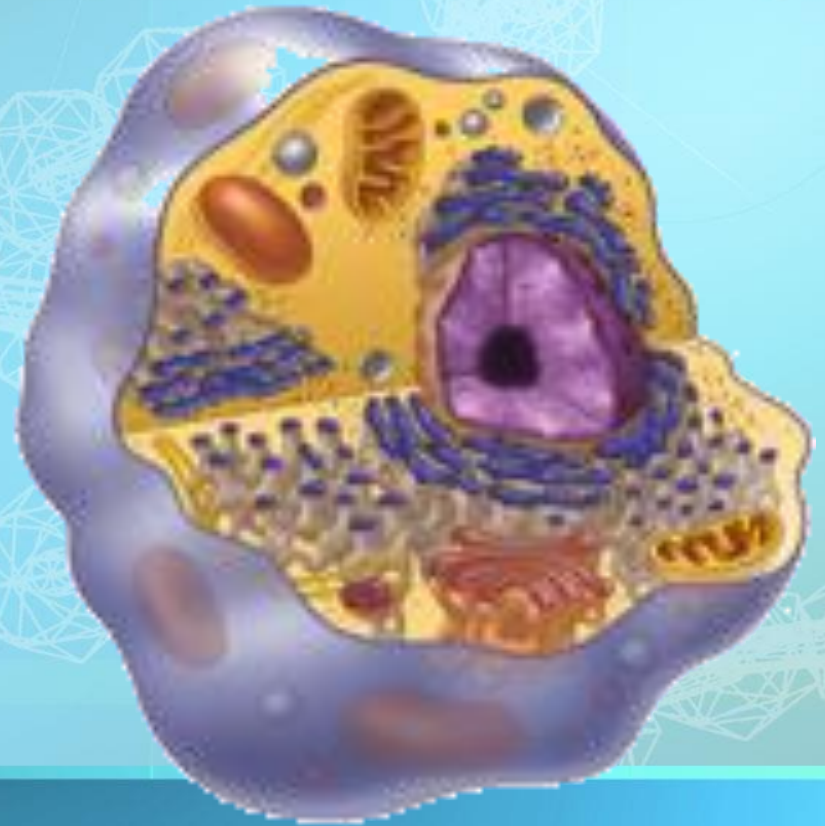
- Cells that **HAVE a nucleus and membrane-bound organelles**
- Includes **protists, fungi, plants, and animals**
- More **complex** type of cells



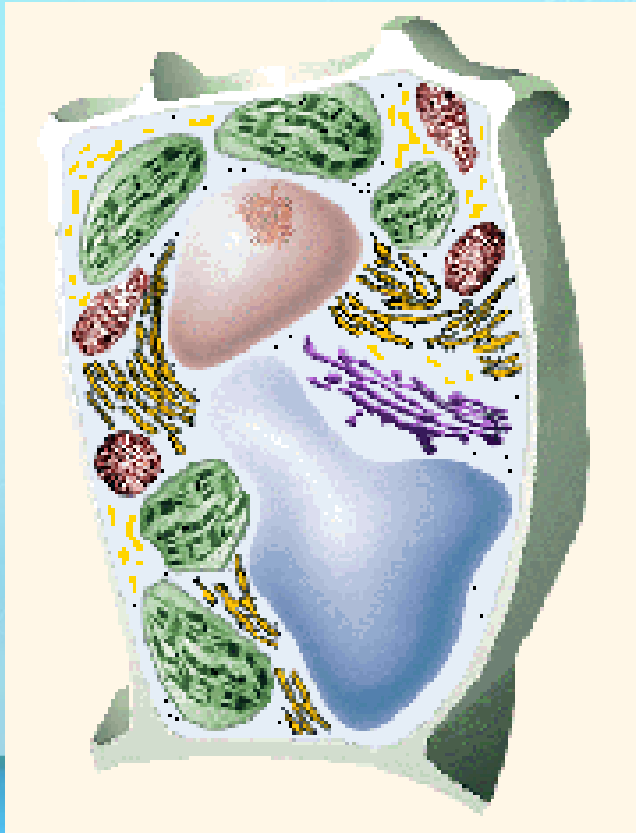
Eukaryotic Cell

Contain 3 basic cell structures:

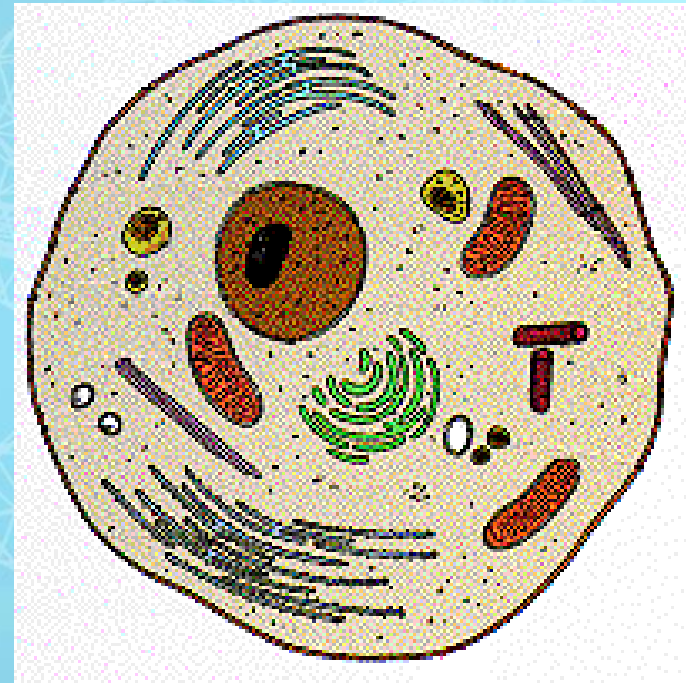
- **Nucleus**
- **Cell Membrane**
- **Cytoplasm with organelles**



Two Main Types of Eukaryotic Cells

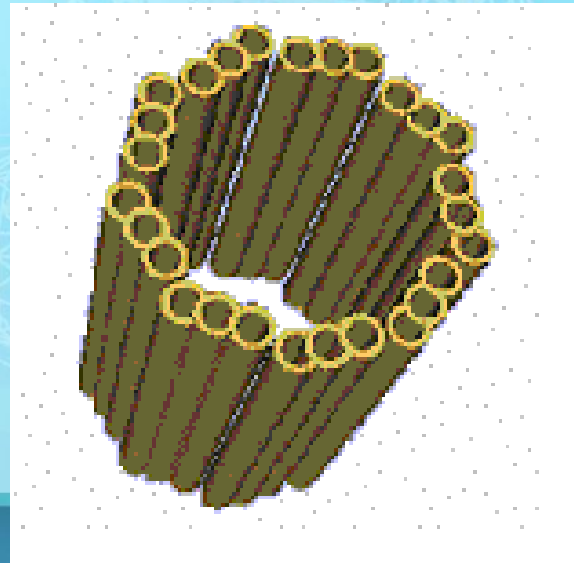


Plant Cell



Animal Cell

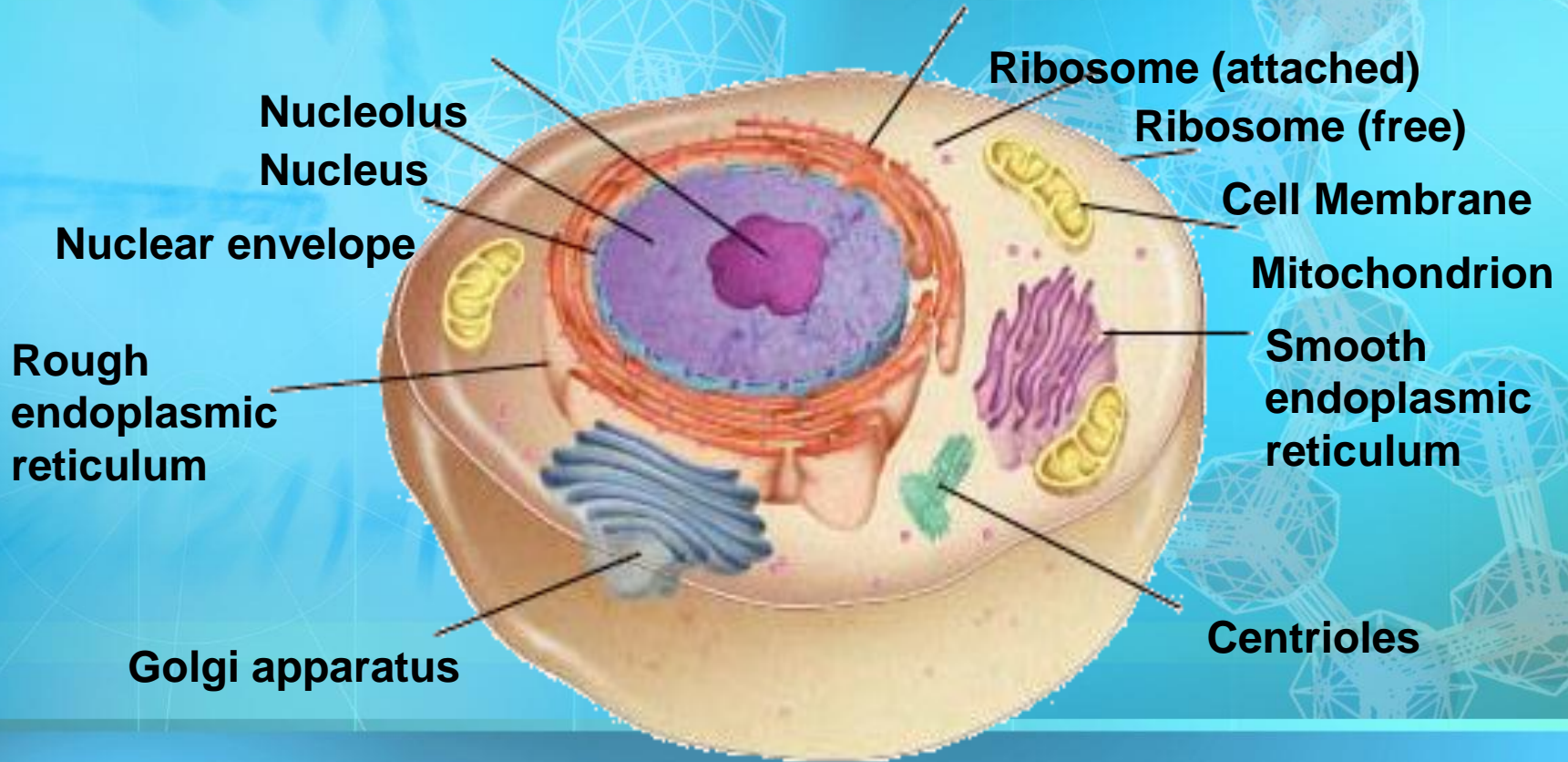
Organelles Outside the Cell



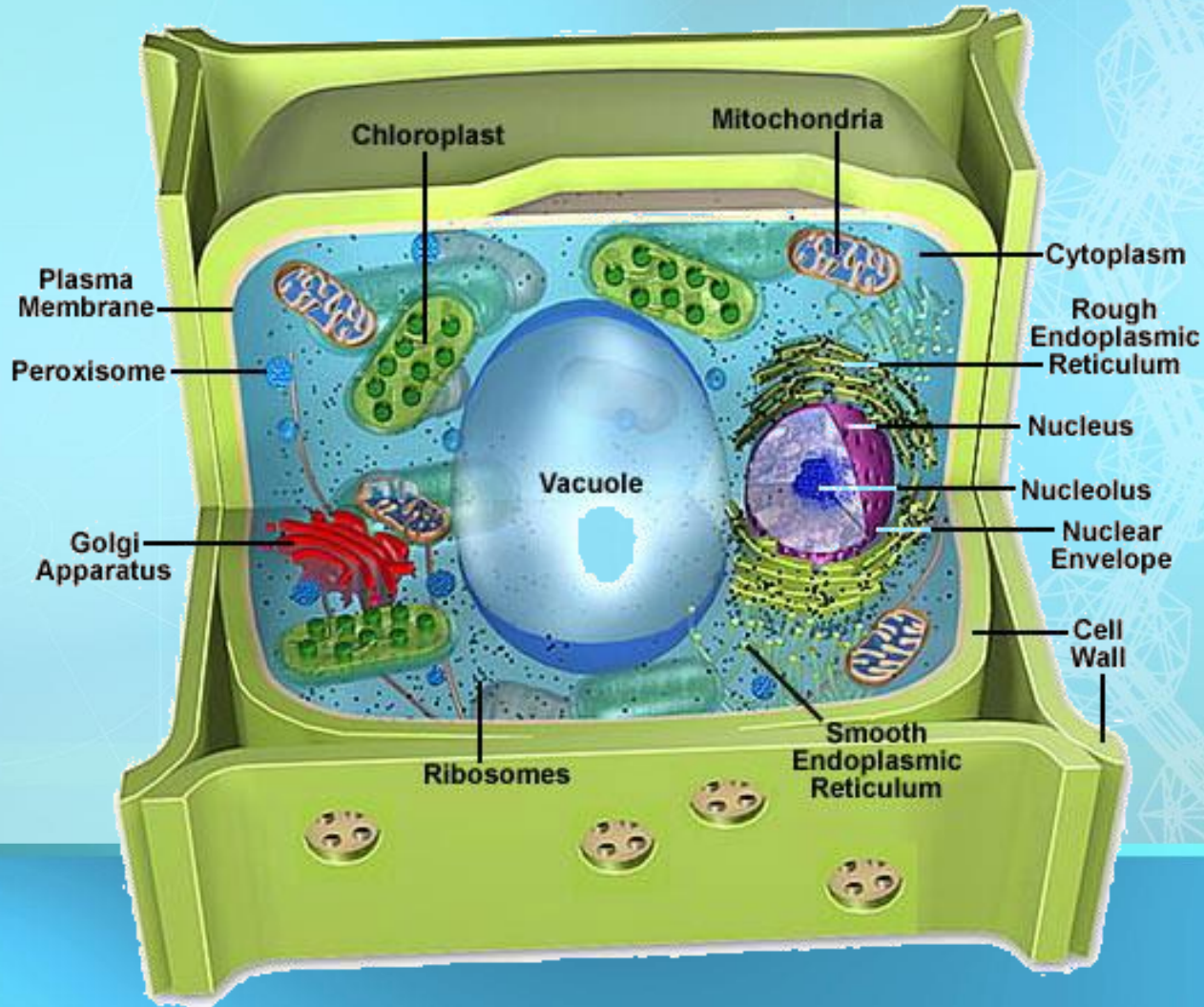
Organelles

- 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



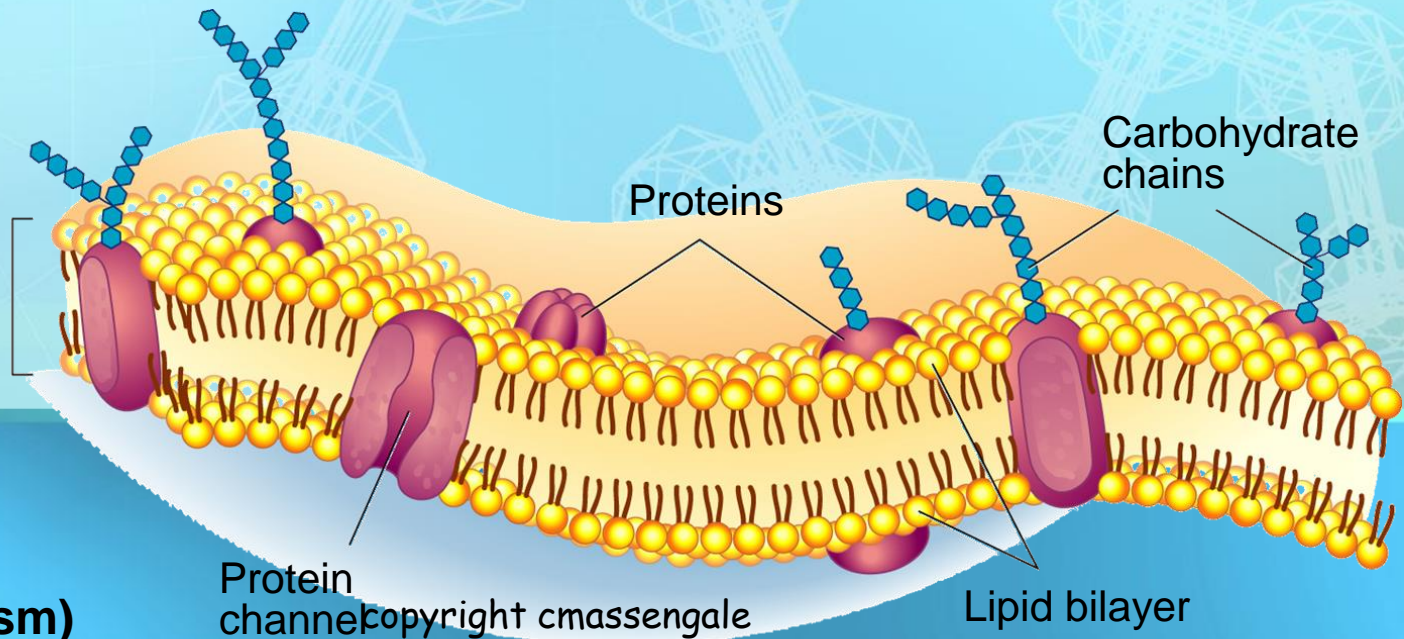
Cell or Plasma Membrane

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

Outside
of cell

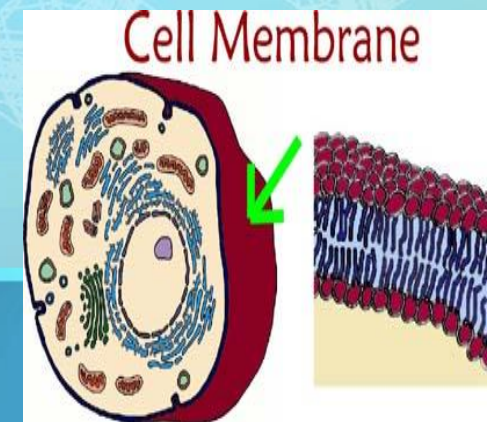
Cell
membrane

Inside
of cell
(cytoplasm)

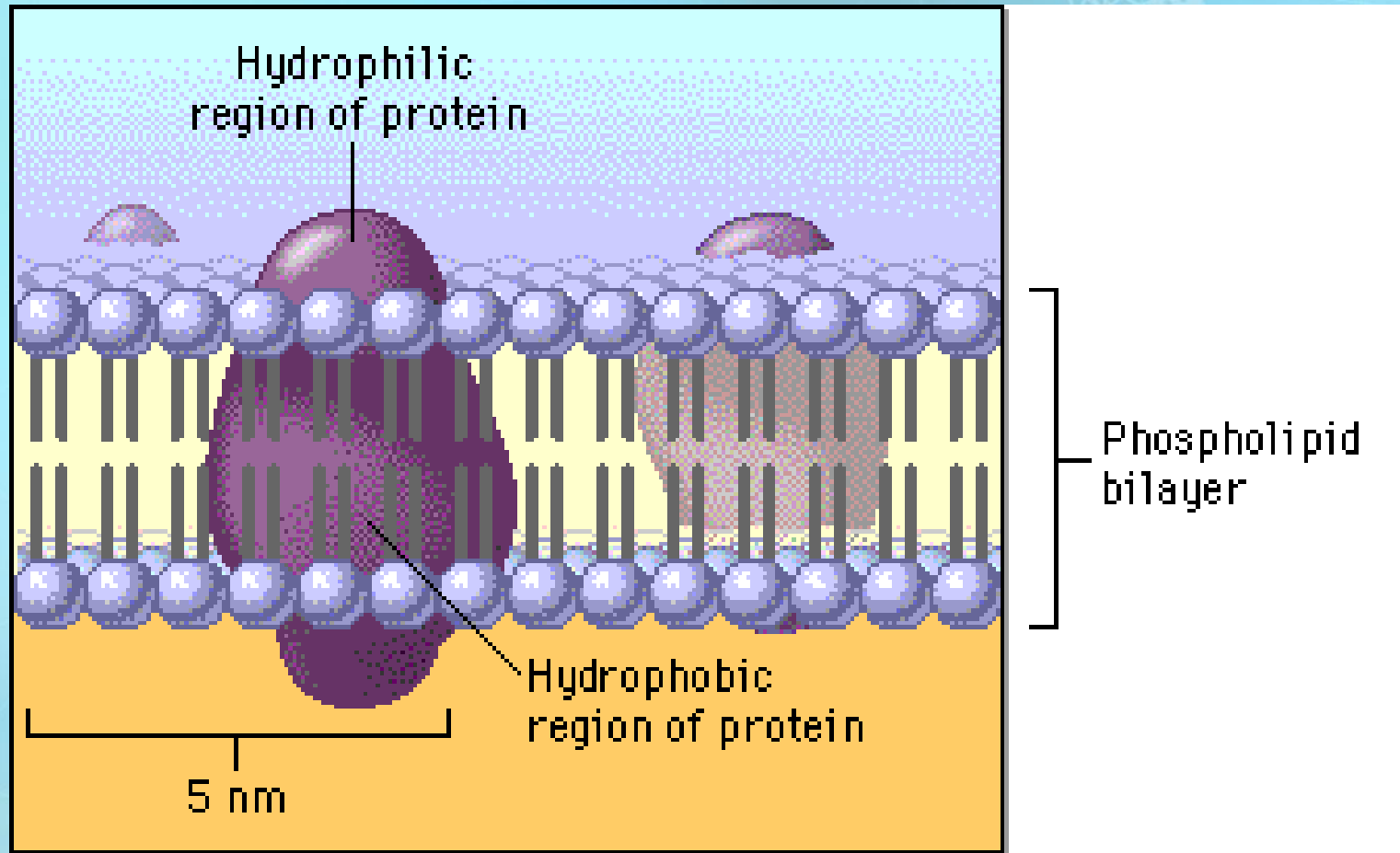


Phospholipids

- **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

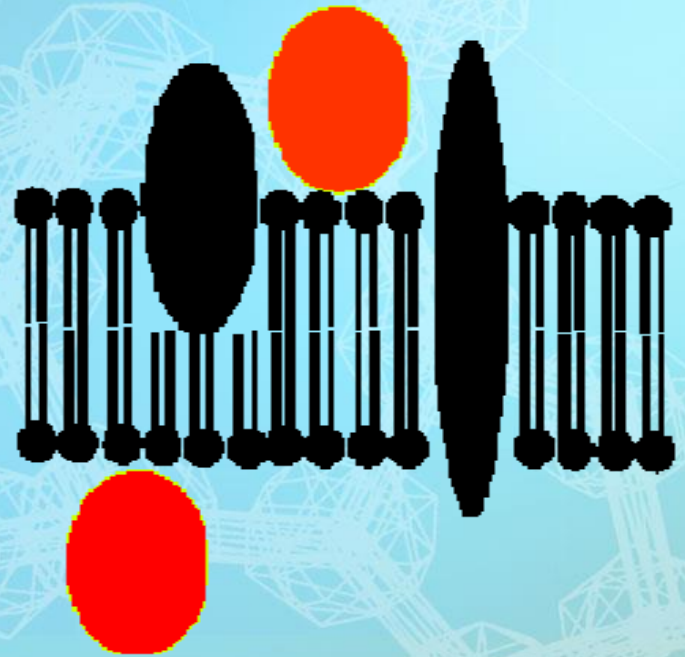


Molecules in cell membranes are constantly moving and changing

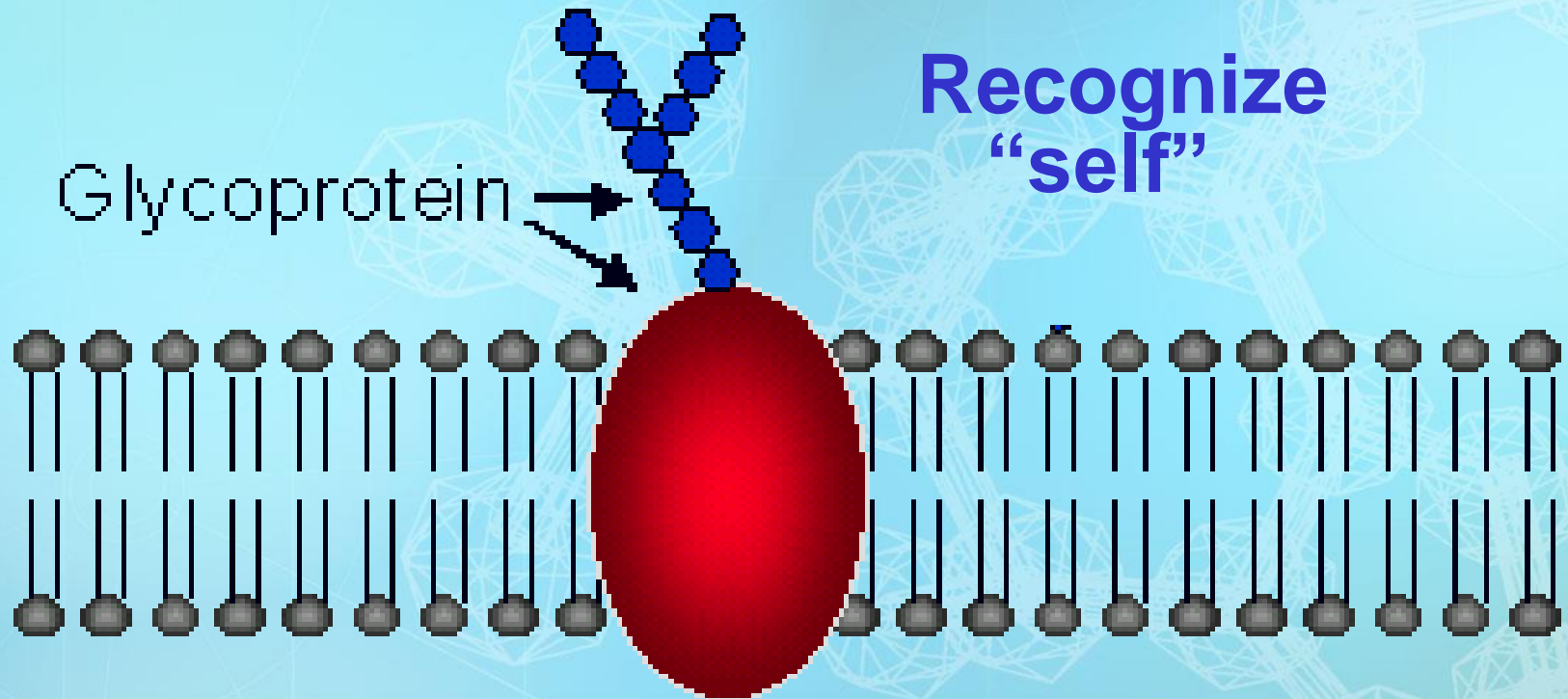
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Cell Membrane Proteins

- 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

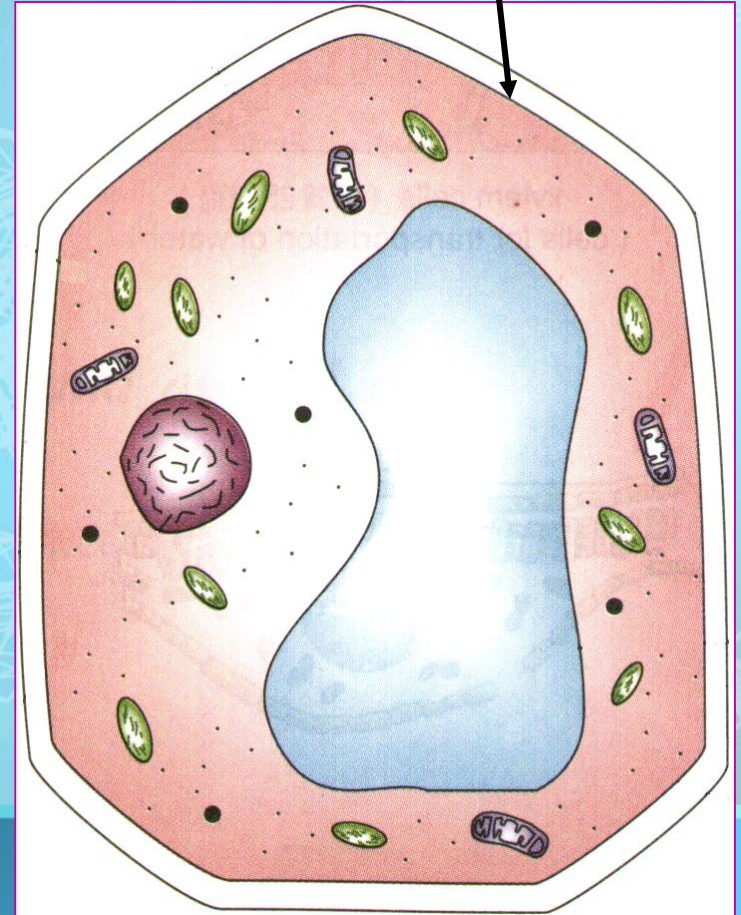


Glycoproteins have **carbohydrate tails** to act as markers for cell recognition

Cell Membrane in Plants

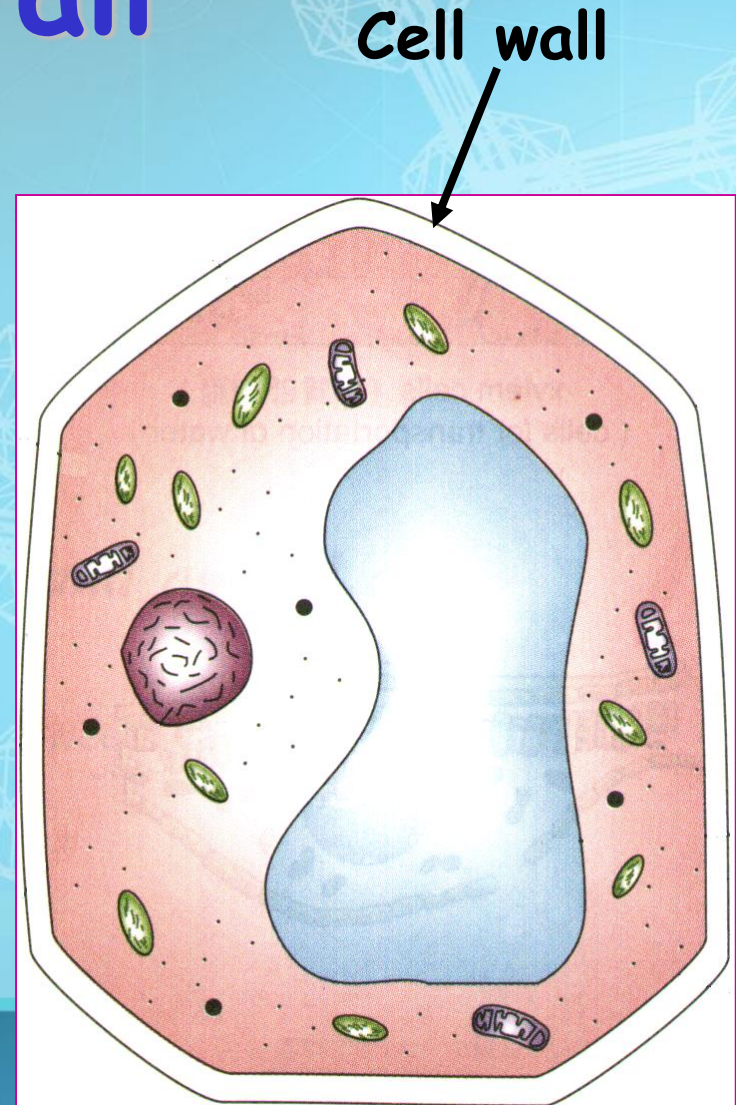
- Lies immediately **against the cell wall** in plant cells
- Pushes out against the cell wall to maintain **cell shape**

Cell membrane



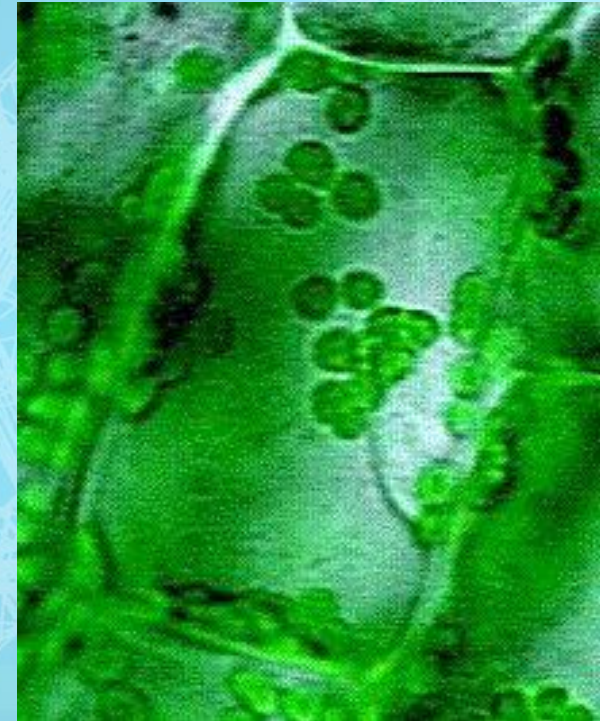
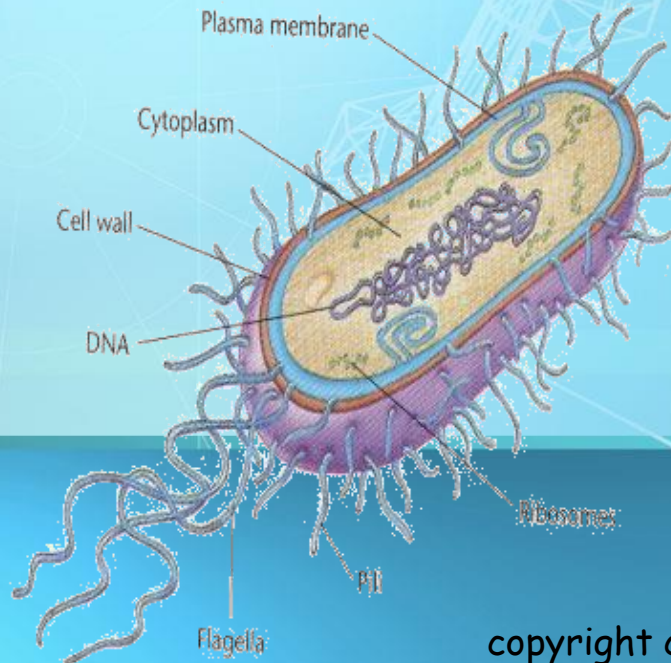
Cell Wall

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



Cell Wall

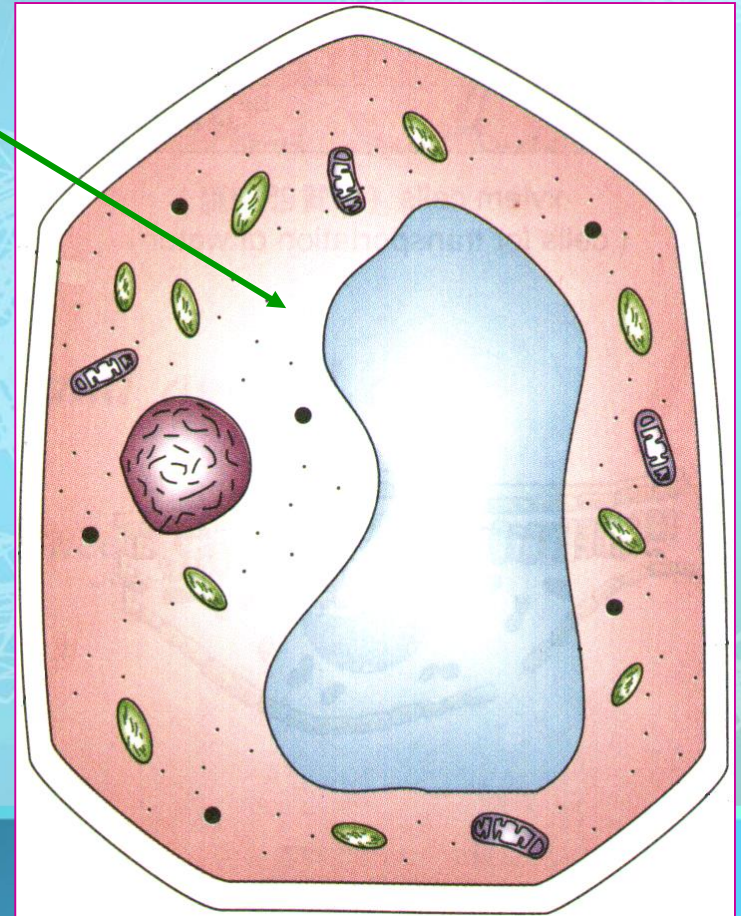
- **Supports and protects cell**
- **Found outside of the cell membrane**



Cytoplasm of a Cell

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

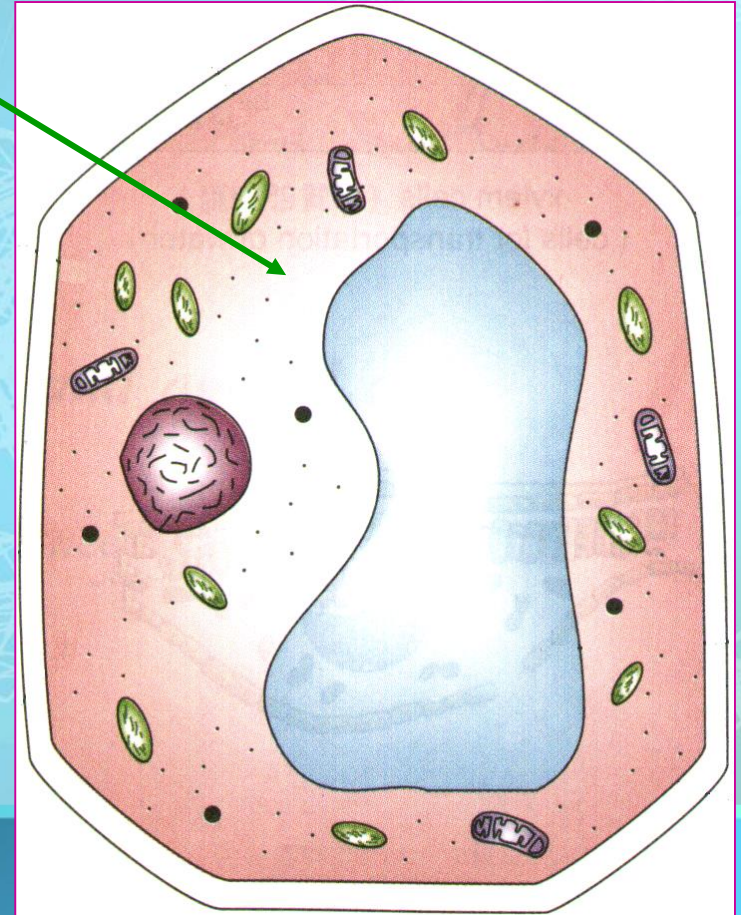
cytoplasm



More on Cytoplasm

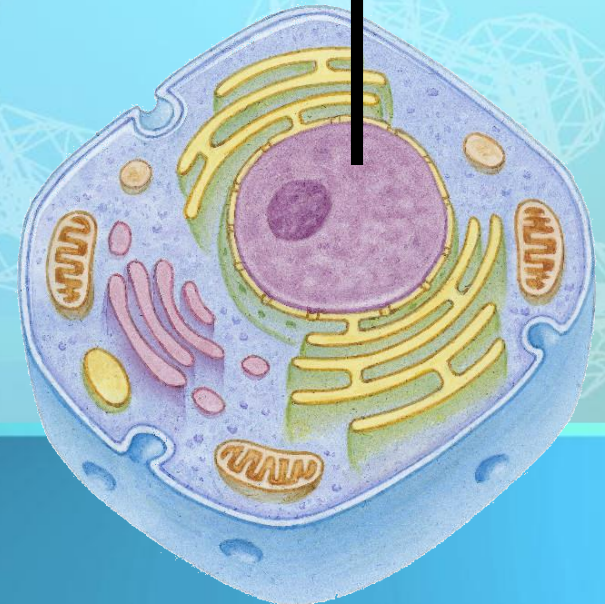
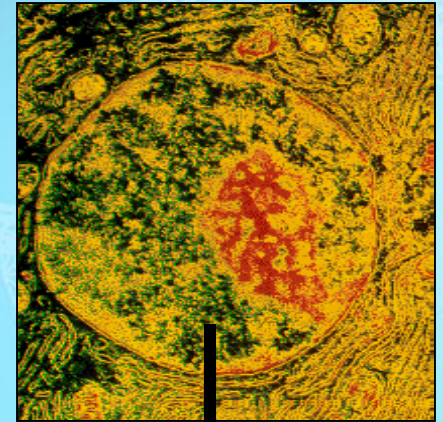
cytoplasm

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

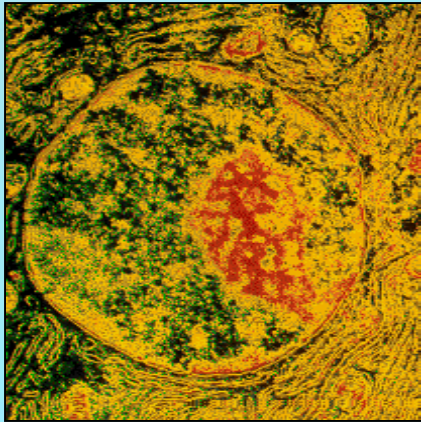


The Control Organelle - Nucleus

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

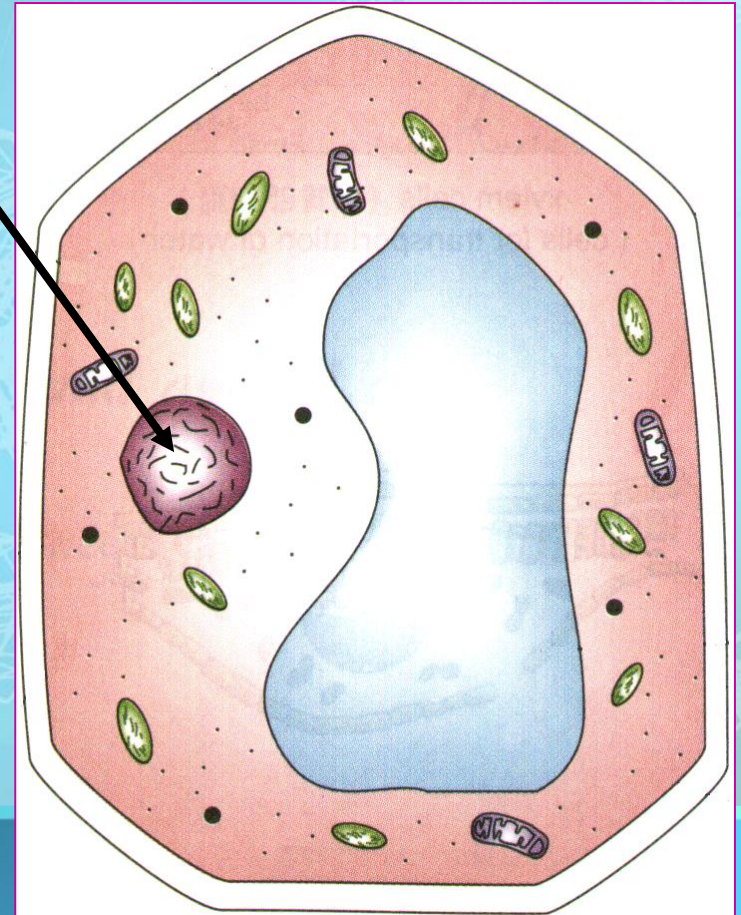


More on the Nucleus



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

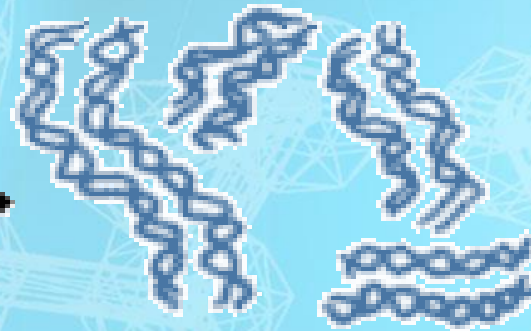
Nucleus



Inside the Nucleus -

The genetic material (DNA) is found

CHROMATIN

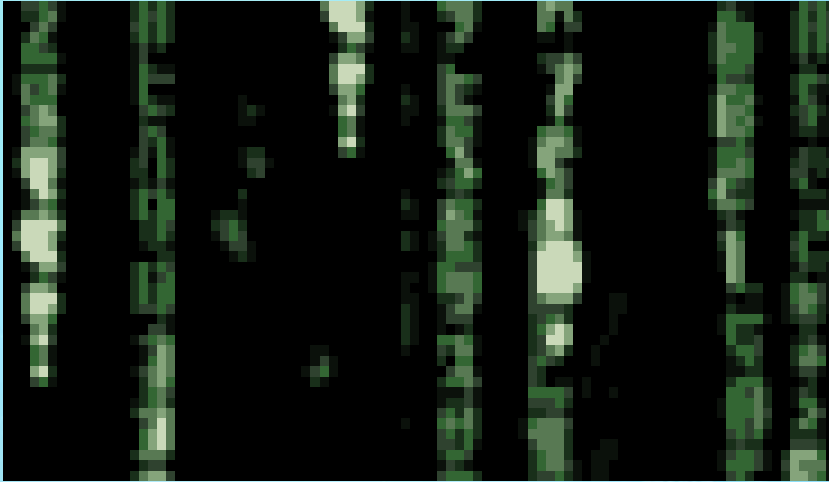


CHROMOSOMES

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

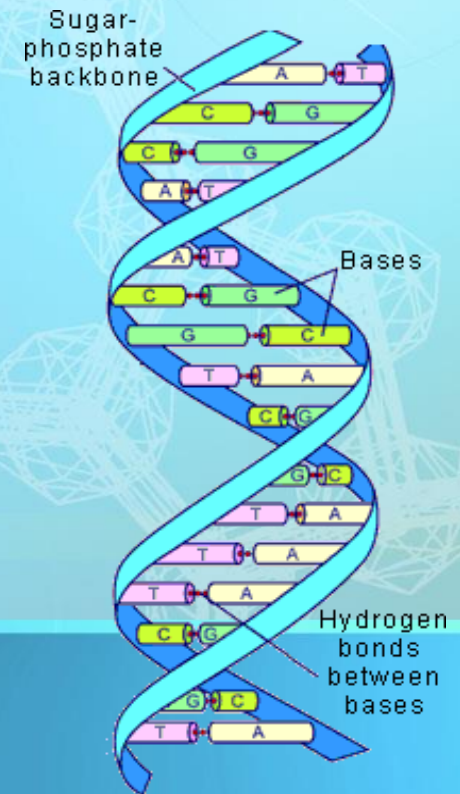
DNA is condensed &
wrapped around proteins
forming
as **CHROMOSOMES**
in dividing cells

What Does DNA do?



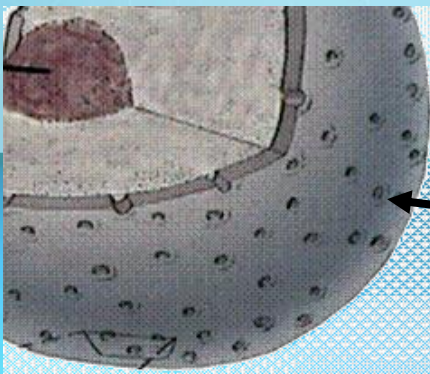
DNA is the **hereditary material** of the cell

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

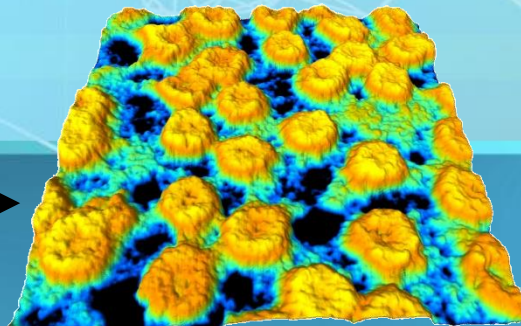


Nuclear Envelope

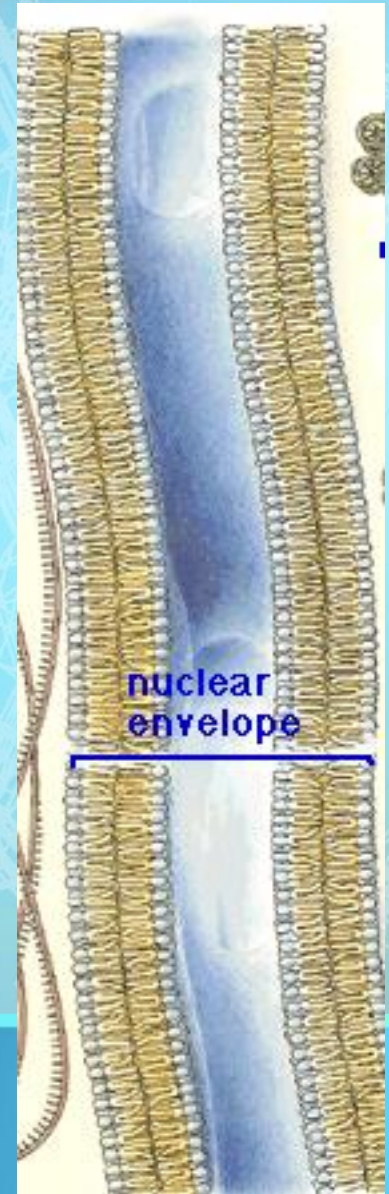
- **Double membrane** surrounding nucleus
- Also called **nuclear membrane**
- Contains **nuclear pores** for materials to enter & leave nucleus
- **Connected to the rough ER**



Nuclear pores

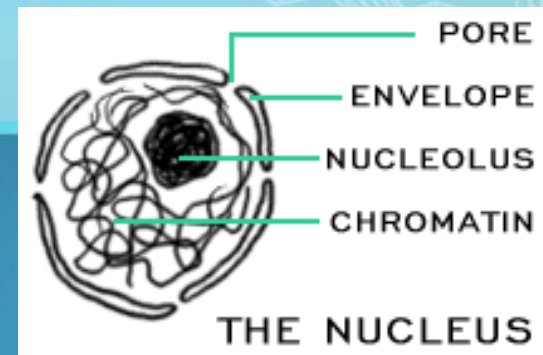
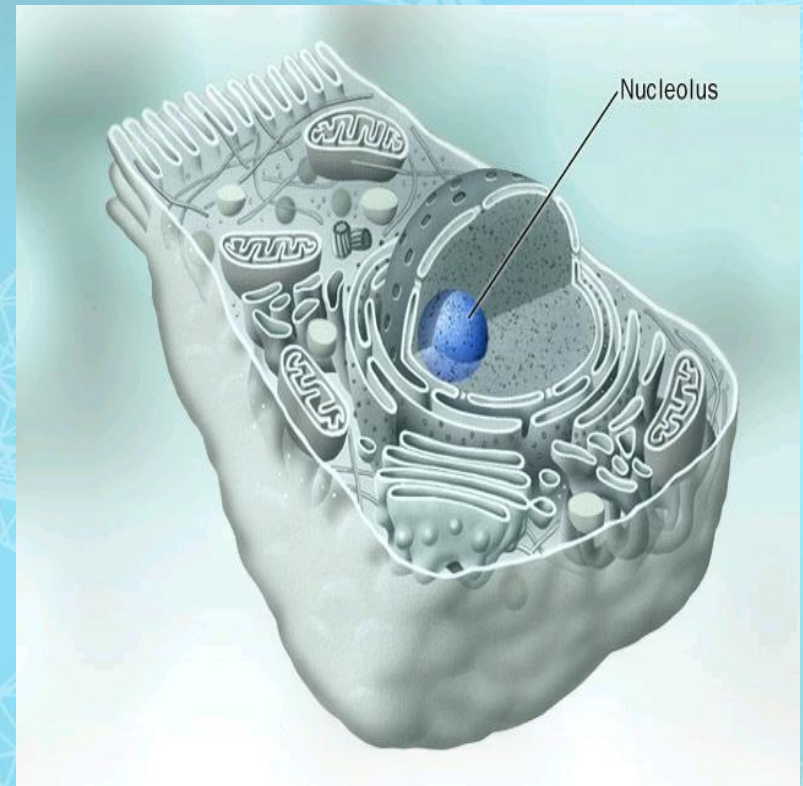


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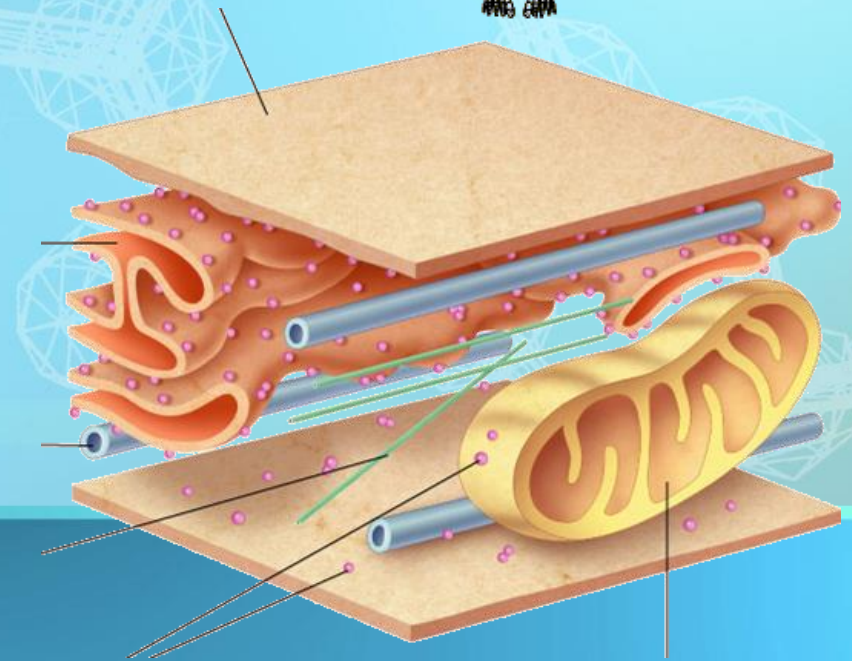
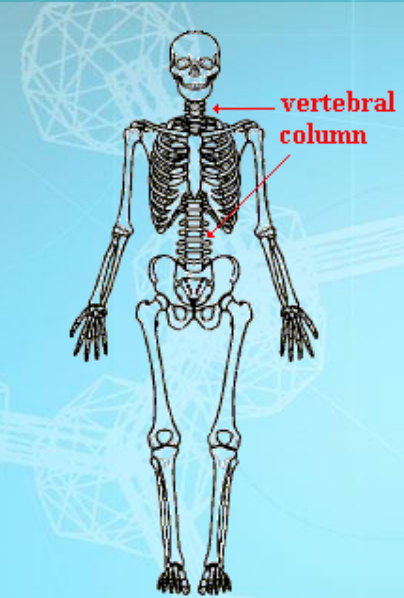
Nucleolus

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

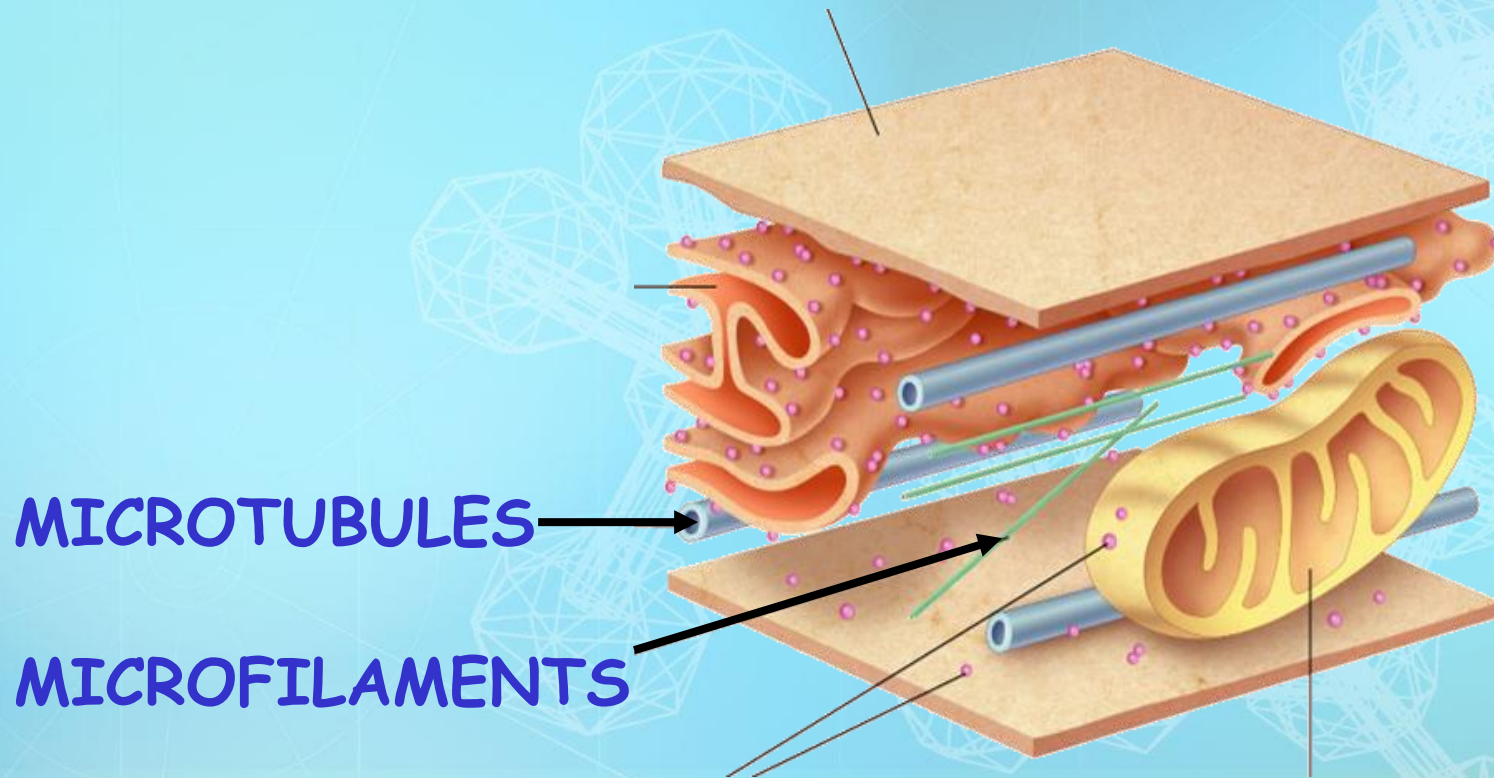


Cytoskeleton

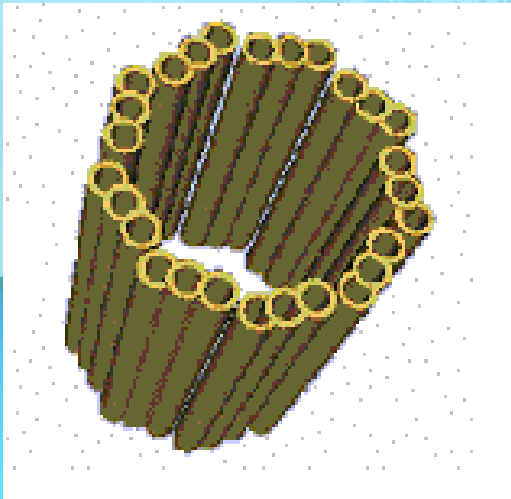
- Helps cell maintain **cell shape**
- Also help **move organelles** around
- Made of **proteins**
- **Microfilaments** are threadlike & made of **ACTIN**
- **Microtubules** are tubelike & made of **TUBULIN**



Cytoskeleton



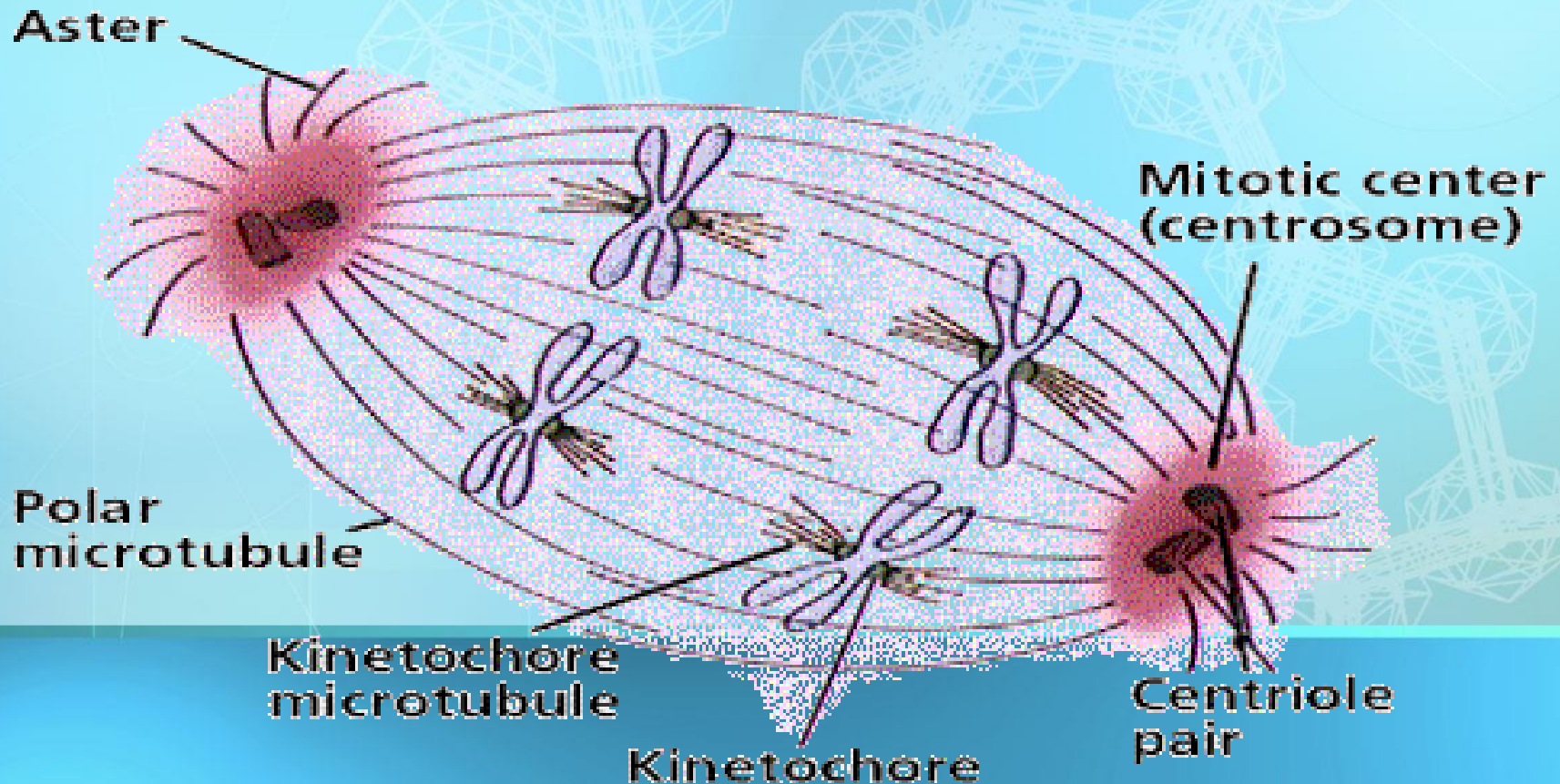
Centrioles



- 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)

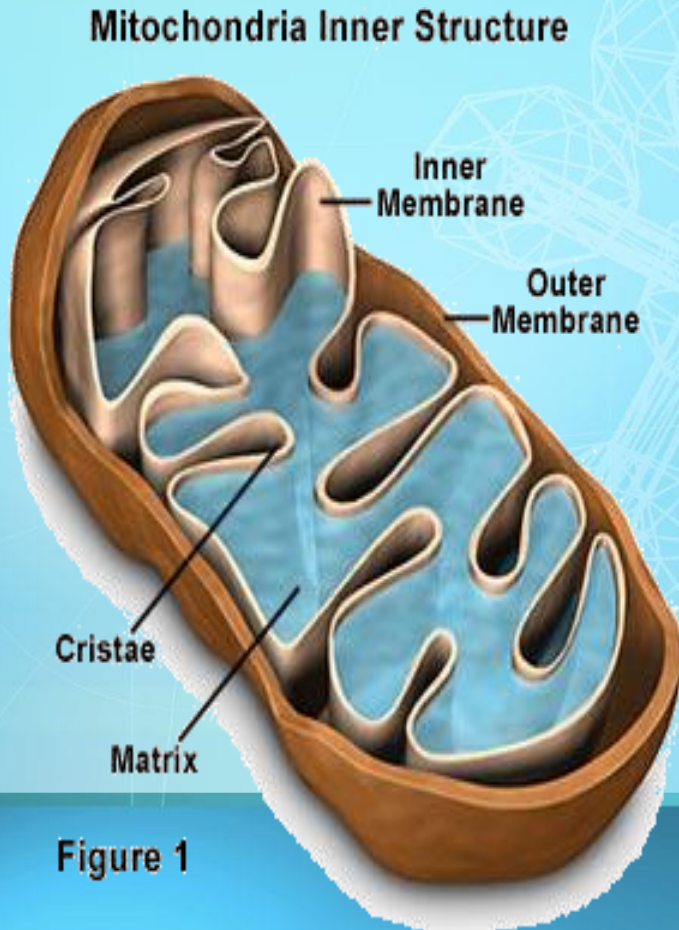


MITOCHONDRIA

Surrounded by a **DOUBLE** membrane

Has its own **DNA**

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



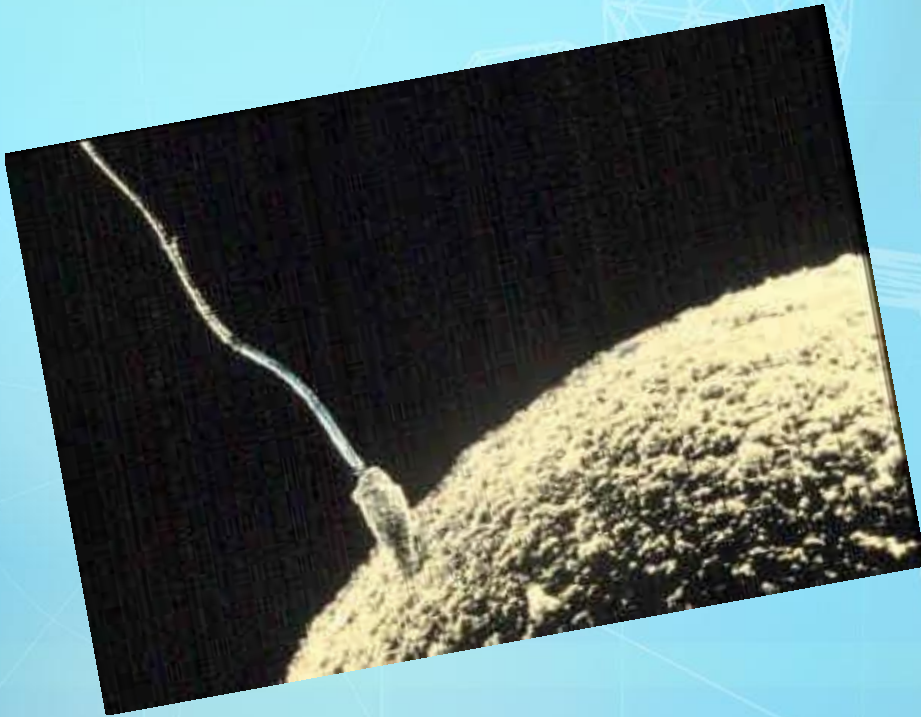
Interior called **MATRIX**

Interesting Fact ---

- Mitochondria Come from cytoplasm in the EGG cell during fertilization

Therefore ...

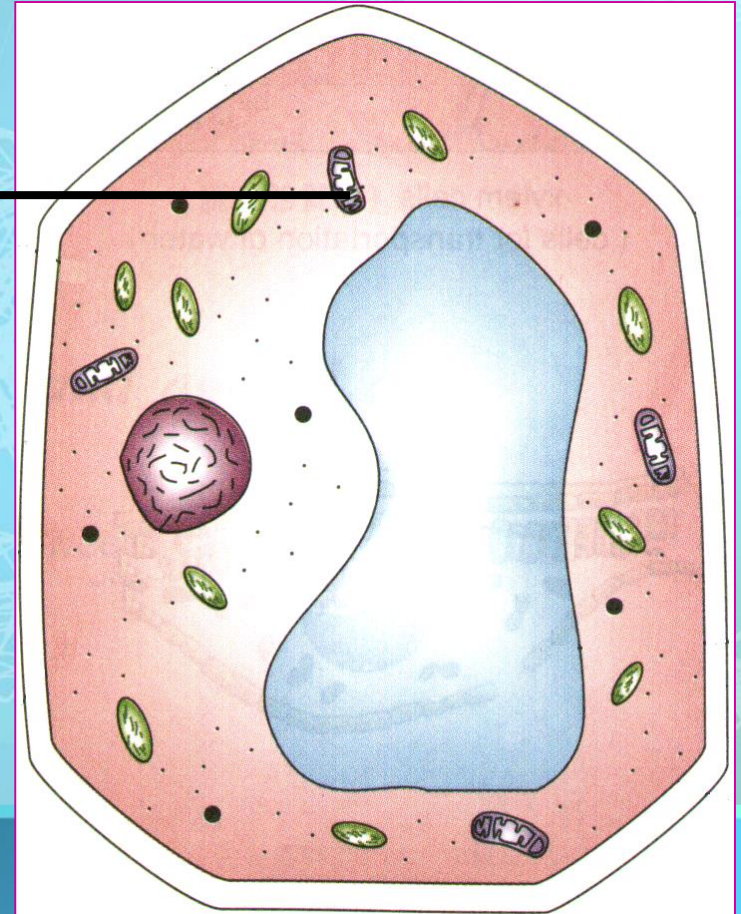
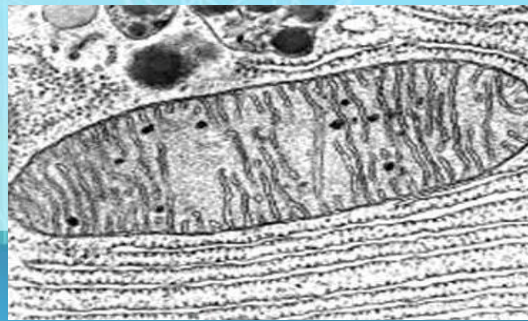
- You inherit your mitochondria from your **mother!**



Cell Powerhouse

Mitochondrion
(mitochondria)

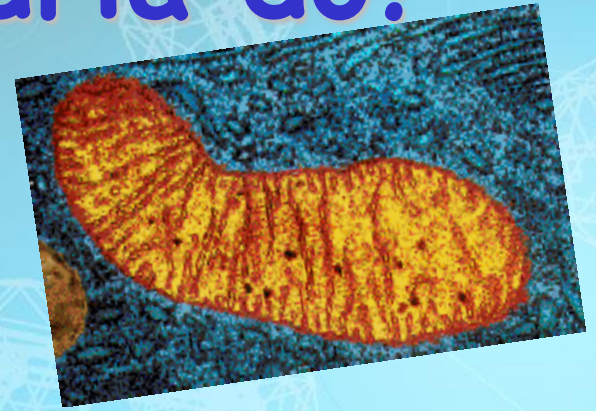
Rod shape



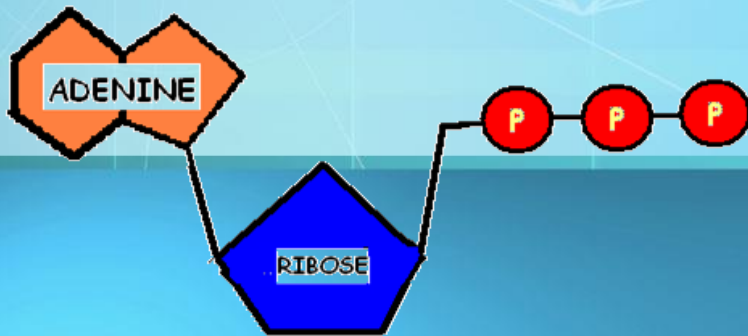
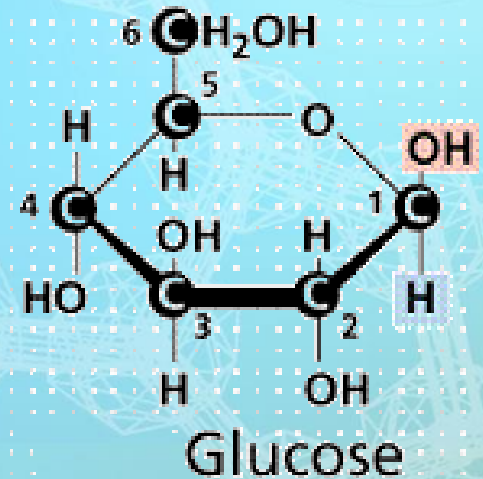
What do mitochondria do?



“Power plant”
of the cell



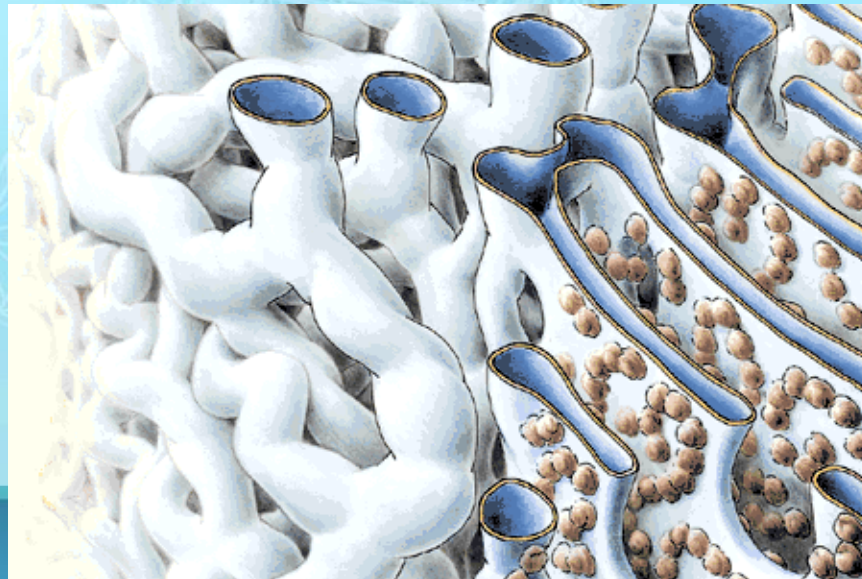
Burns glucose to
release energy (ATP)



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**

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Rough Endoplasmic Reticulum (Rough ER)

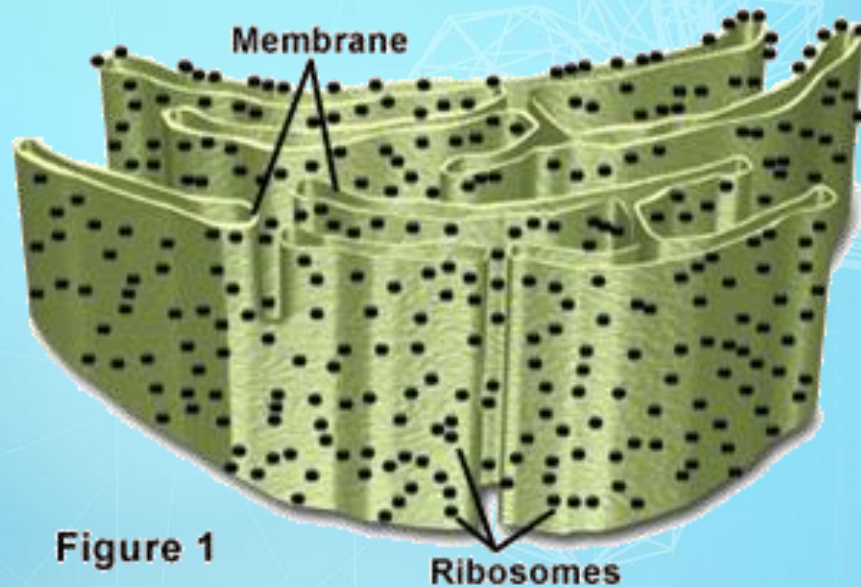
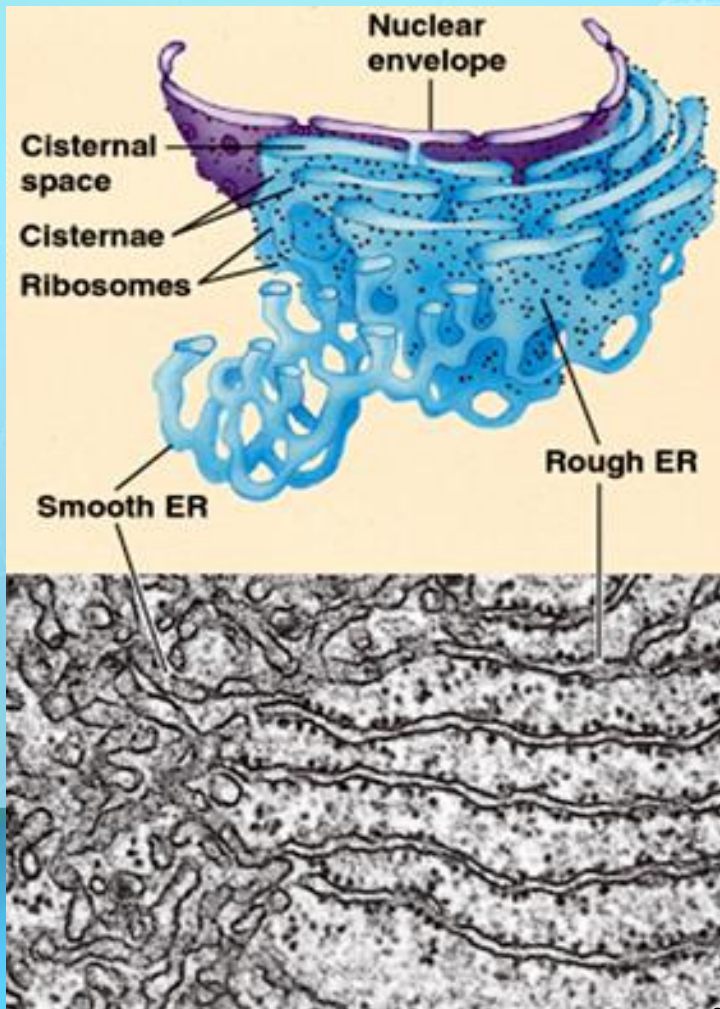


Figure 1

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

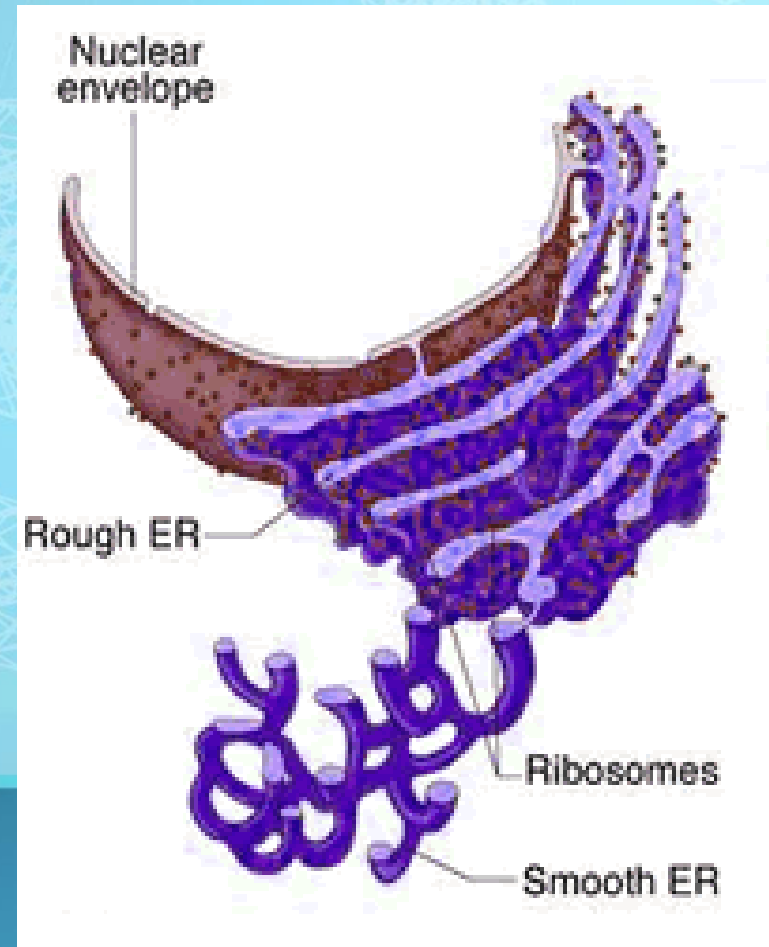
Rough Endoplasmic Reticulum (Rough ER)



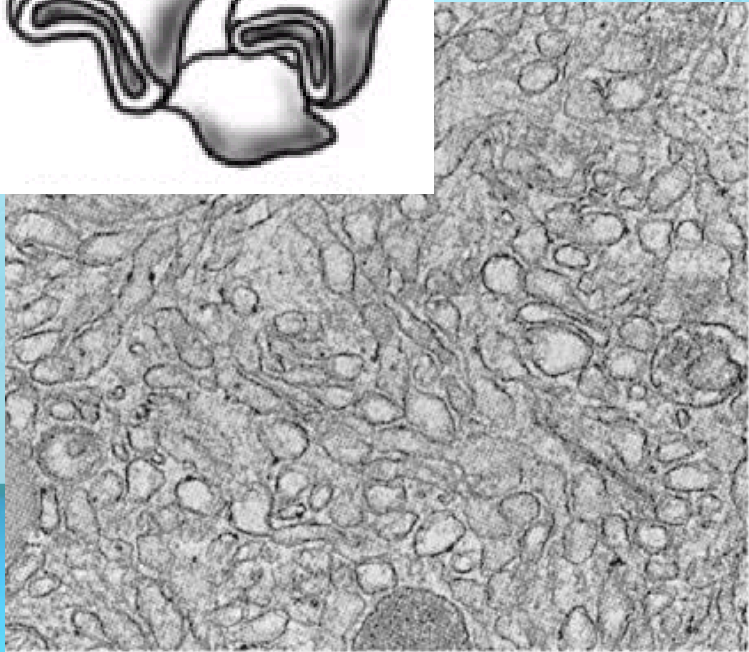
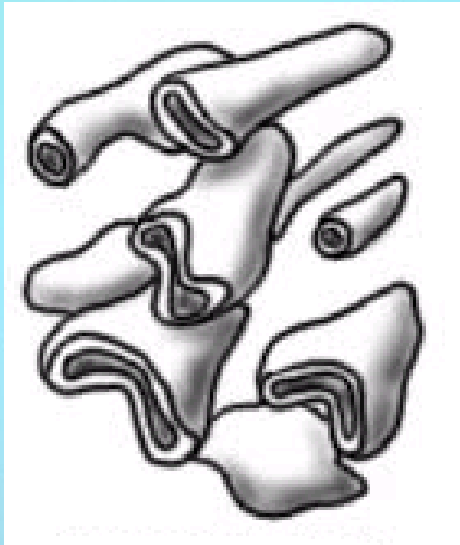
- Proteins are made by **ribosomes on ER surface**
- They are then **threaded into the interior of the Rough ER** to be modified and transported

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

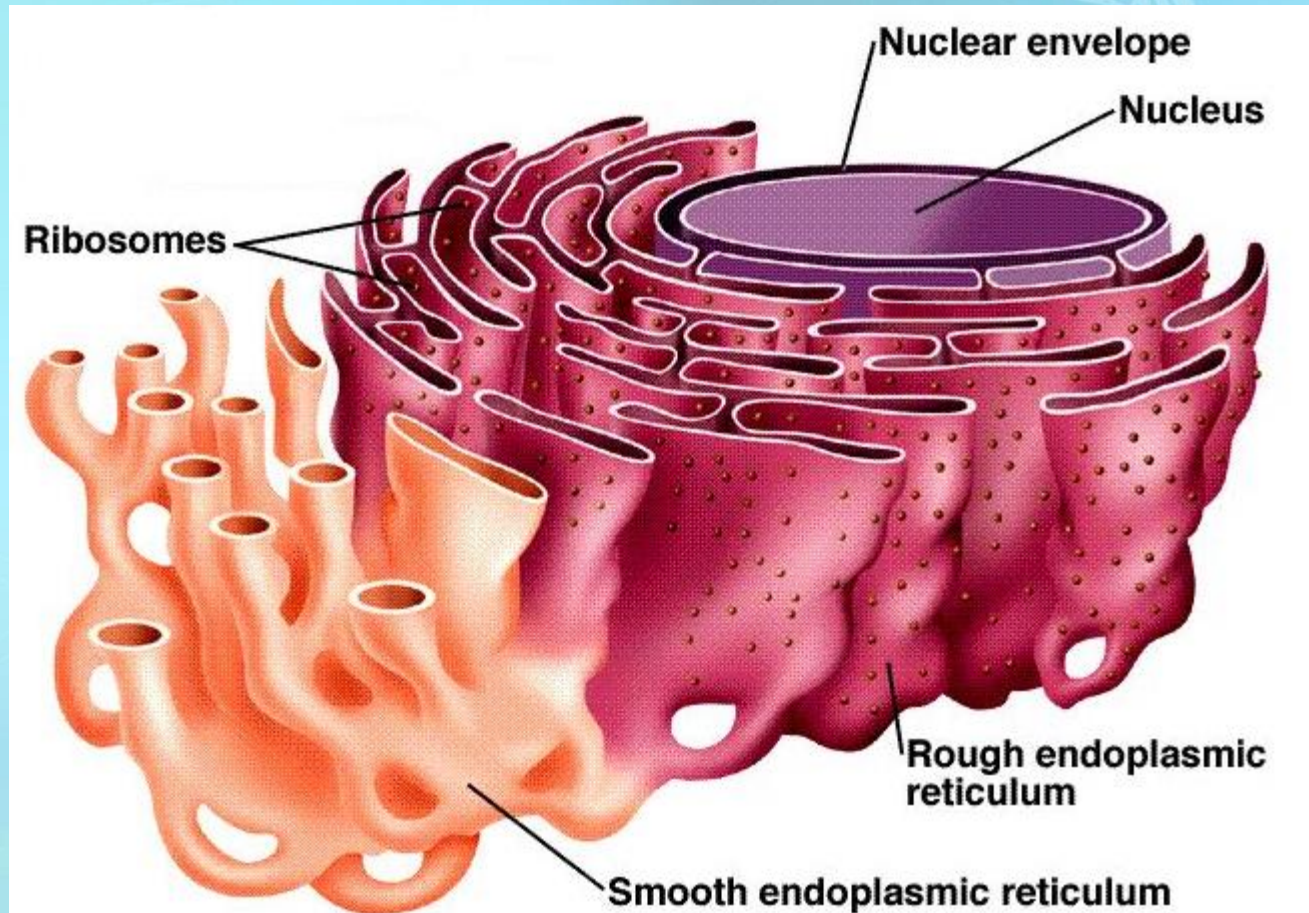


Functions of the Smooth ER



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

Endomembrane System

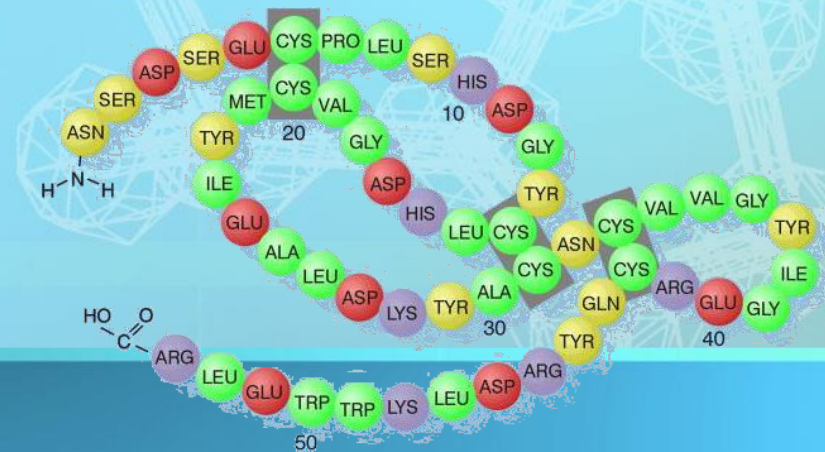
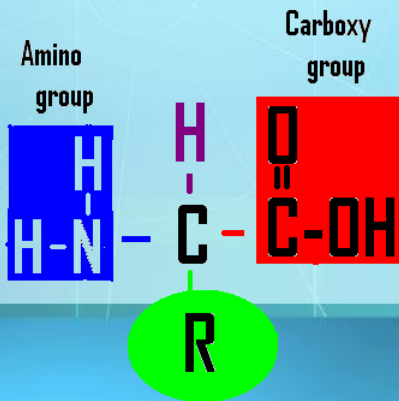


Includes nuclear membrane connected to ER connected to cell membrane (transport)

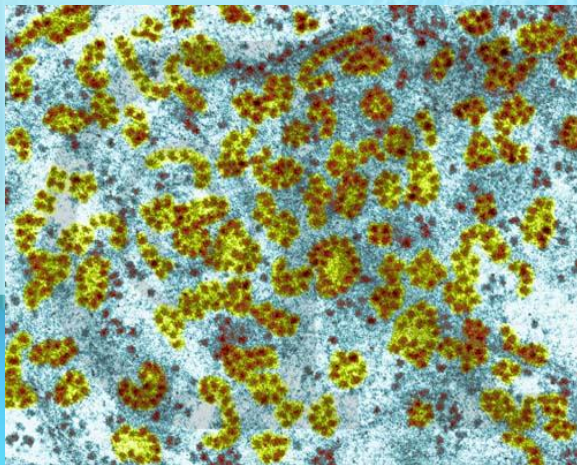
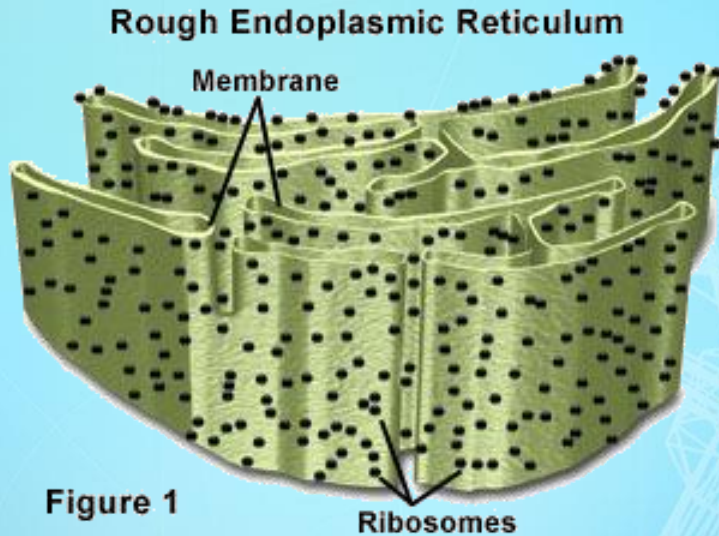
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Ribosomes

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



Ribosomes



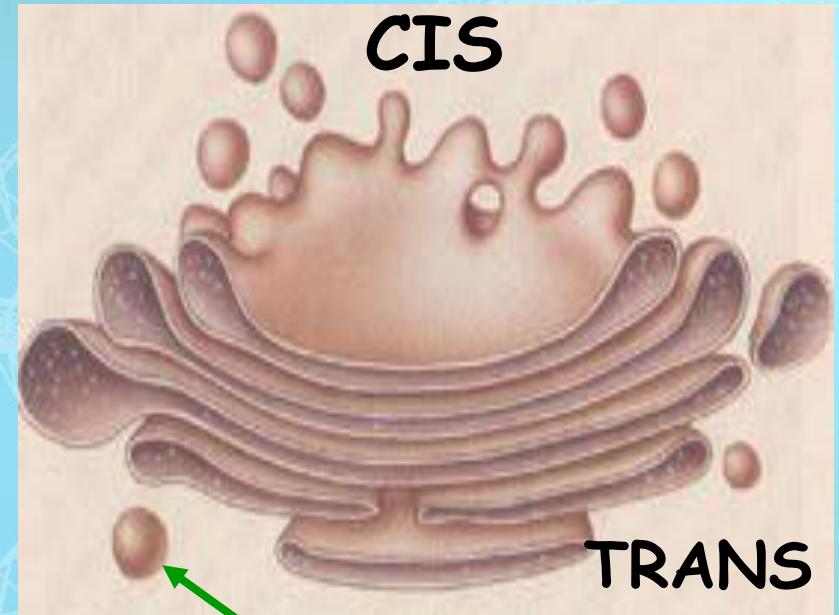
Can be attached to
Rough ER

OR

Be free
(unattached)
in the
cytoplasm

Golgi Bodies

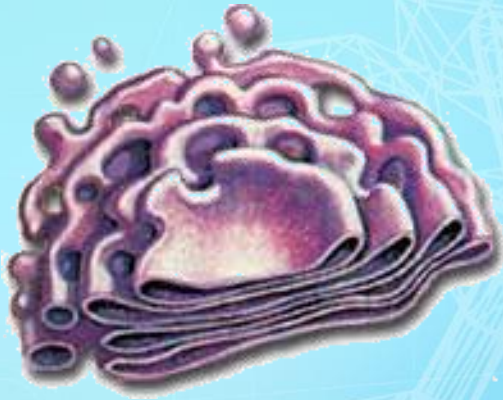
- Stacks of **flattened sacs**
- Have a shipping side (trans face) and receiving side (cis face)
- Receive **proteins** made by ER
- **Transport vesicles** with modified proteins pinch off the ends



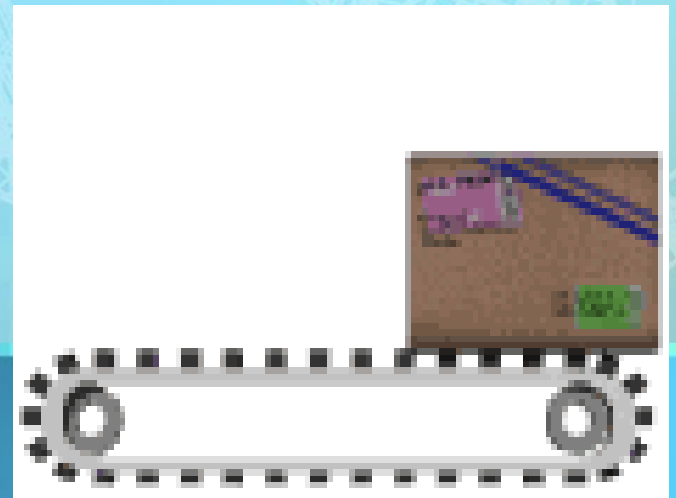
Transport vesicle

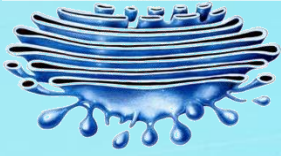
Golgi Bodies

Look like a stack of pancakes

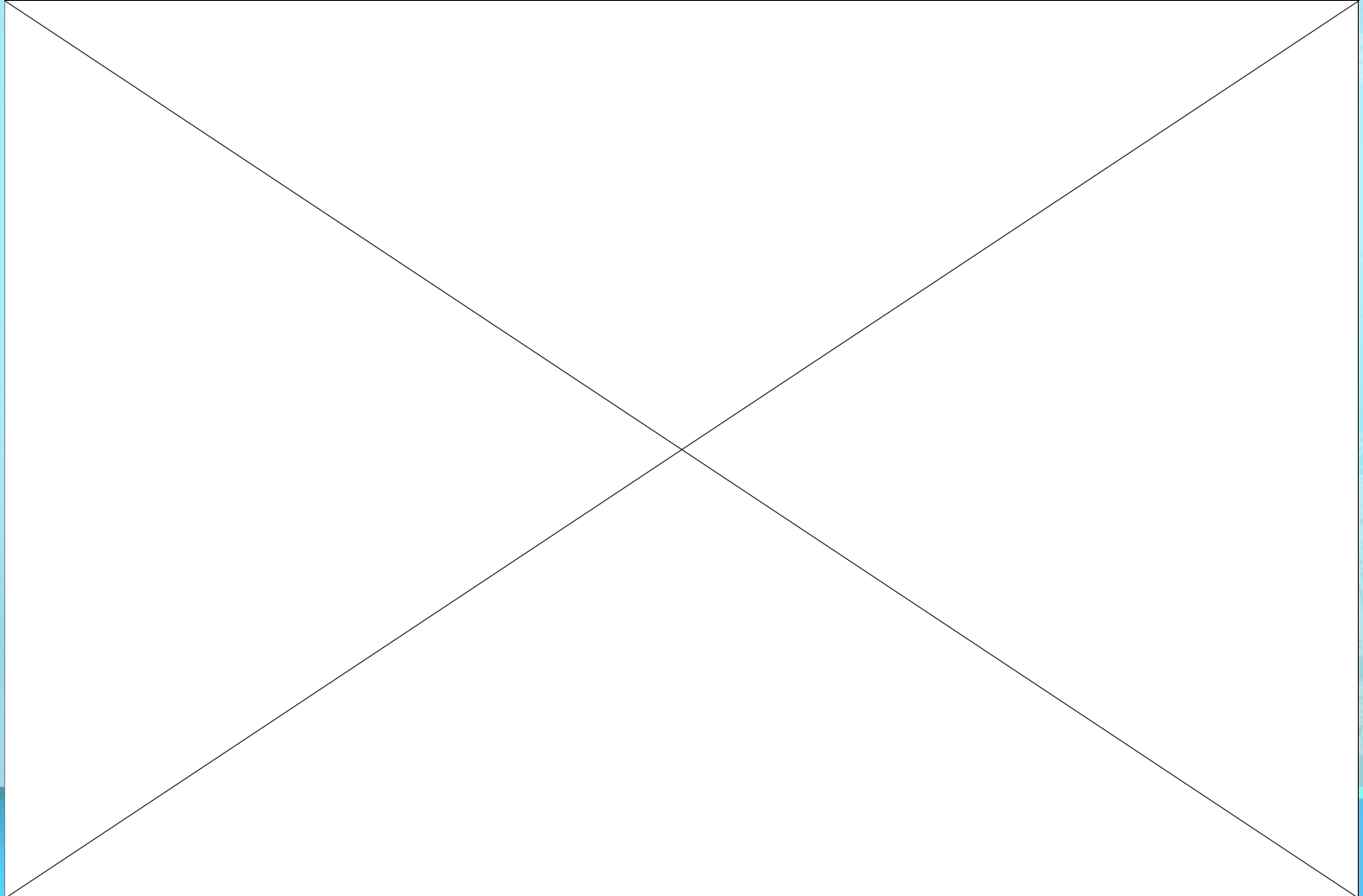


Modify, sort, & package
molecules from ER
for **storage** OR
transport out of cell





Golgi



Golgi Animation

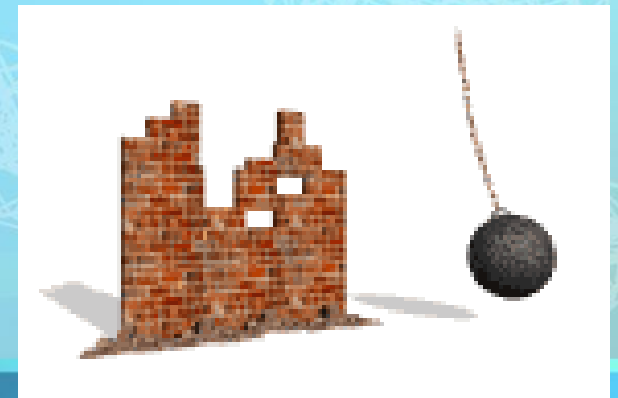
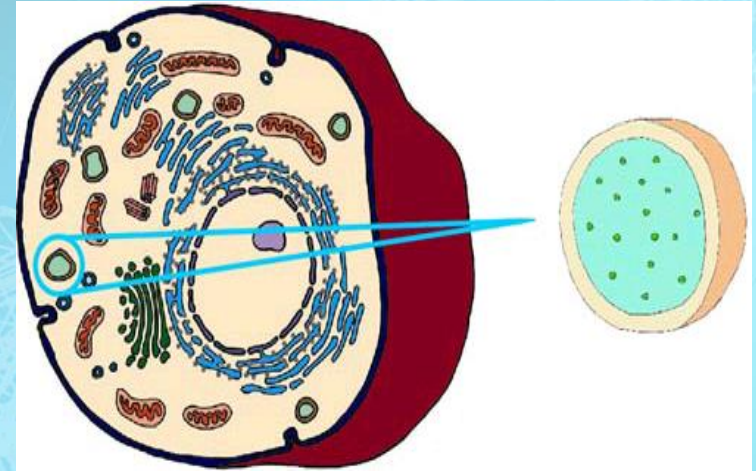


Materials are transported from Rough ER
to Golgi to the cell membrane by VESICLES

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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)



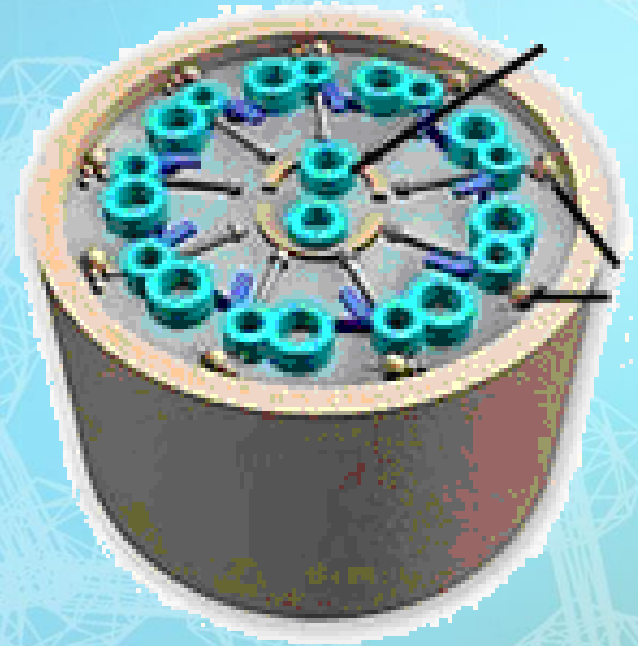
Lysosome Digestion

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



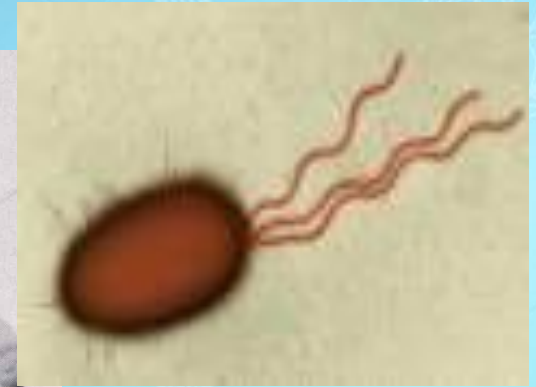
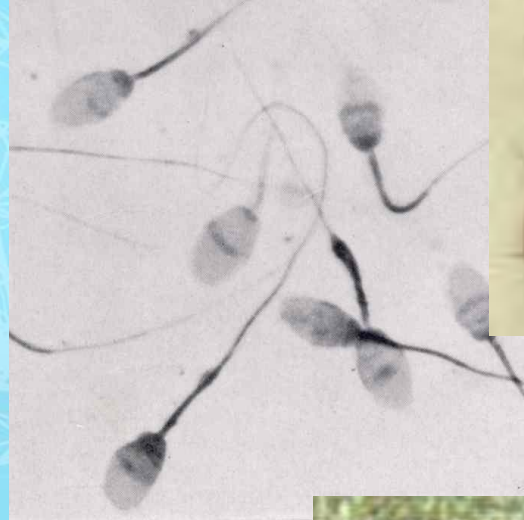
Cilia & Flagella

- 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

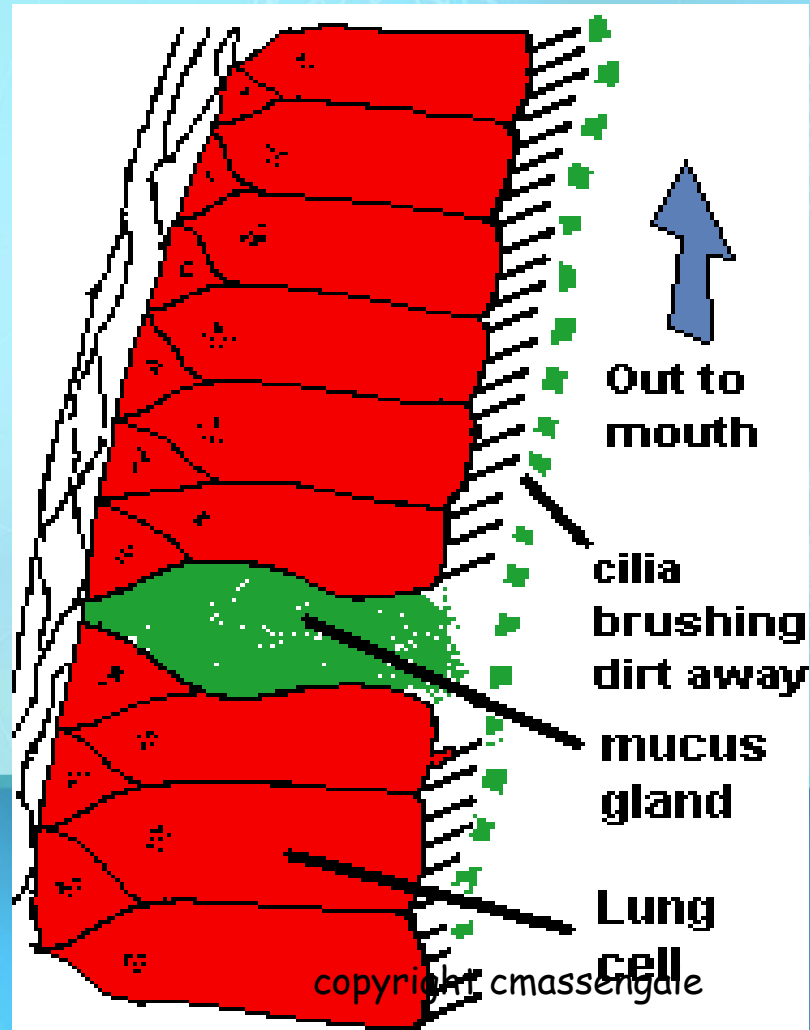
- **Cilia** are shorter and more numerous on cells
- **Flagella** are longer and fewer (usually 1-3) on cells



Cell Movement with Cilia & Flagella

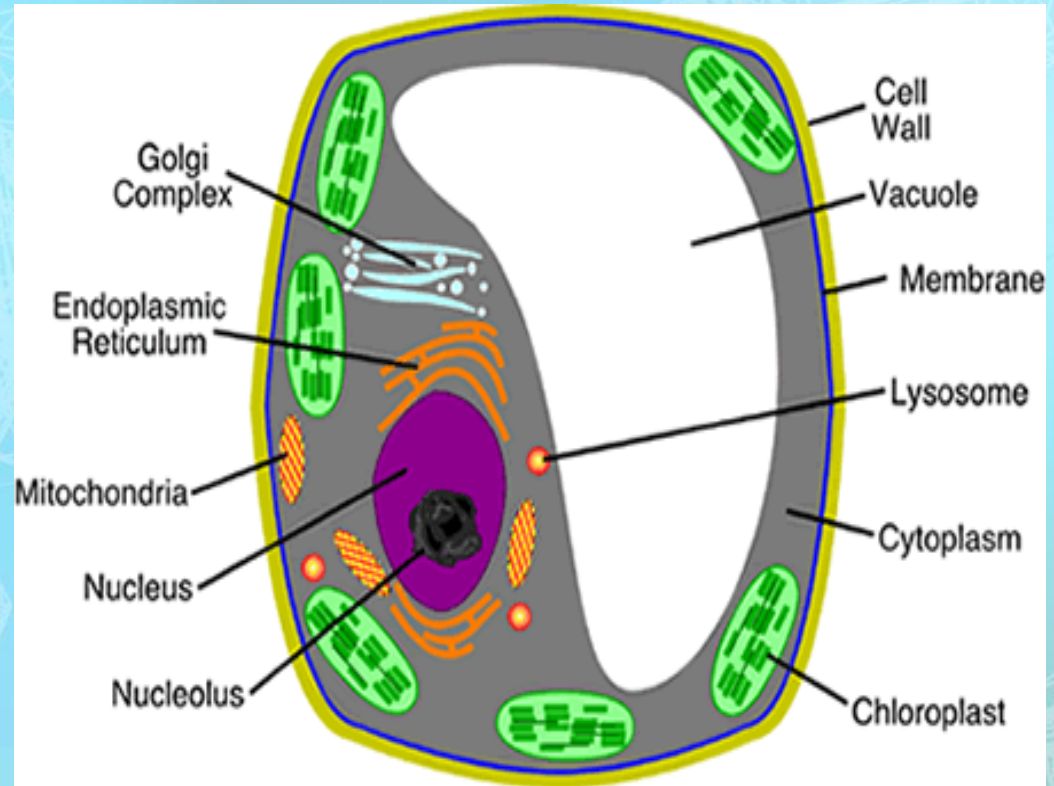


Cilia Moving Away Dust Particles from the Lungs Respiratory System



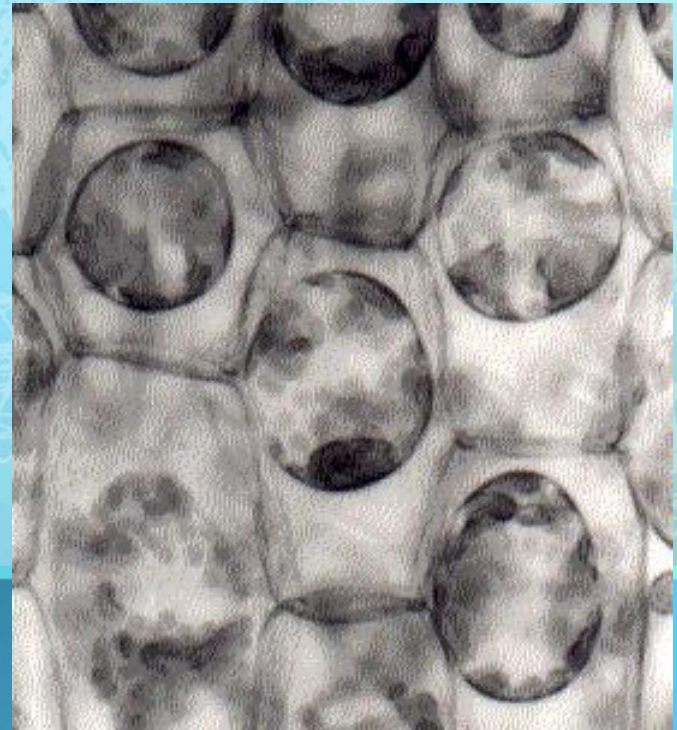
Vacuoles

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



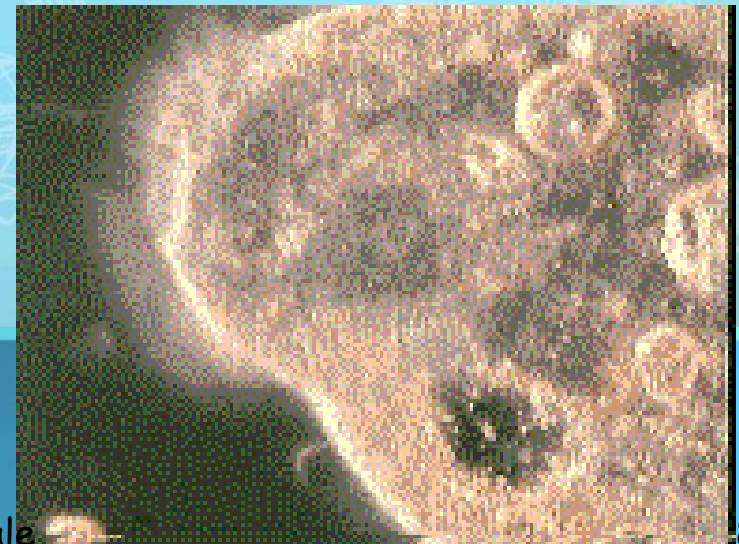
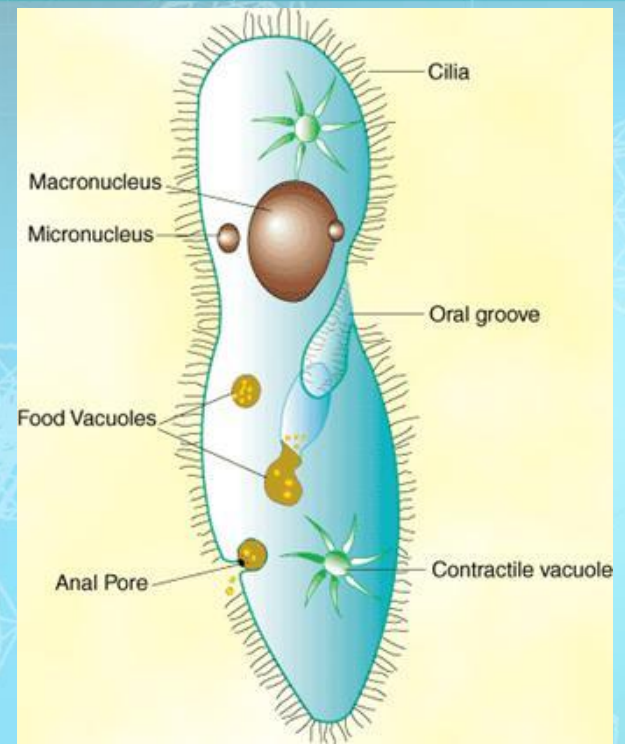
Vacuoles

- 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)

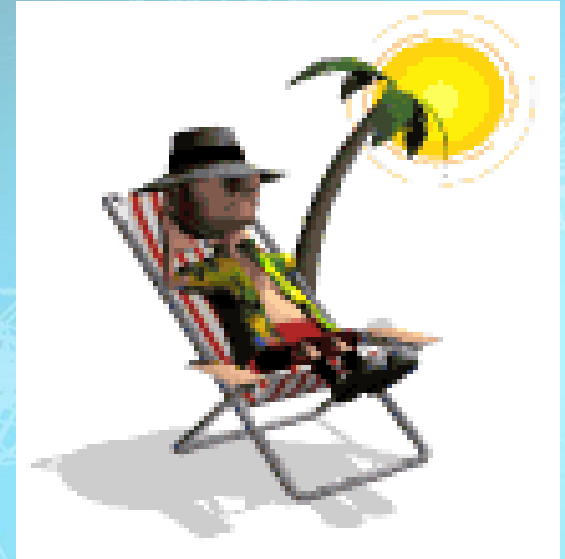


Contractile vacuole animation



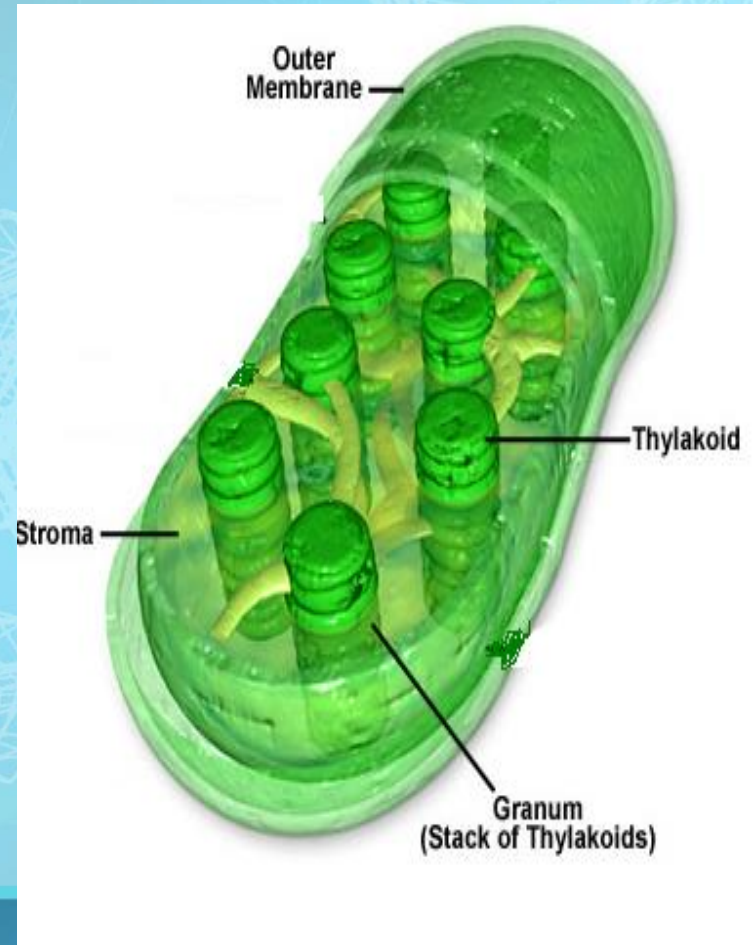
Chloroplasts

- 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**



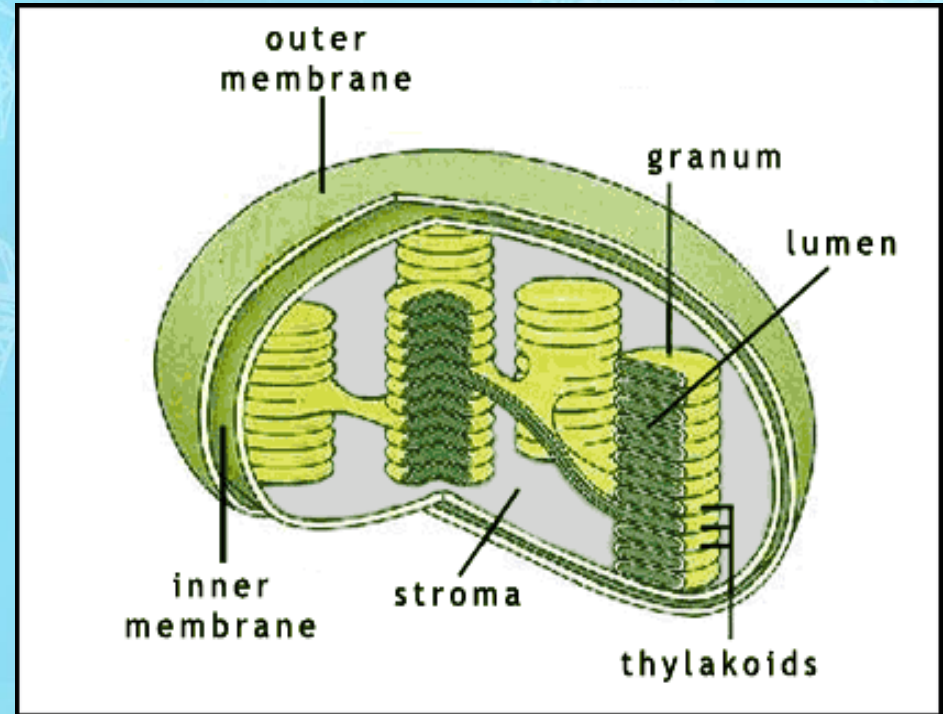
Chloroplasts

- 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 ($L \times W$)
- **Volume of a cell** is determined by multiplying length times width times height ($L \times W \times H$)
- 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!

