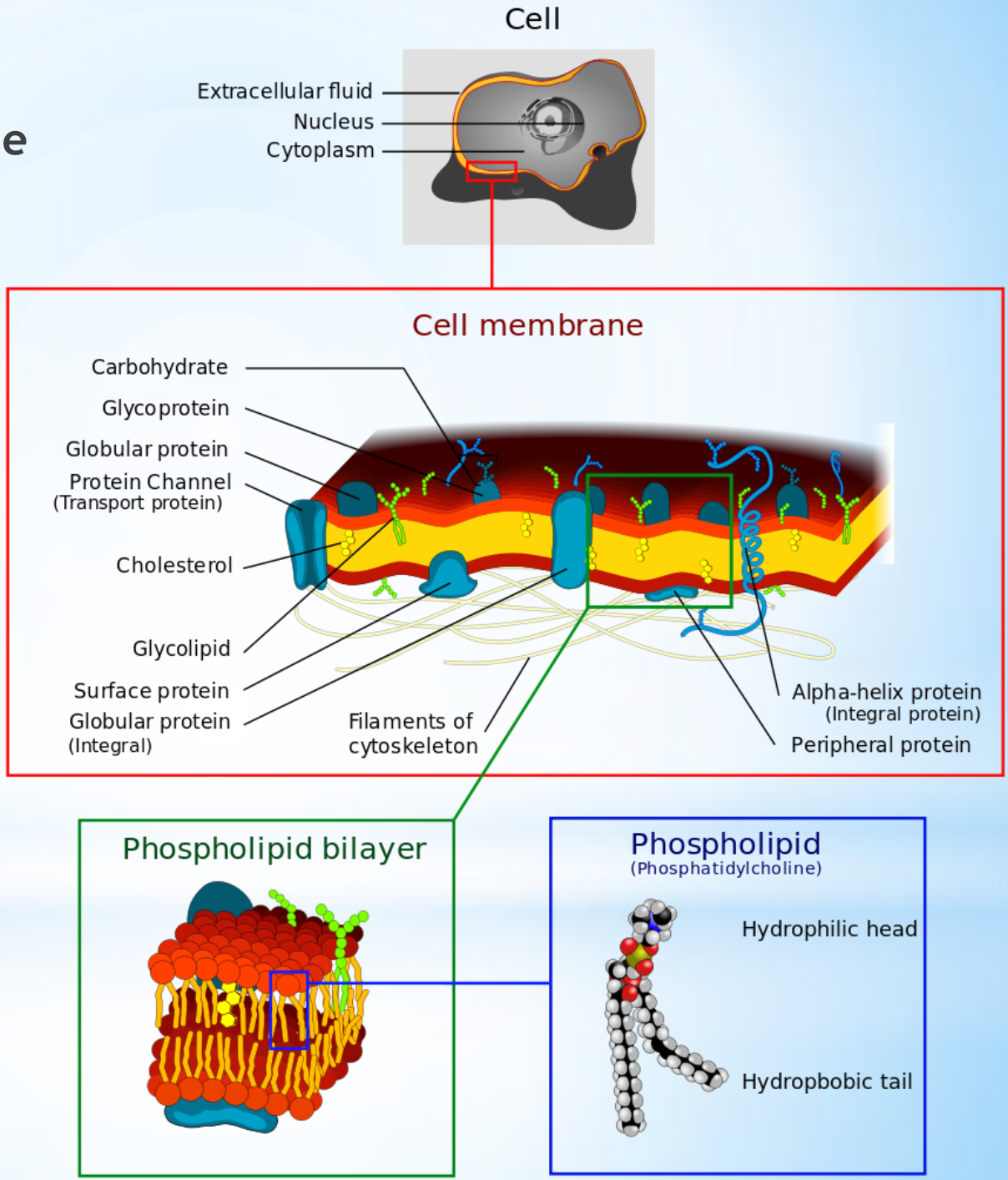
1. Cell Membrane Structure

2.4: Cell membranes are selectively permeable due to their structure.

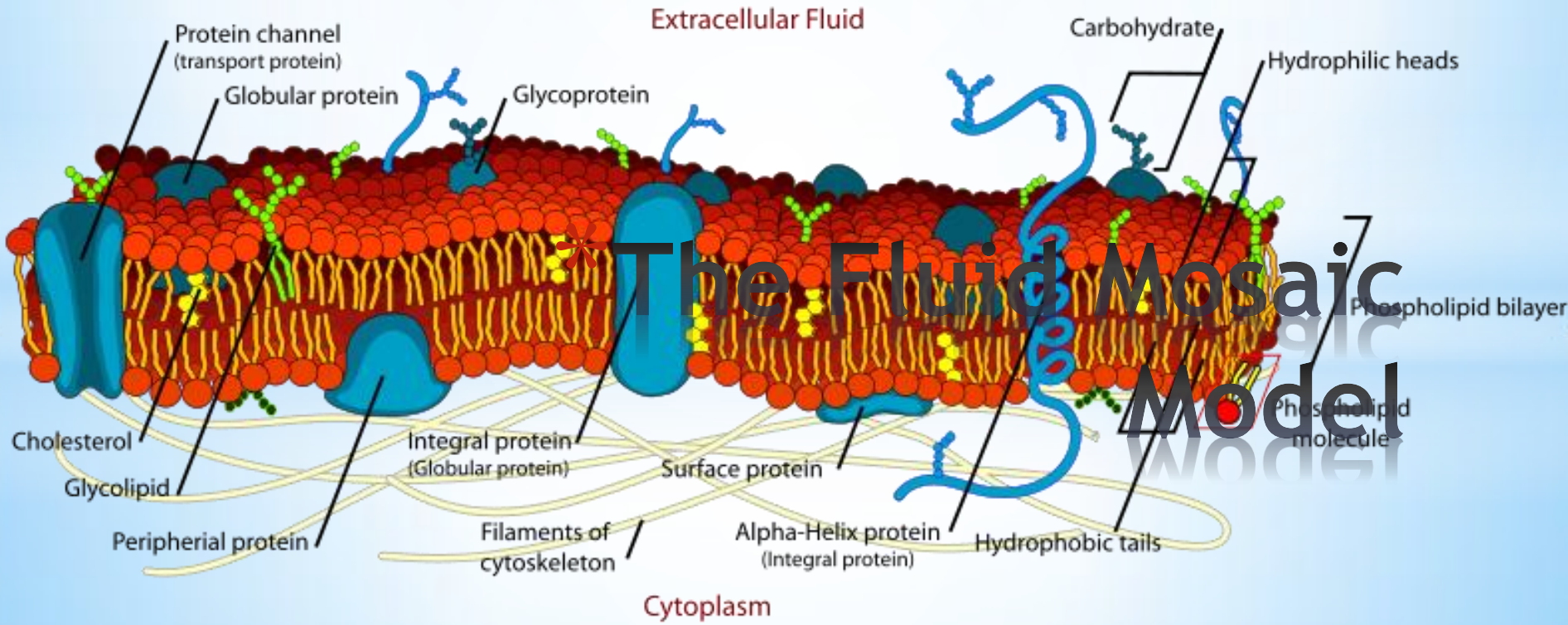
The **cell membrane** is a boundary between the cell and the environment.

It controls the **transport** of materials in/out of the cell.

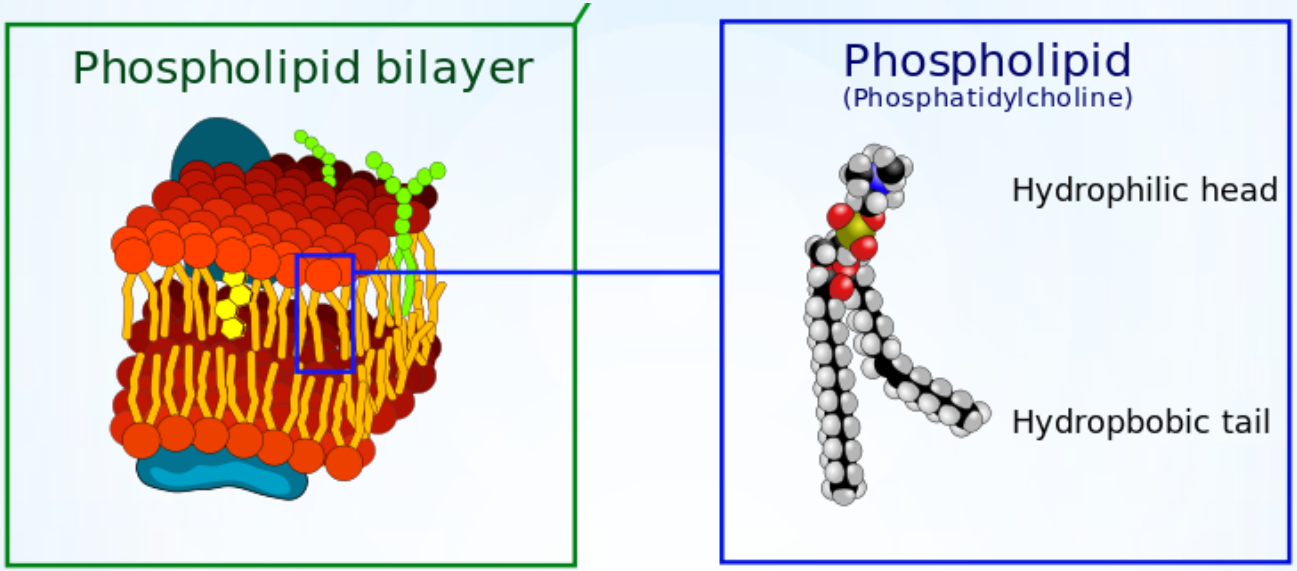


Connects membrane structure to function.

2 components: phospholipids and proteins



The Fluid Mosaic Model



*Phospholipids

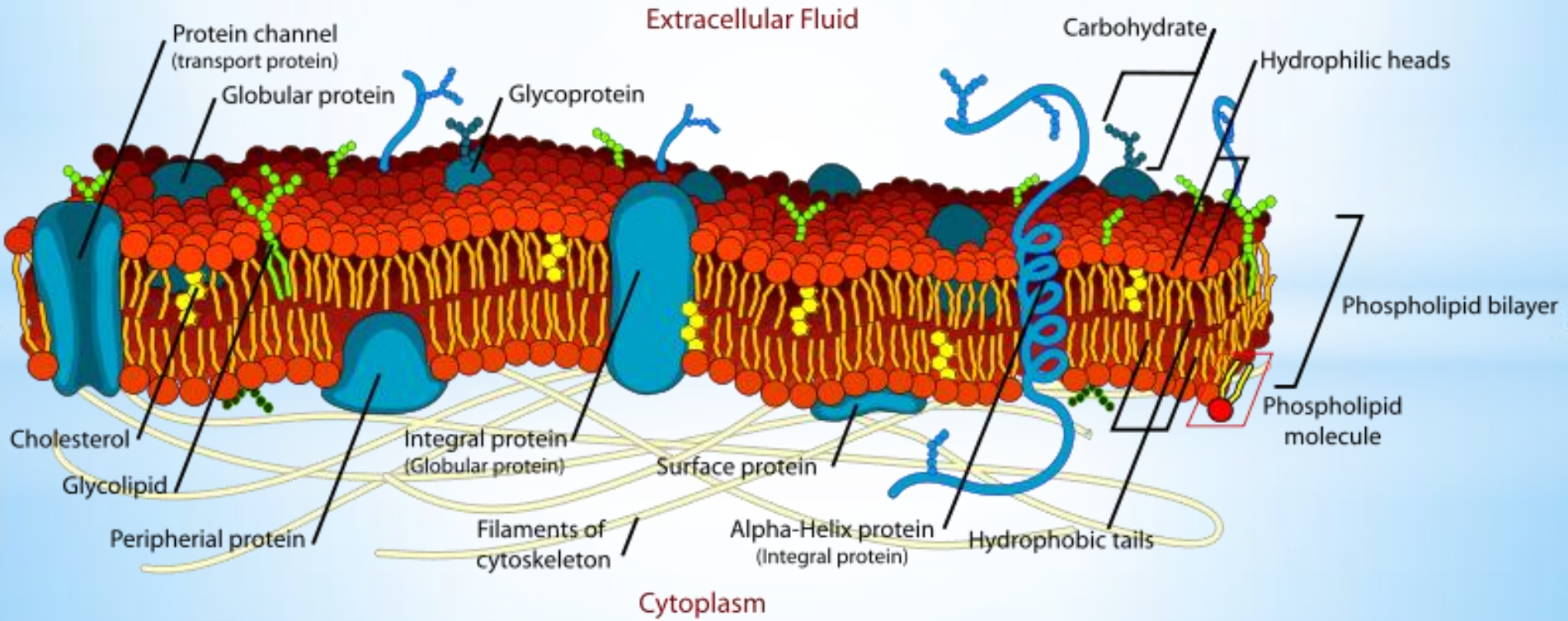
Phospholipids are **amphipathic**.

They spontaneously form a **bi-layer** in aqueous environments.

The inside of the bi-layer is **hydrophobic**.

*Membrane Proteins

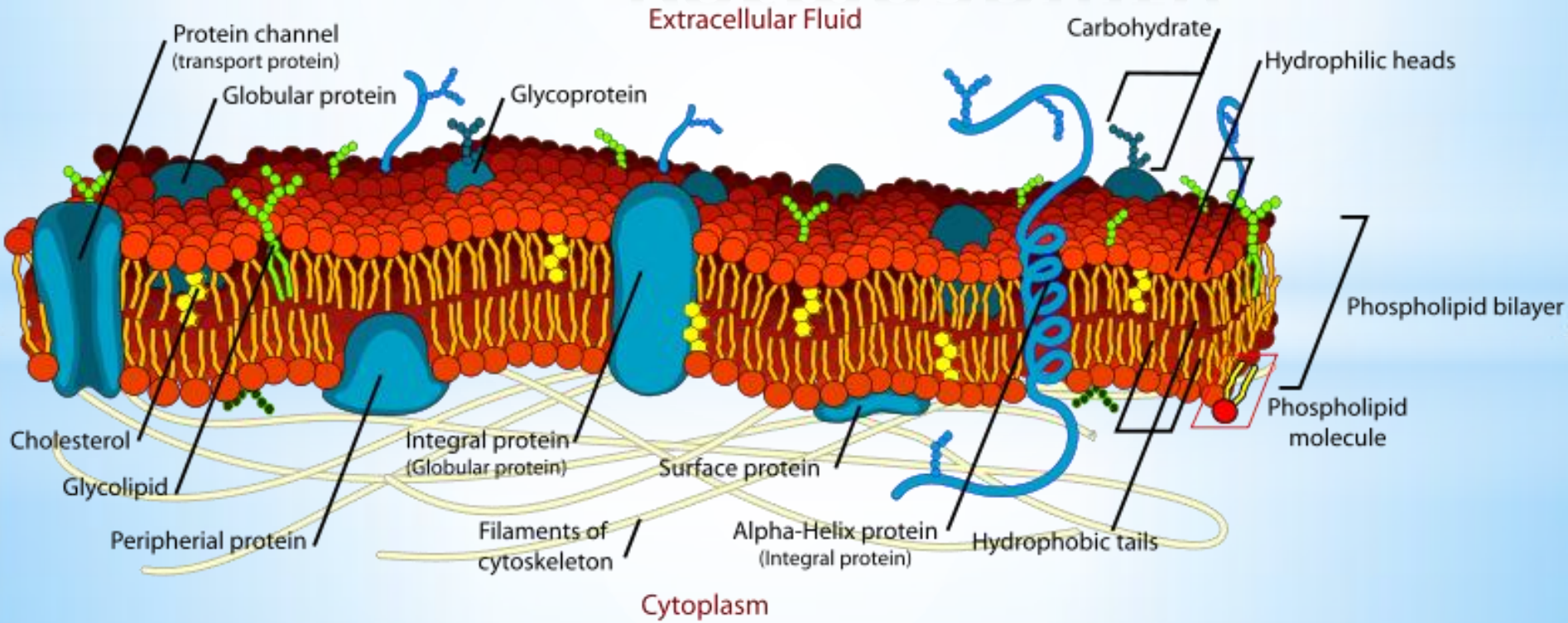
Membrane proteins serve a variety of functions for the cell.



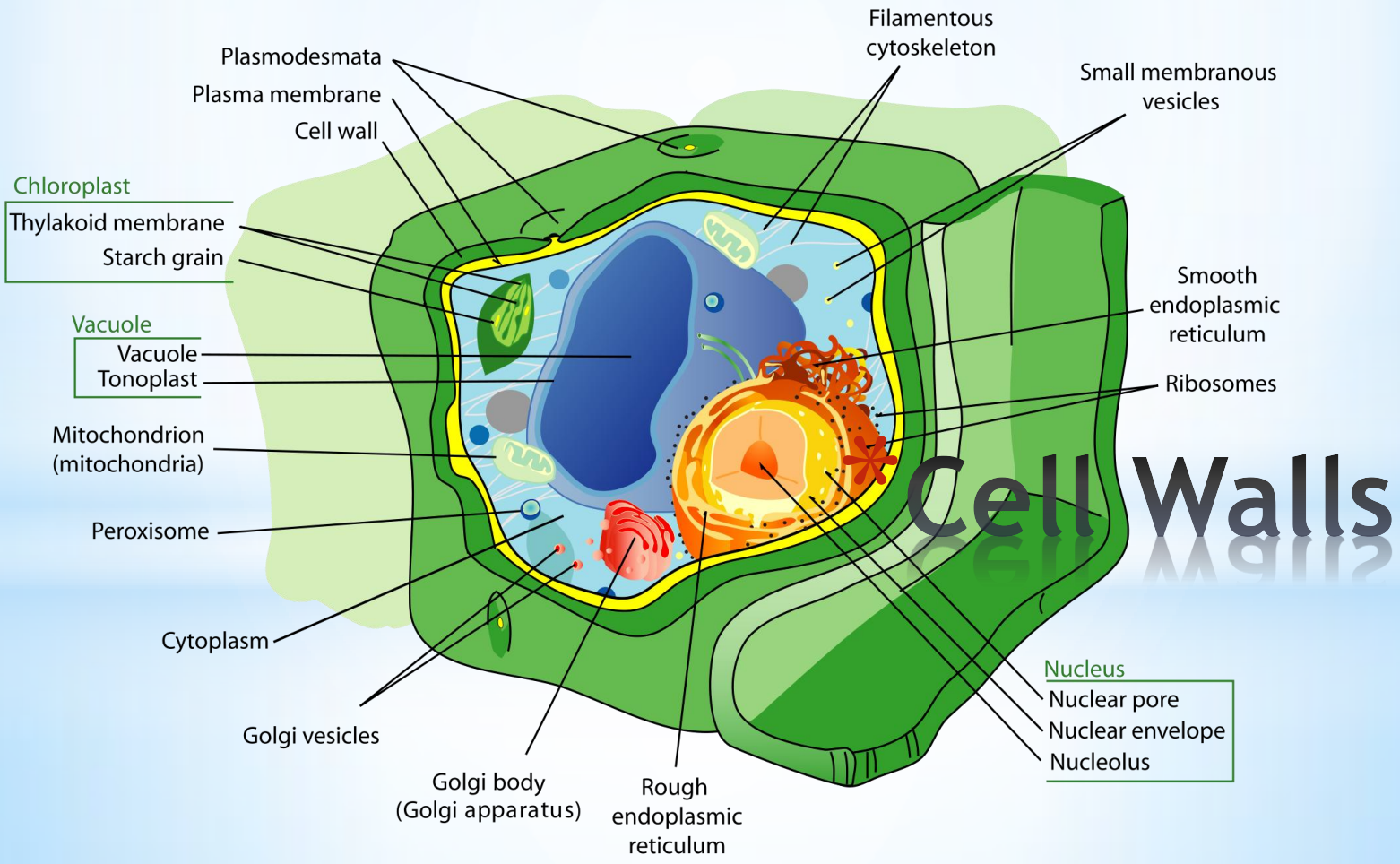
Only small, non-polar molecules move through the bi-layer.

All other material must move through protein **pores**

*Selective Permeability

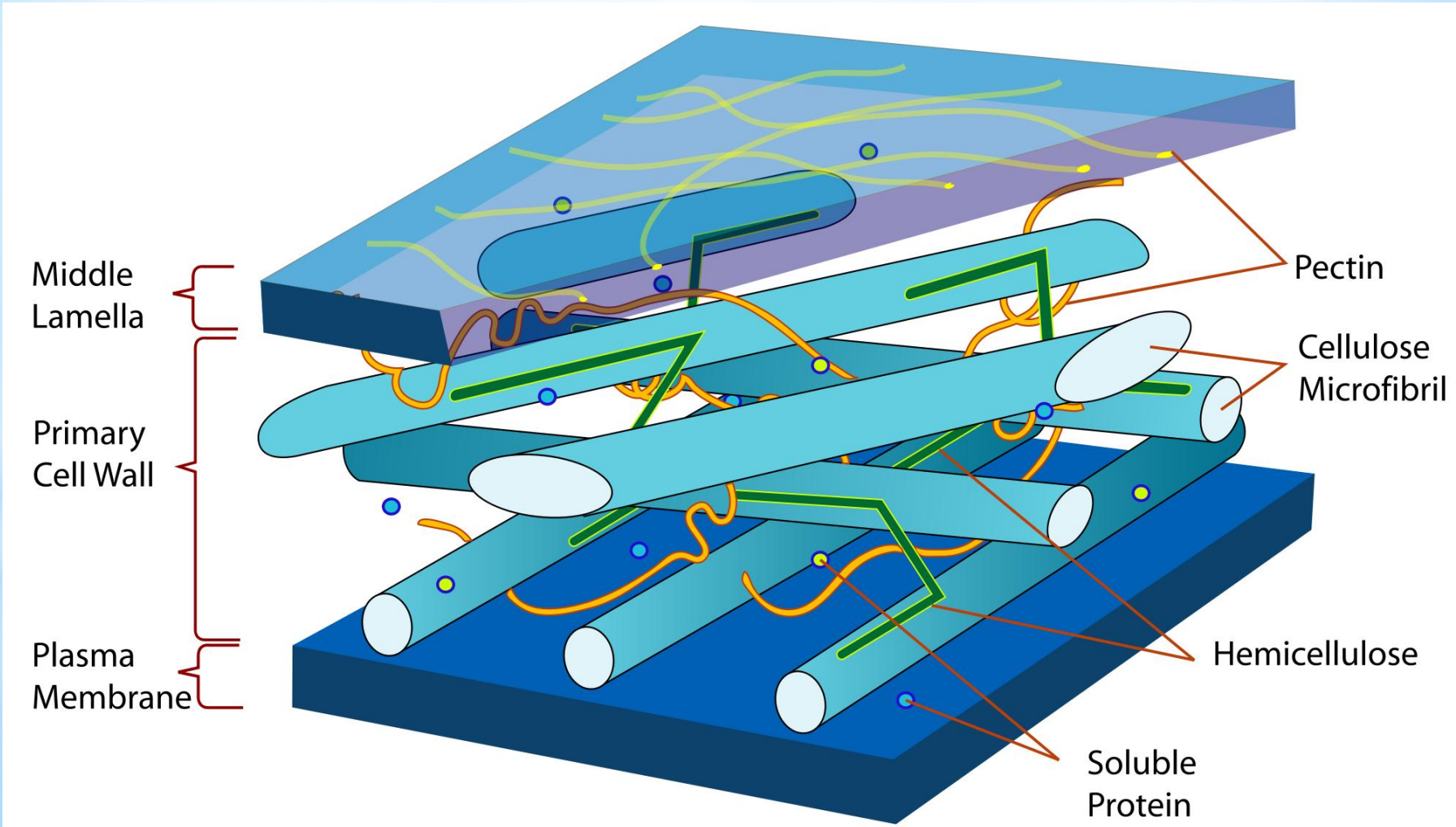


Many cells are surrounded by **cell walls**, which are inactive structural supports.



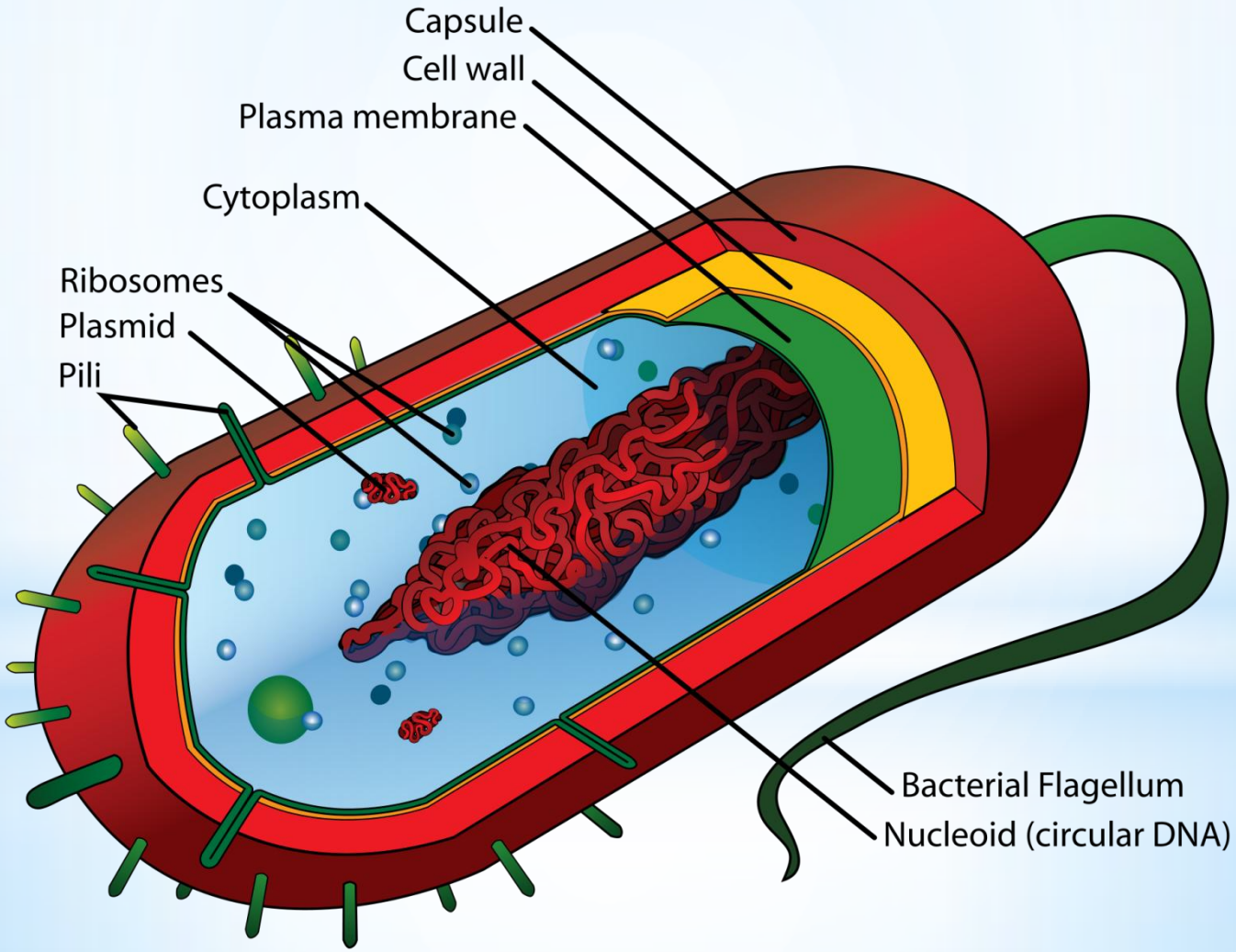
*Cell Wall Structure

All cell walls are fibers of **structural polysaccharides.**



Plant-like, fungal, and prokaryotic cells all have cell walls (of different polysaccharides).

Animal-like cells do not.

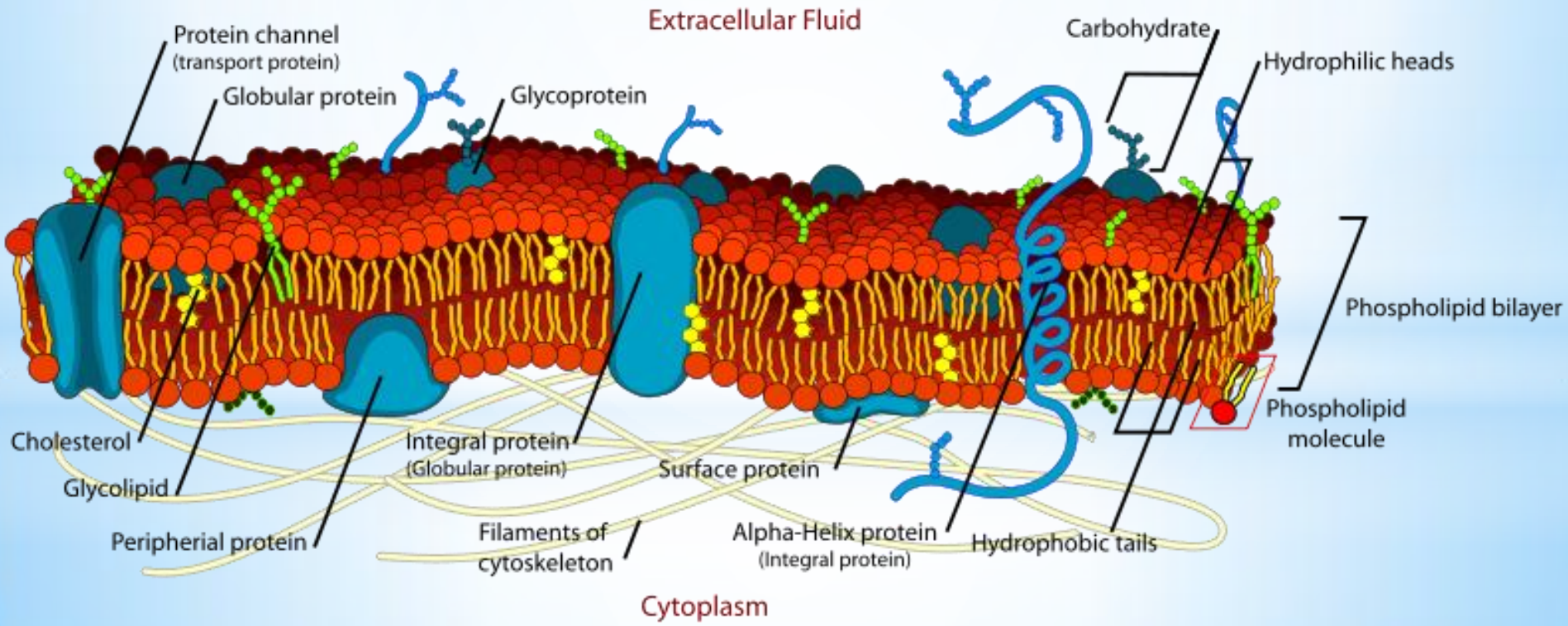


1. Mechanisms of Cellular Transport

2.5: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.

Transport is controlled by the cell membrane.

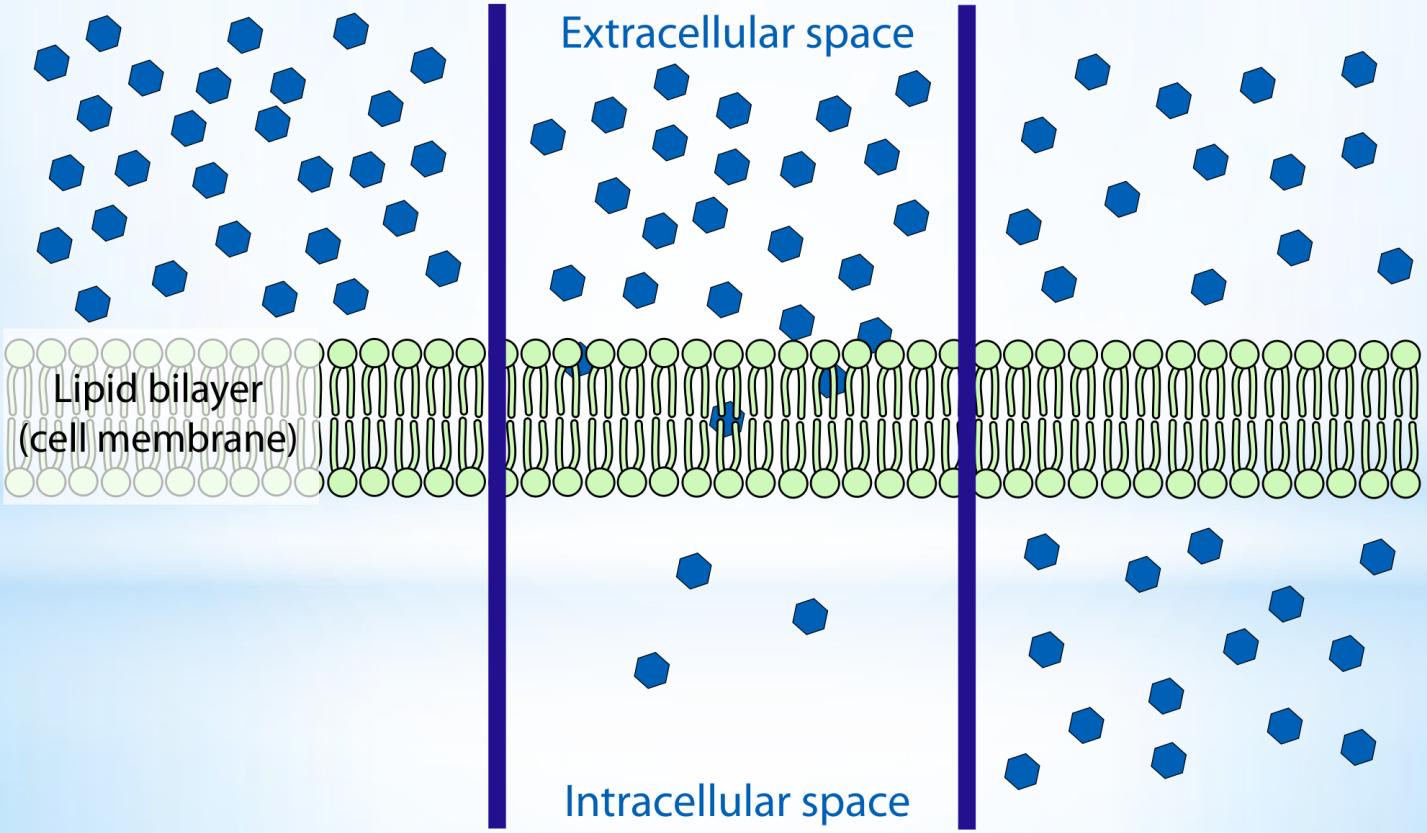
Transport can be **active** or **passive**.



Passive Transport

Does not require energy, moves with the concentration gradient.

Passive Transport is called "**Diffusion**"

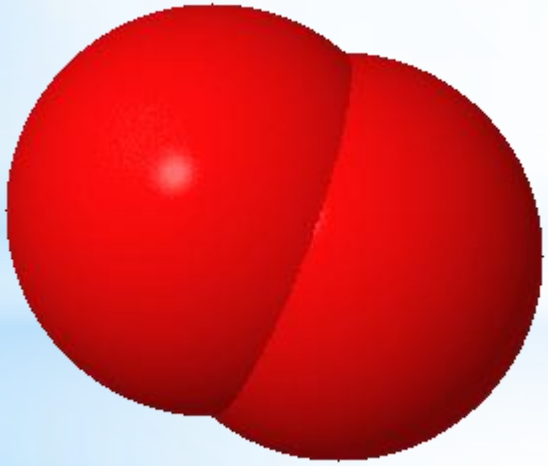


TIME

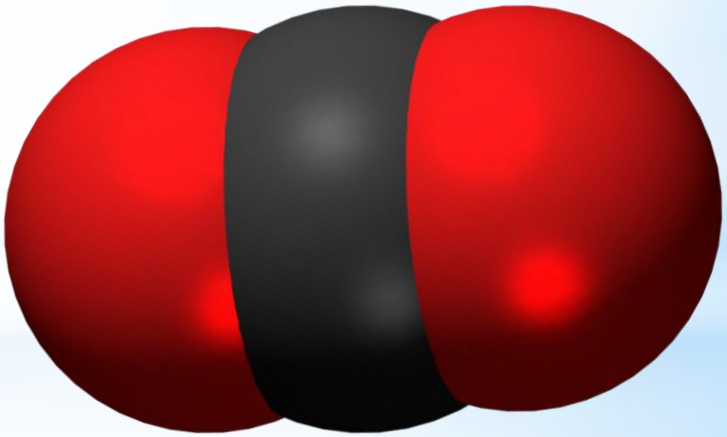
*Simple Diffusion

Small, non-polar molecules are able to diffuse across the phospholipid bi-layer.

Cells control simple diffusion by controlling the concentrations of these molecules.



Oxygen (O_2)

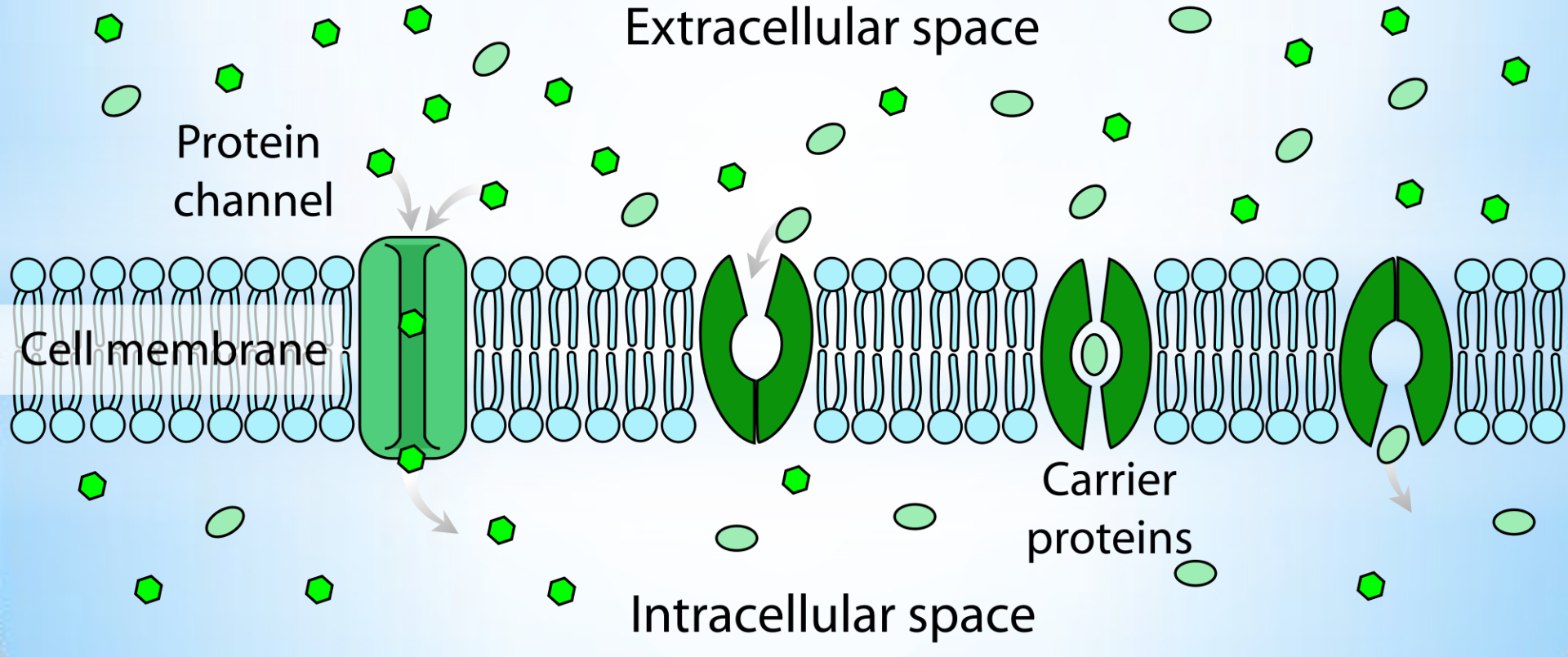


Carbon Dioxide (CO_2)

*Facilitated Diffusion

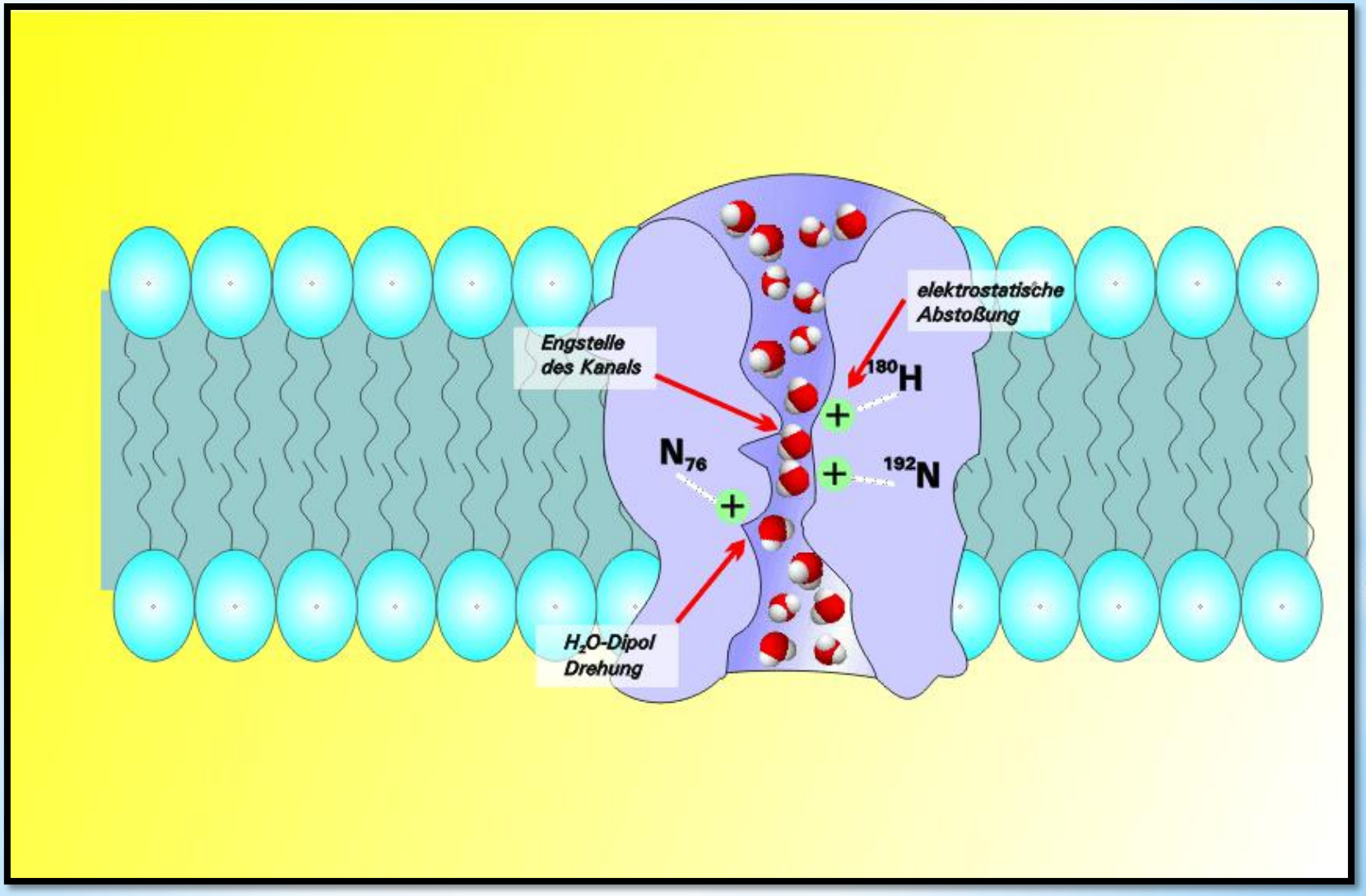
Molecules that are polar/charged, must diffuse through protein pores in the cell membrane.

Pores are specific for specific molecules.



*Ex. Aquaporins

Channels that allow water to diffuse (“**osmosis**”)

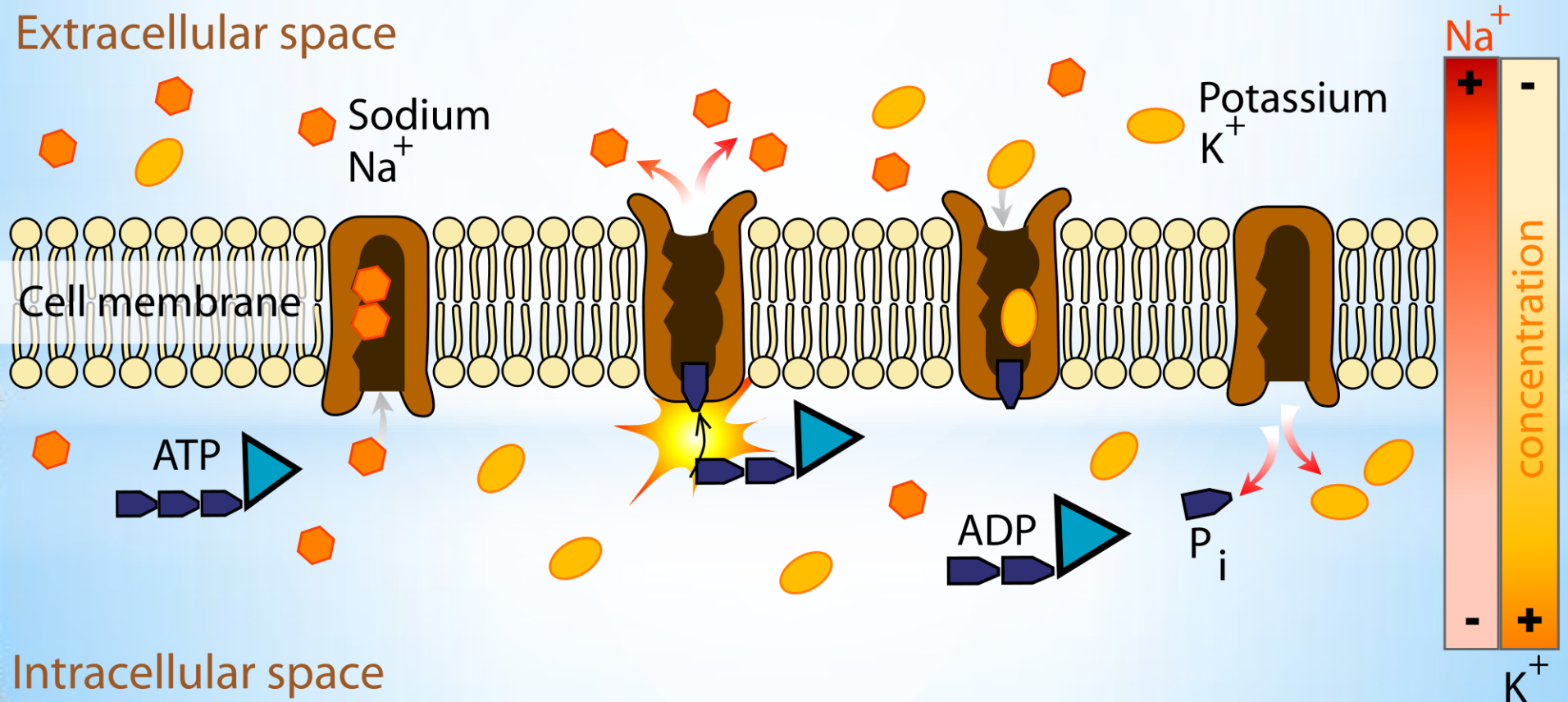


*Active Transport

Cells move molecules against the concentration gradient by using energy.

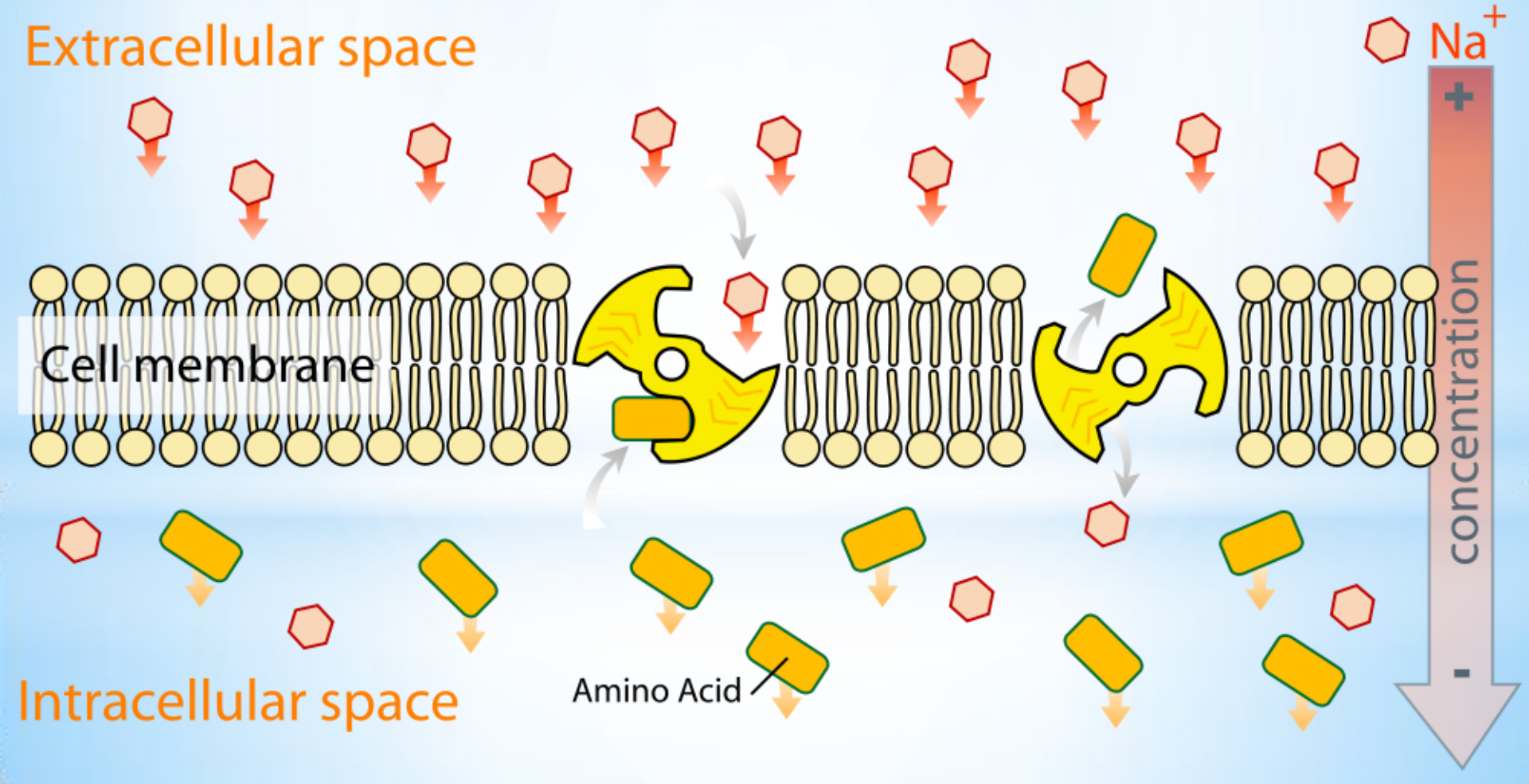
The energy is used to operate **“pump proteins”**.

Ex. Sodium-Potassium Pump

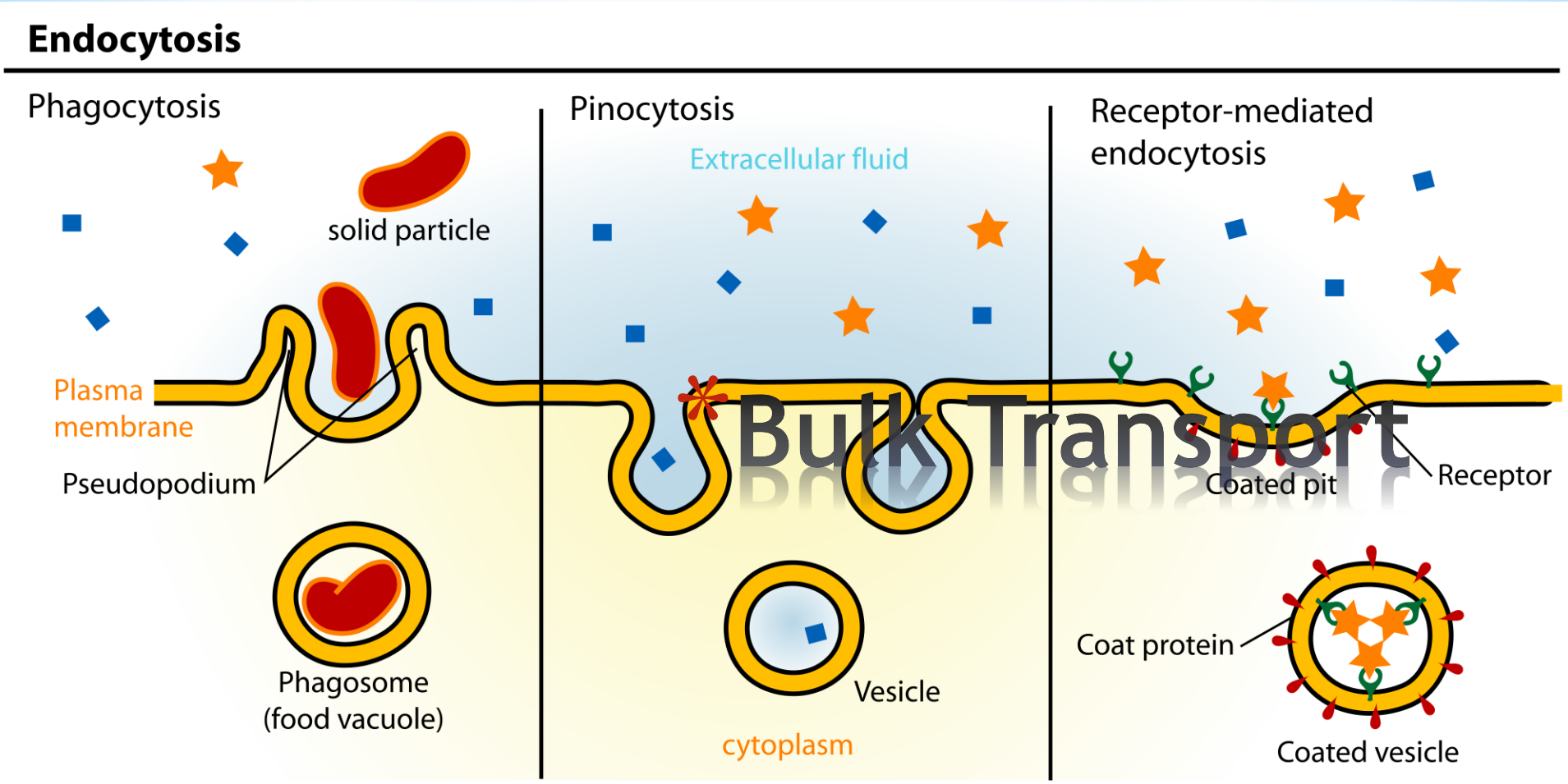


*Co-Transport

Cells can transport multiple molecules simultaneously using **co-transporters**.



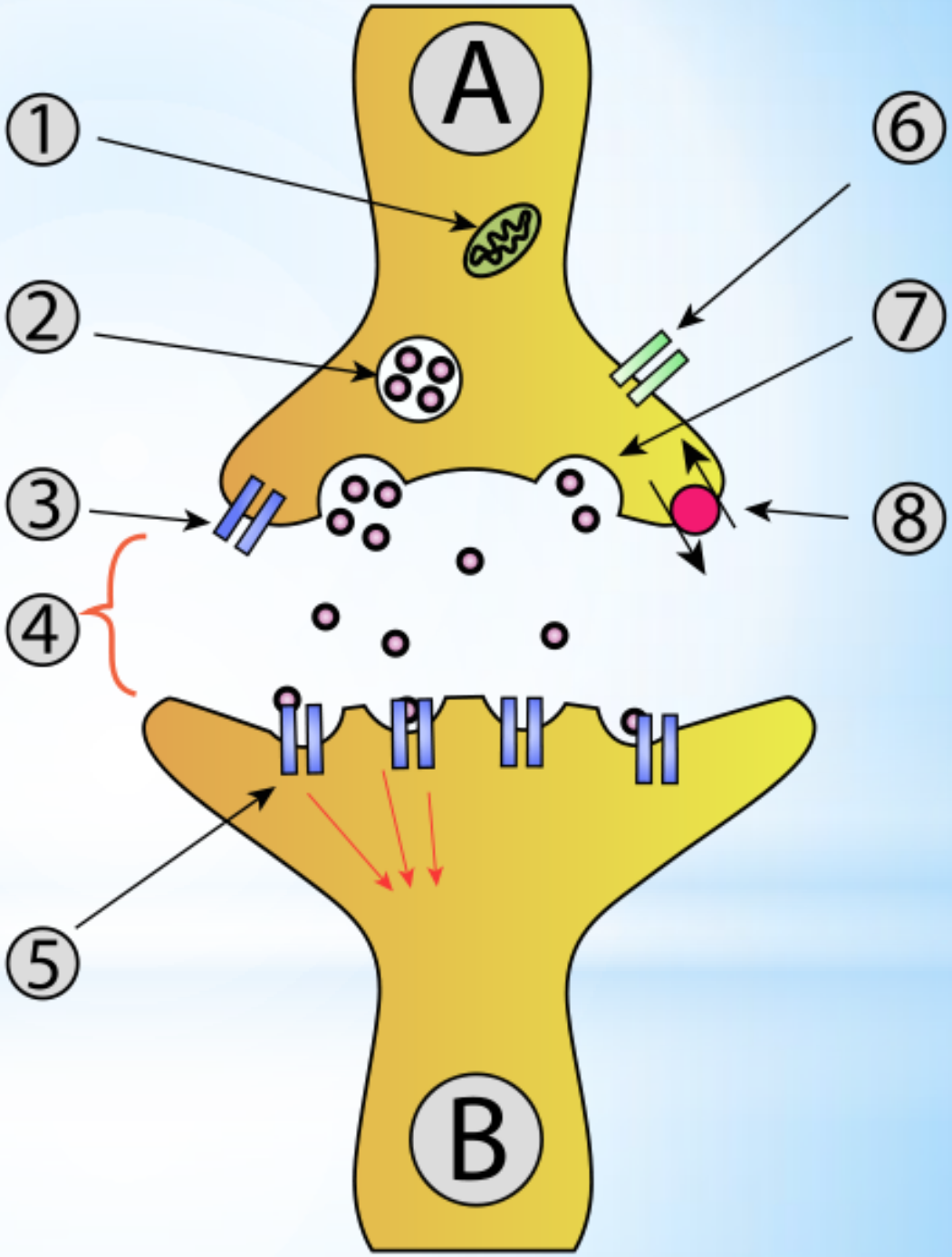
Cells transport bulk molecules by surrounding them with membrane ("**vesicles**")



Vesicular transport can be internal (“**endocytosis**”)

or external (“**exocytosis**”)

Shown: Release of molecules from cell A to cell B.



*2. Analyzing Transport

2.5: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.

*Tonicity

A measurement of the relative concentrations of solute between two solutions (inside and outside of cell).

Hypertonic: More solute/less solvent.

Hypotonic: Less solute/more solvent

Isotonic: Equal concentrations.

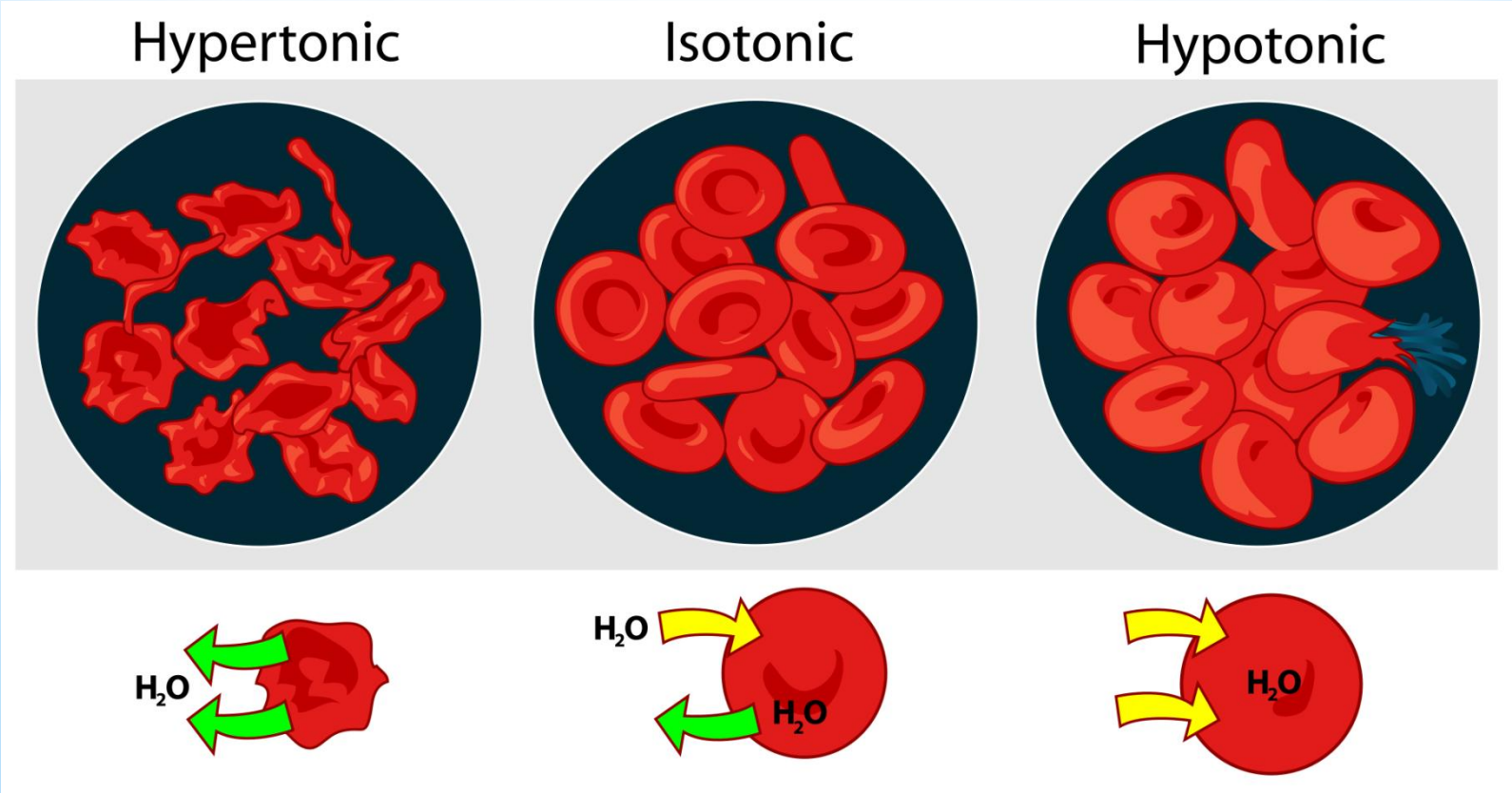
These terms are comparative.

The solvent is always water.

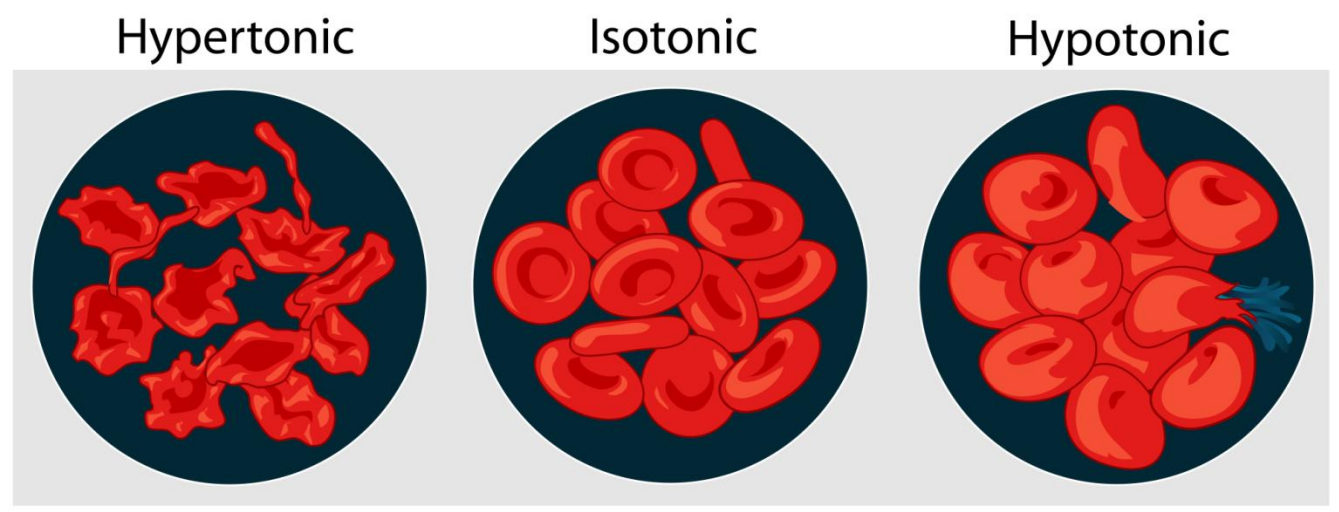
Tonicity effects cell physiology.

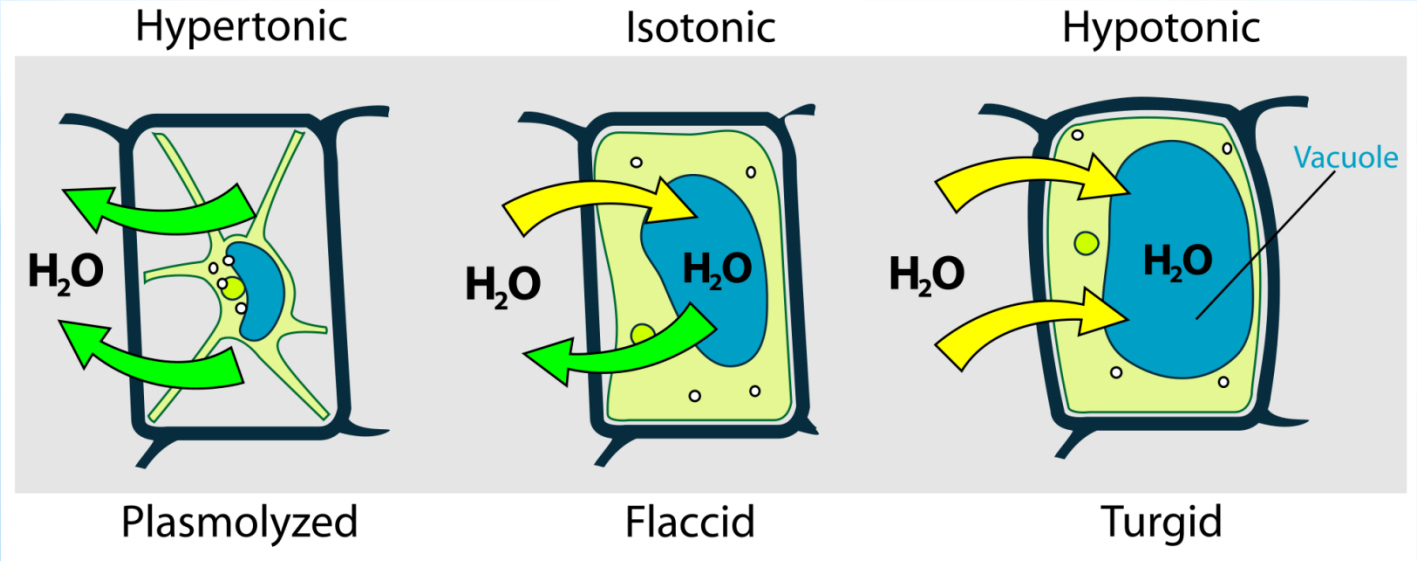
Solute moves from hypertonic to hypotonic solutions IF it is able to.

Solvent (water) moves from hypotonic to hypertonic solutions.



Different cell types are adapted to different tonicity relationships.





*3. Math Skills- Water Potential and solute potential

2.5: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.

*What You Have To Do

Be able to calculate water potential and use it to determine how likely it is that water will move in to or out of a cell.

Water Potential (Ψ): A measurement of how likely it is that water will move in/out of a solution. Pure water is assigned a potential of 0.

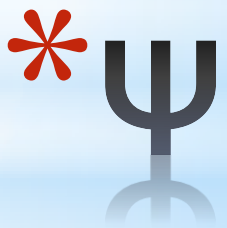
The more negative the potential, the more likely water will move in to the area.

$$\Psi = \Psi_p + \Psi_s$$

Ψ_p = pressure potential (external force).

Ψ_s = solute potential (tonicity).

The units for Ψ are pressure units. Typically bars (aka torr, mmHg)



If a system is at amospheric pressure, Ψ_p is 0

*Solute Potential

$$\Psi_s = -iCRT$$

* i = ionization constant for the solute (1.0 for sucrose, 2.0 for NaCl, etc.)
* C = molar concentration of the solute
* R= pressure constant 0.0831 liter bars/mole K
* T= temperature in Kelvin (C + 273)

Determine which of the following solutions will gain the most water if placed in to a sample of pure water in a piece of dialysis tubing at the temperature indicated:

Solution:	Solute:	Tonicity:	Temperature
A	Sucrose	2M	298K
B	NaCl	1M	290K
C	Glucose	1M	300K

*Sample Problem

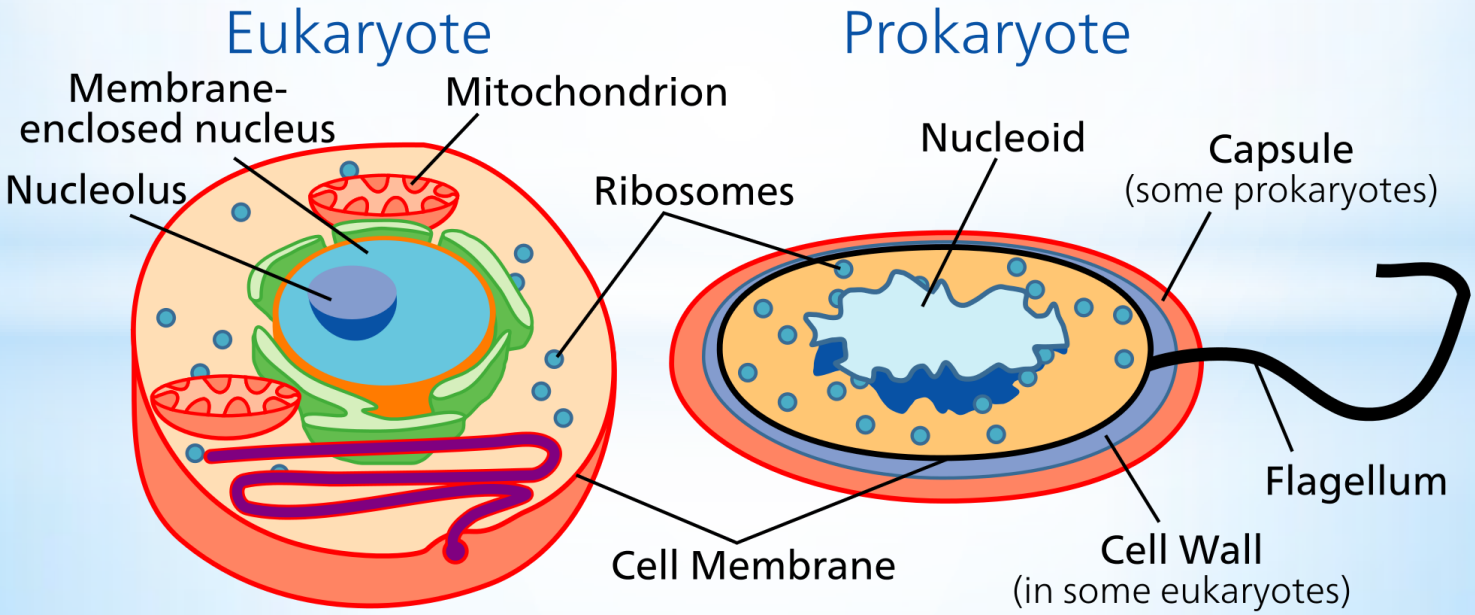
*1. Cellular Compartmentalization

2.6: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.

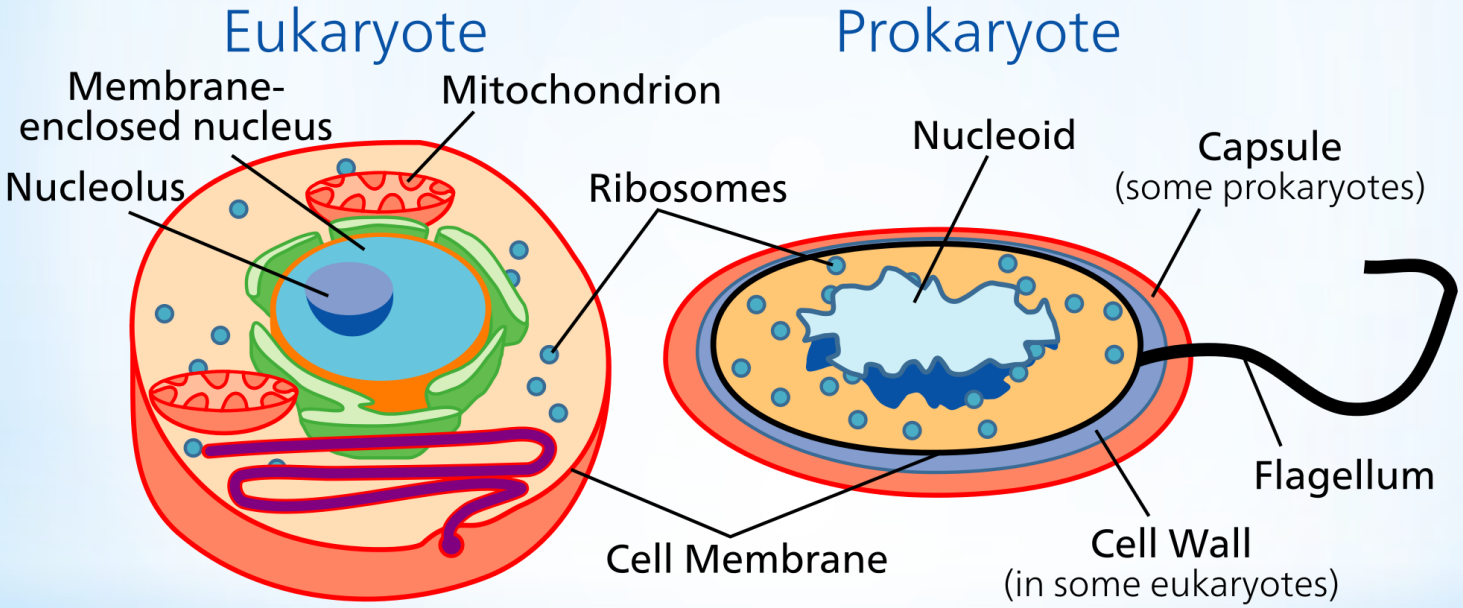
*Cells are Compartmentalized

Compartmentalization allows for increased control and efficiency of cellular processes.

Different areas of the cell can be specialized for different metabolic tasks.



*Prokaryotes and Eukaryotes



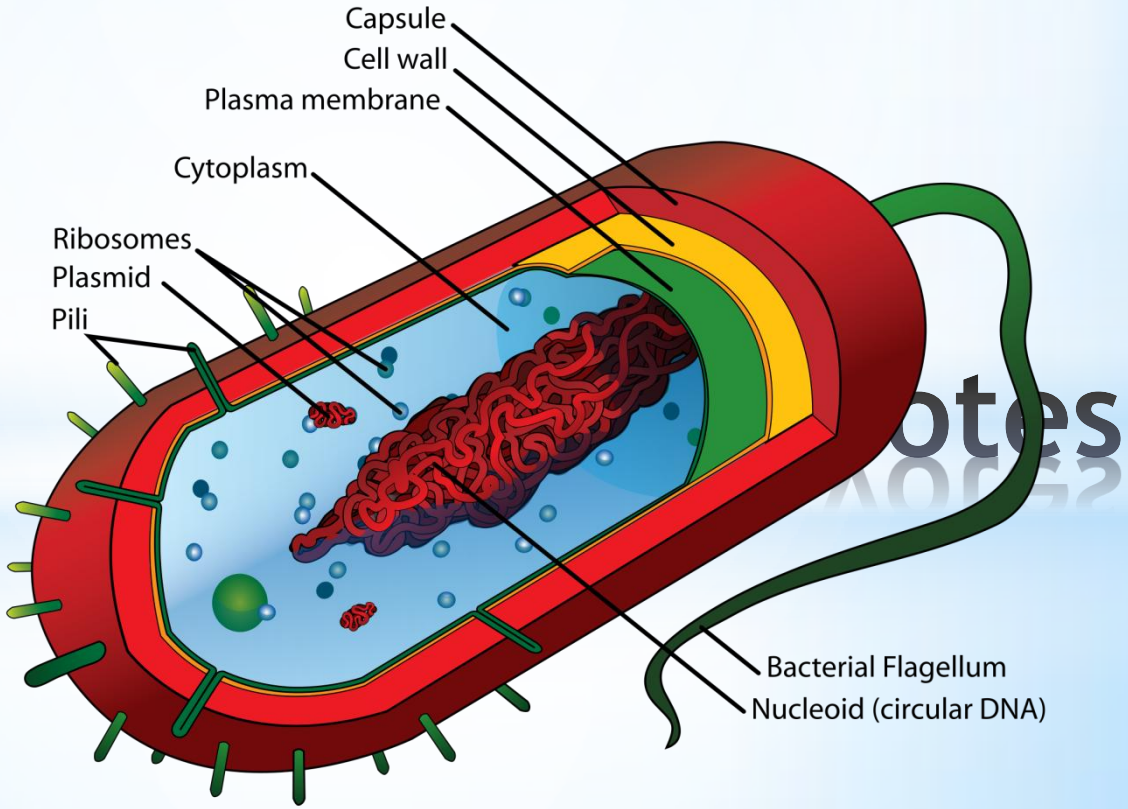
The major dividing line in cellular organization.

Prokaryotes: No internal compartments.

Eukaryotes: Many internal compartments (“**organelles**”)

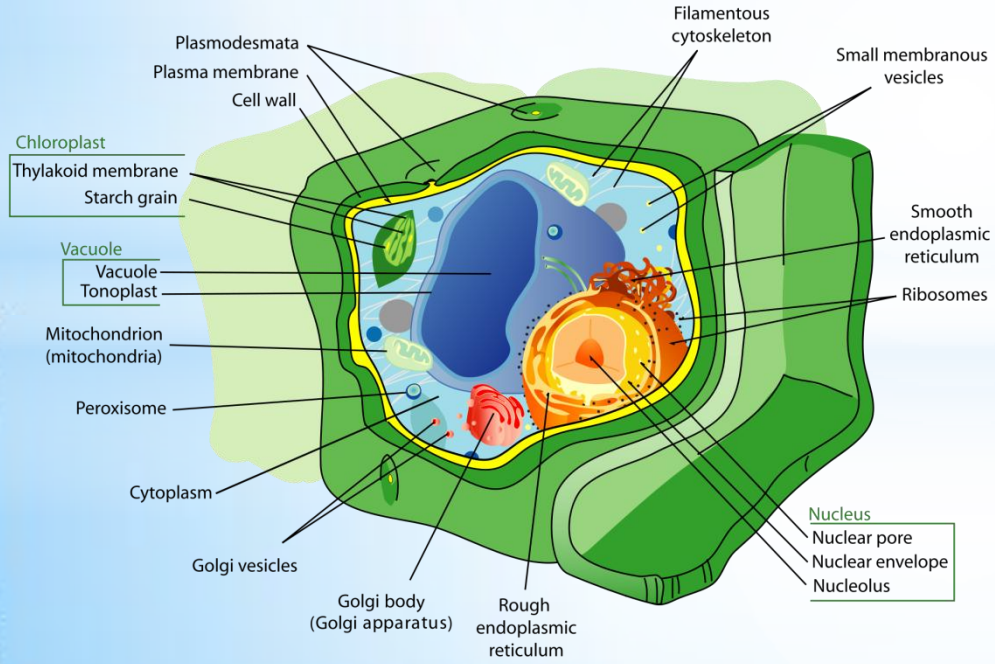
AKA “**Bacteria**”.

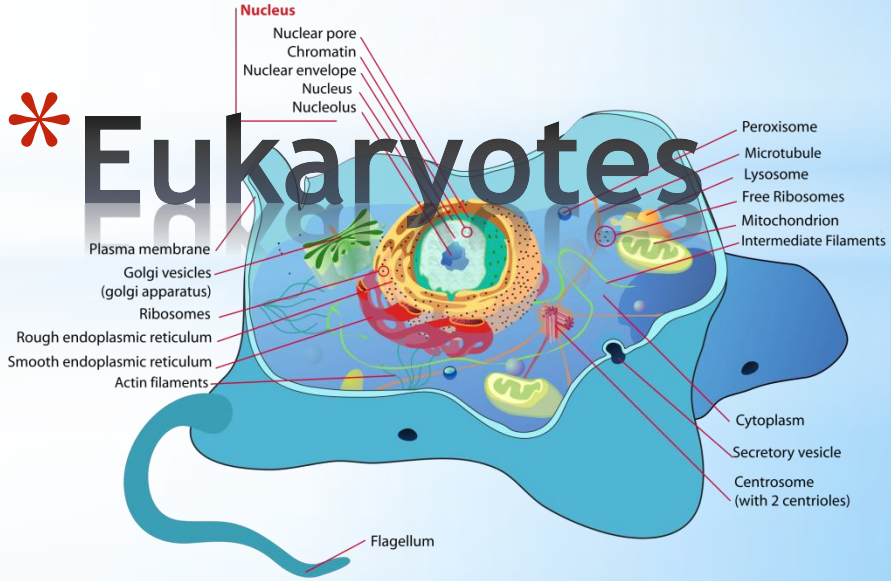
The vast majority of life on Earth. Always unicellular, contain less DNA, and generally smaller than Eukaryotes.



Protists, Plants, Fungi, and Animals.

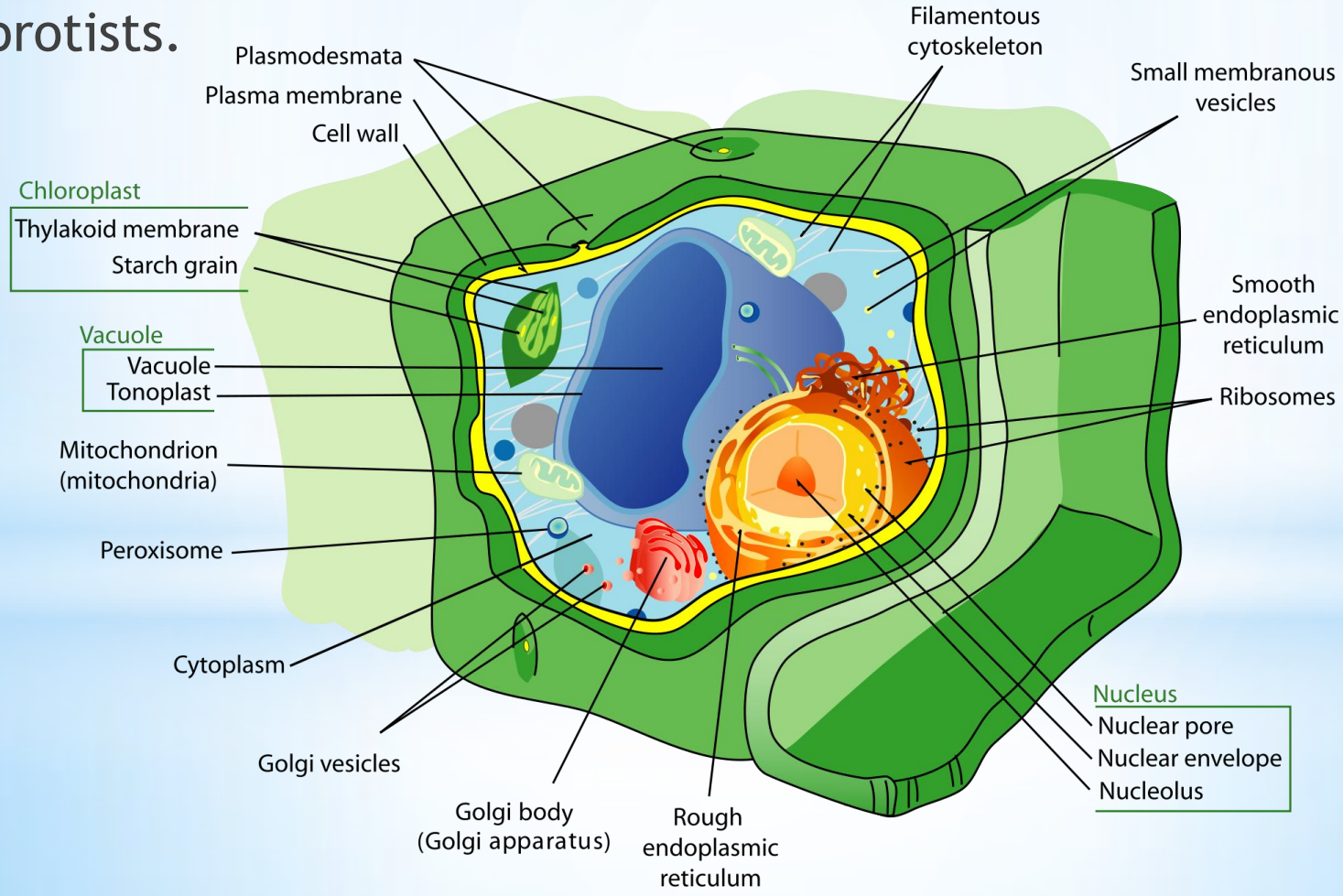
Unicellular and multicellular. Generally larger cells than prokaryotes.





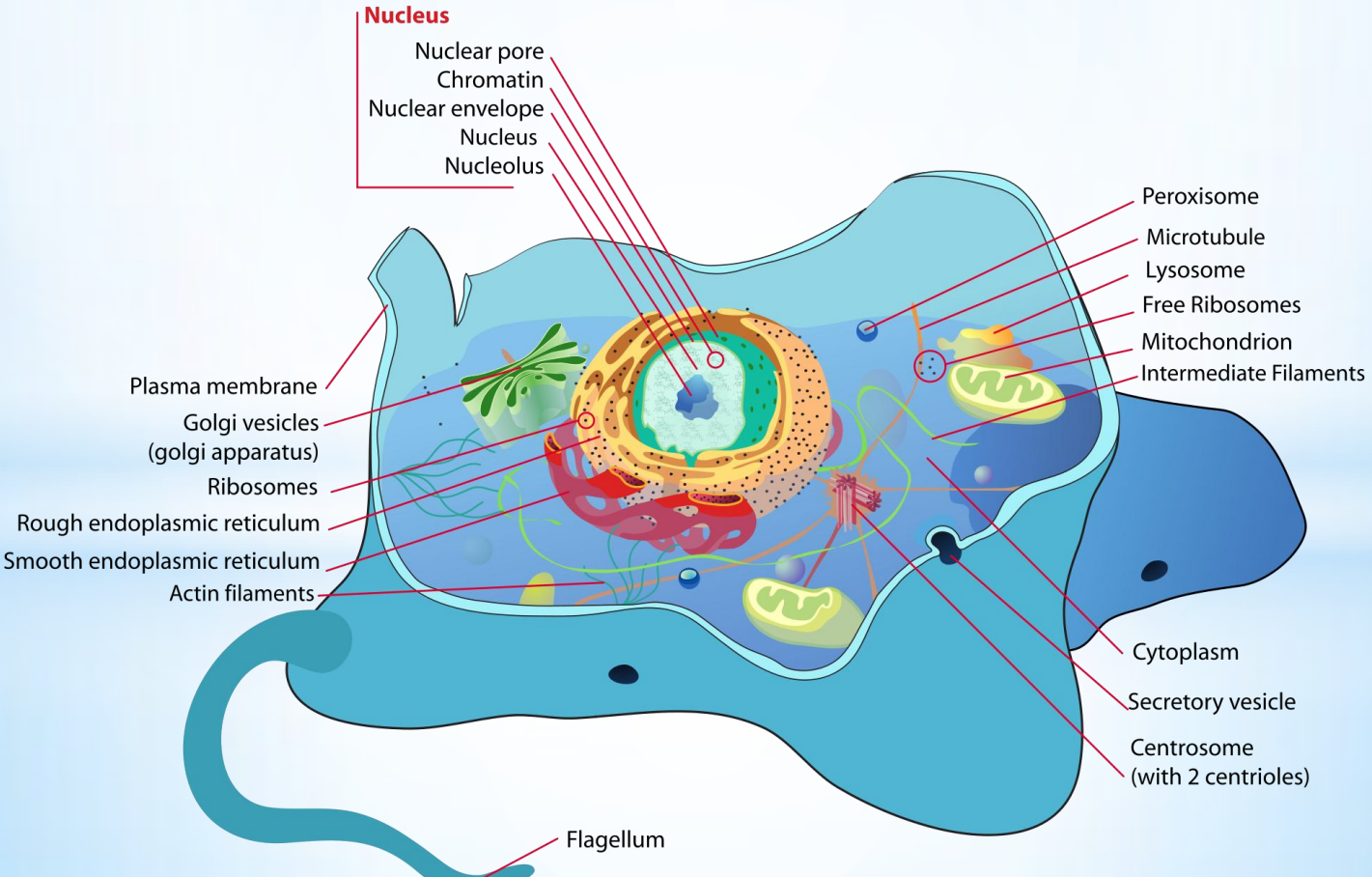
*"Plant-Like" Eukaryotes

Adapted for **autotrophic nutrition.** Plants and photosynthetic protists.



*"Animal-Like" Eukaryotes

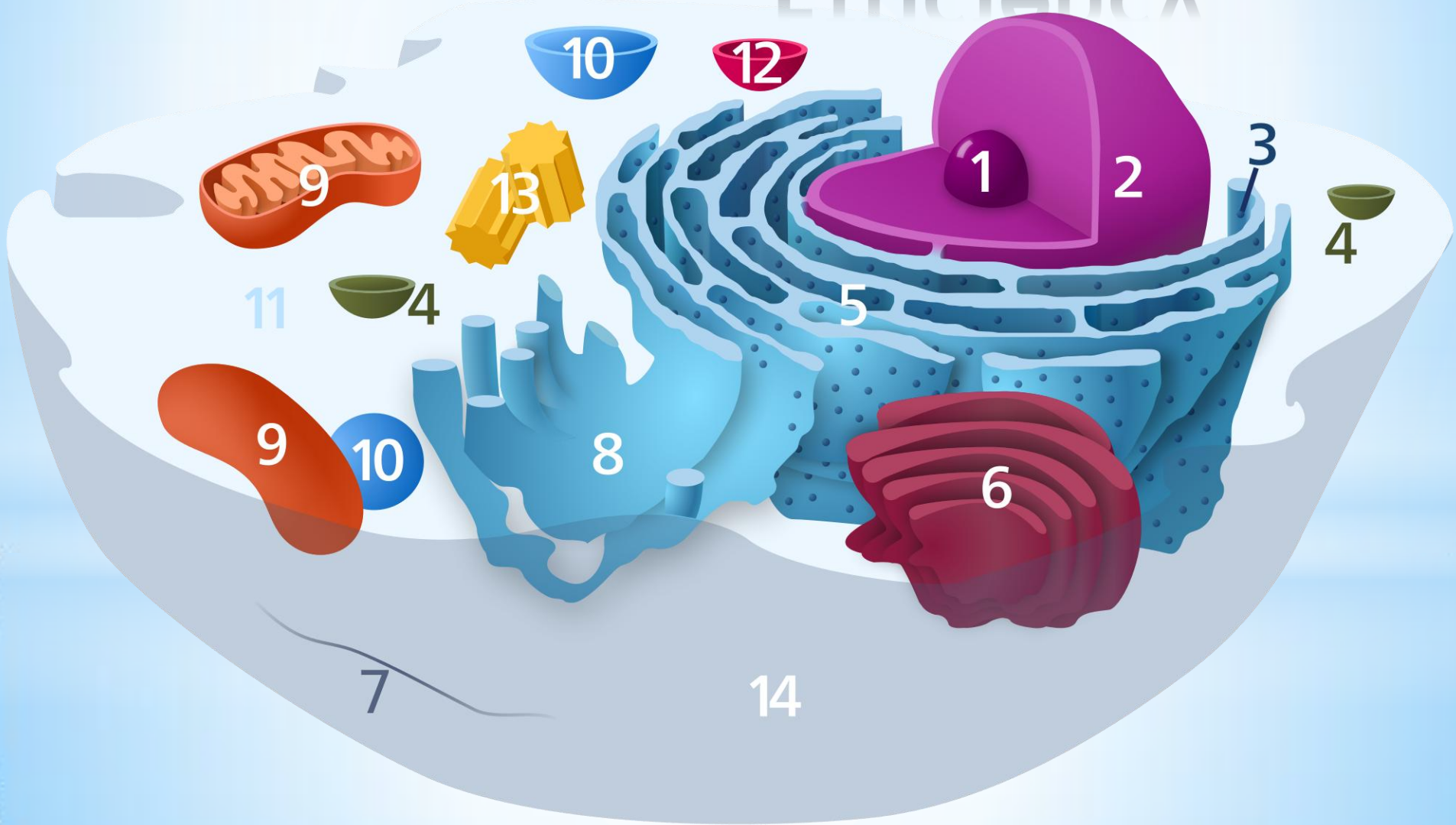
Adapted for **heterotrophic nutrition**. Animals, Fungi, and heterotrophic Protists.



2. Major Eukaryotic Organelles

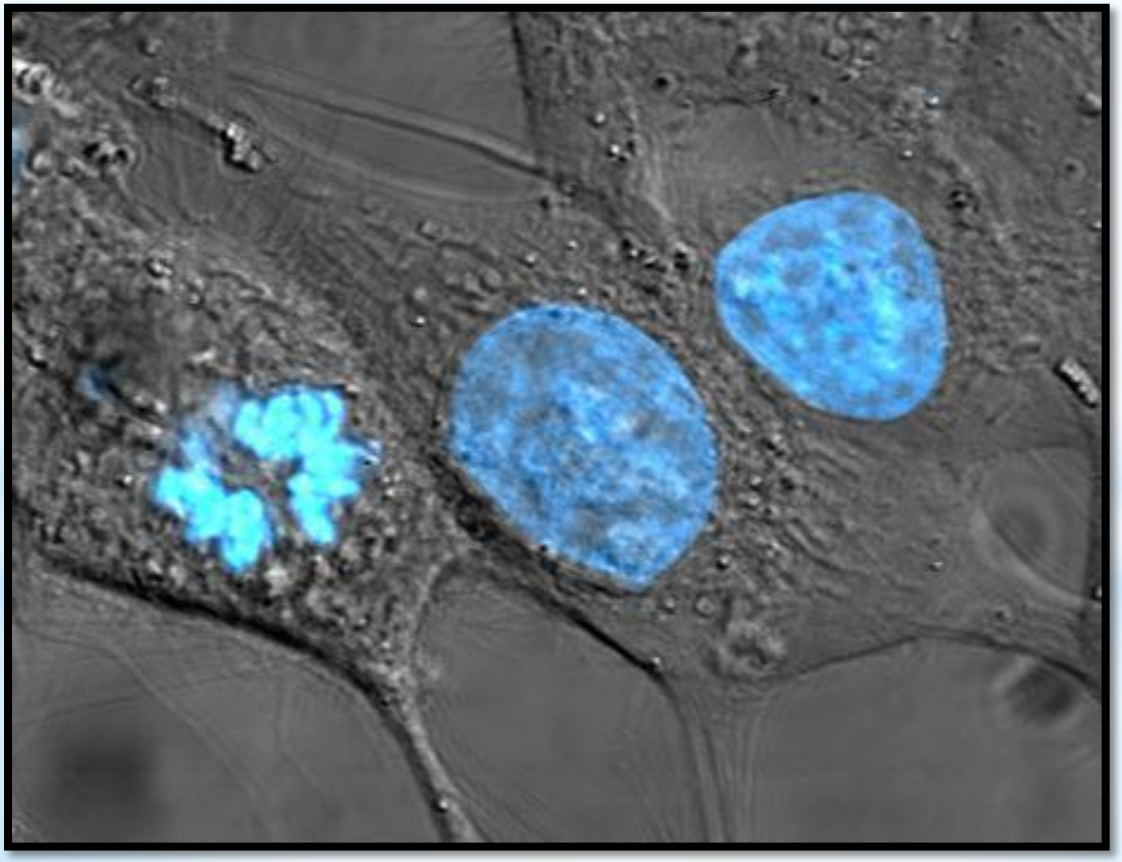
2.6: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.

*Organelles Increase Efficiency

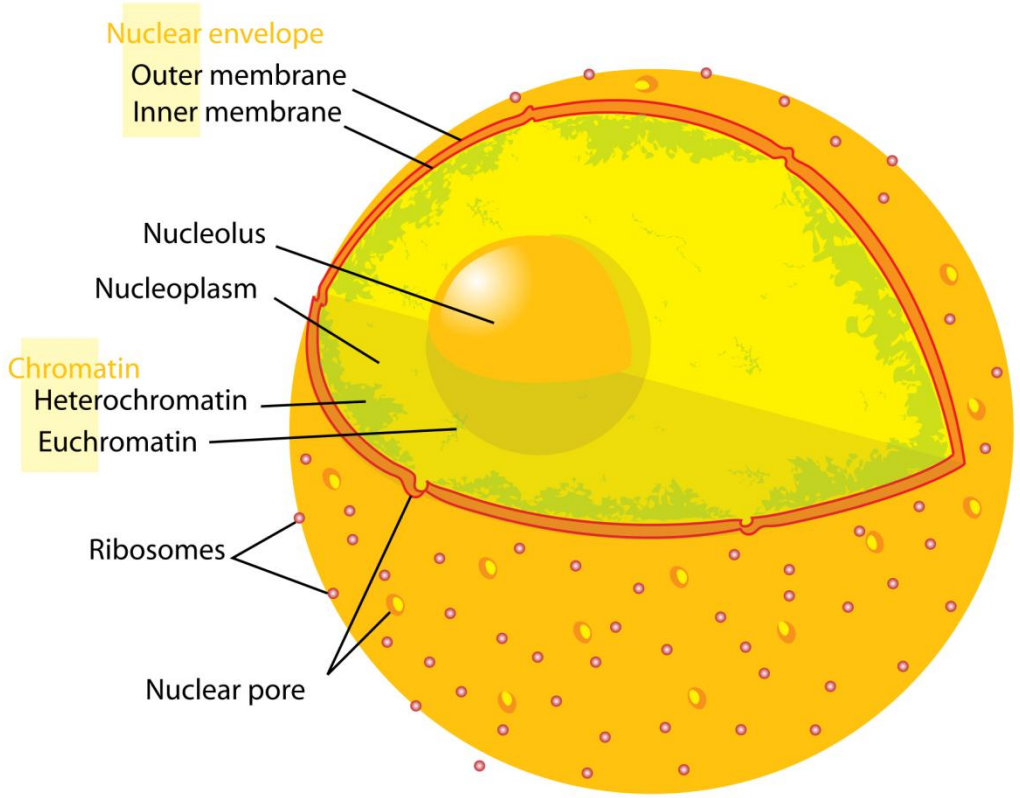


*The Nuclear Membrane

Porous membrane that separates the cell's **DNA genome** from the rest of the cellular environment.



The nuclear membrane is structured to allow its function in storing cellular information and allowing information to flow from the nucleus to ribosomes in the cytoplasm.

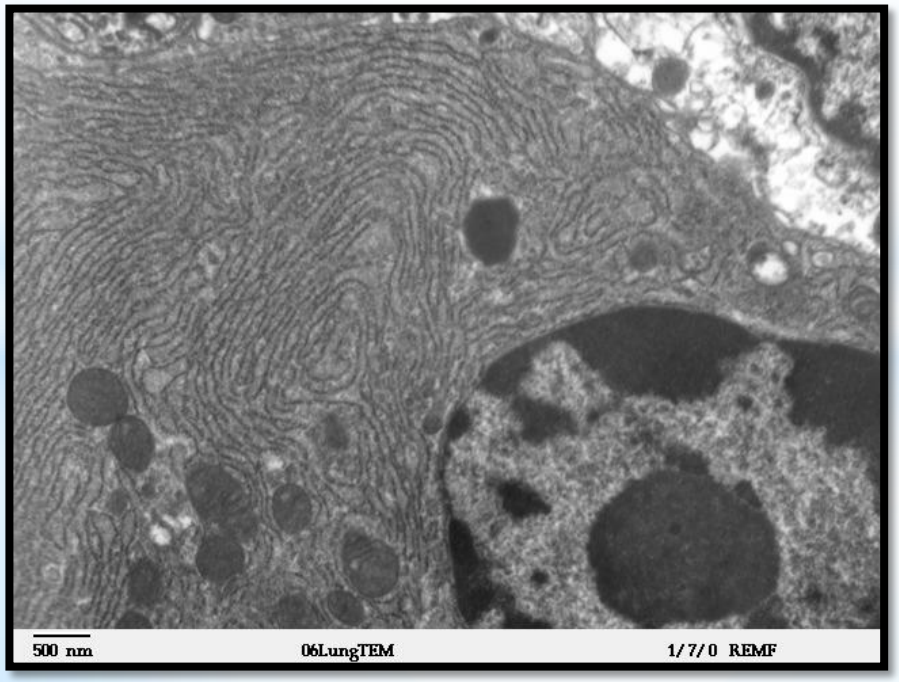


*Endoplasmic Reticulum

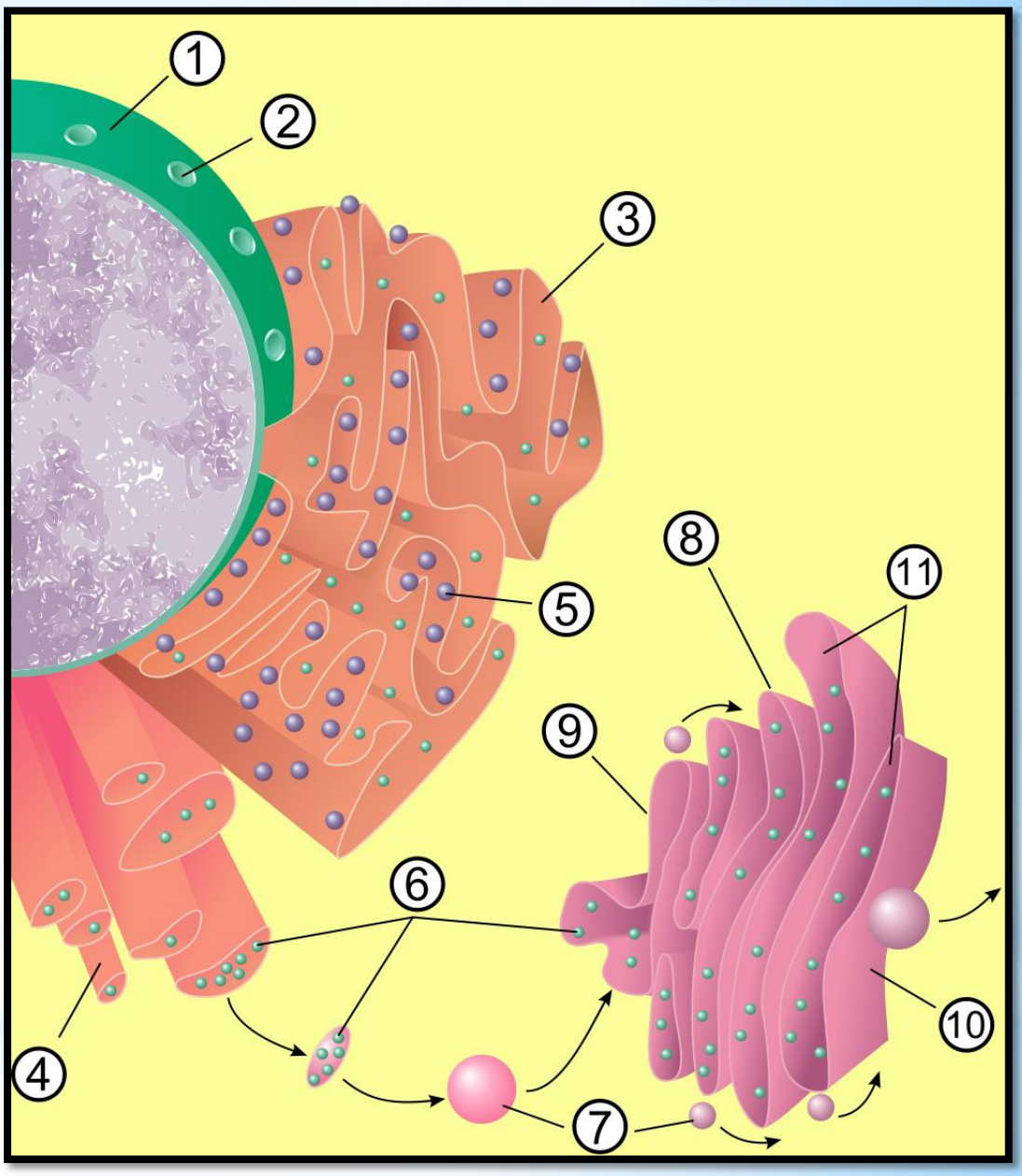
Membranous channels that run throughout the cell. Produce membrane and transport proteins.

Rough ER: covered in "**bound**" ribosomes.

Smooth ER: not covered in ribosomes

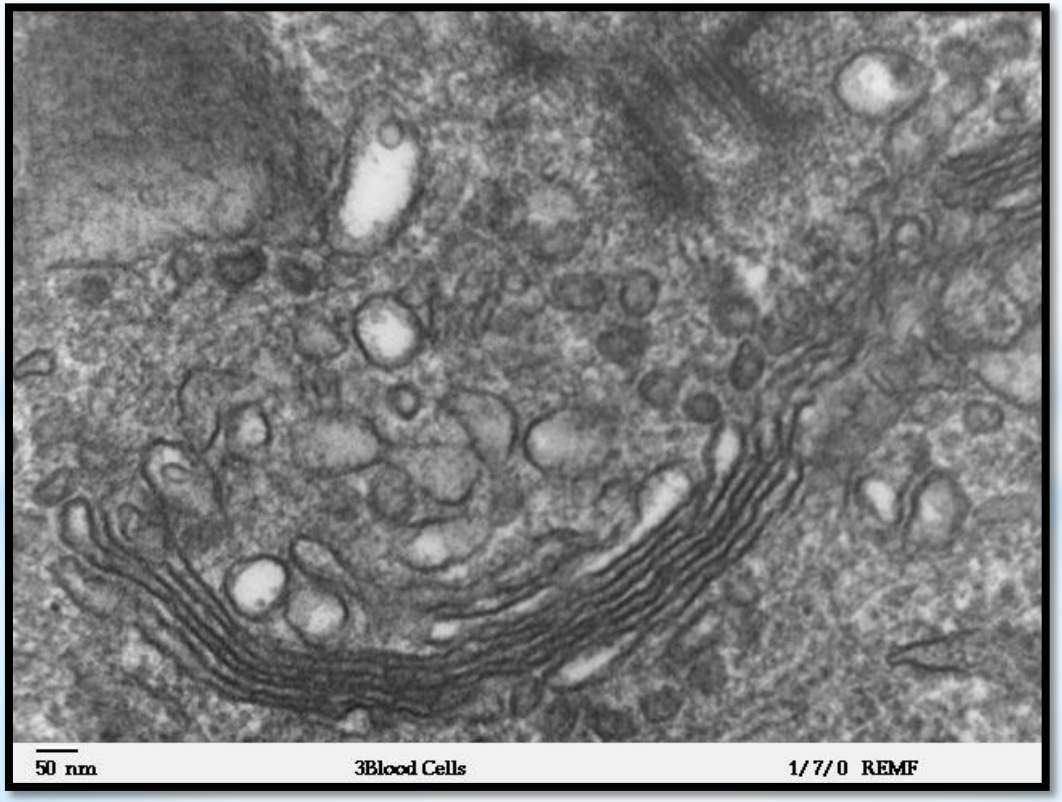


The ER (#3, #4) is part of the cell's "**endomembrane system**", which is involved in production and transport of membrane and membrane proteins.

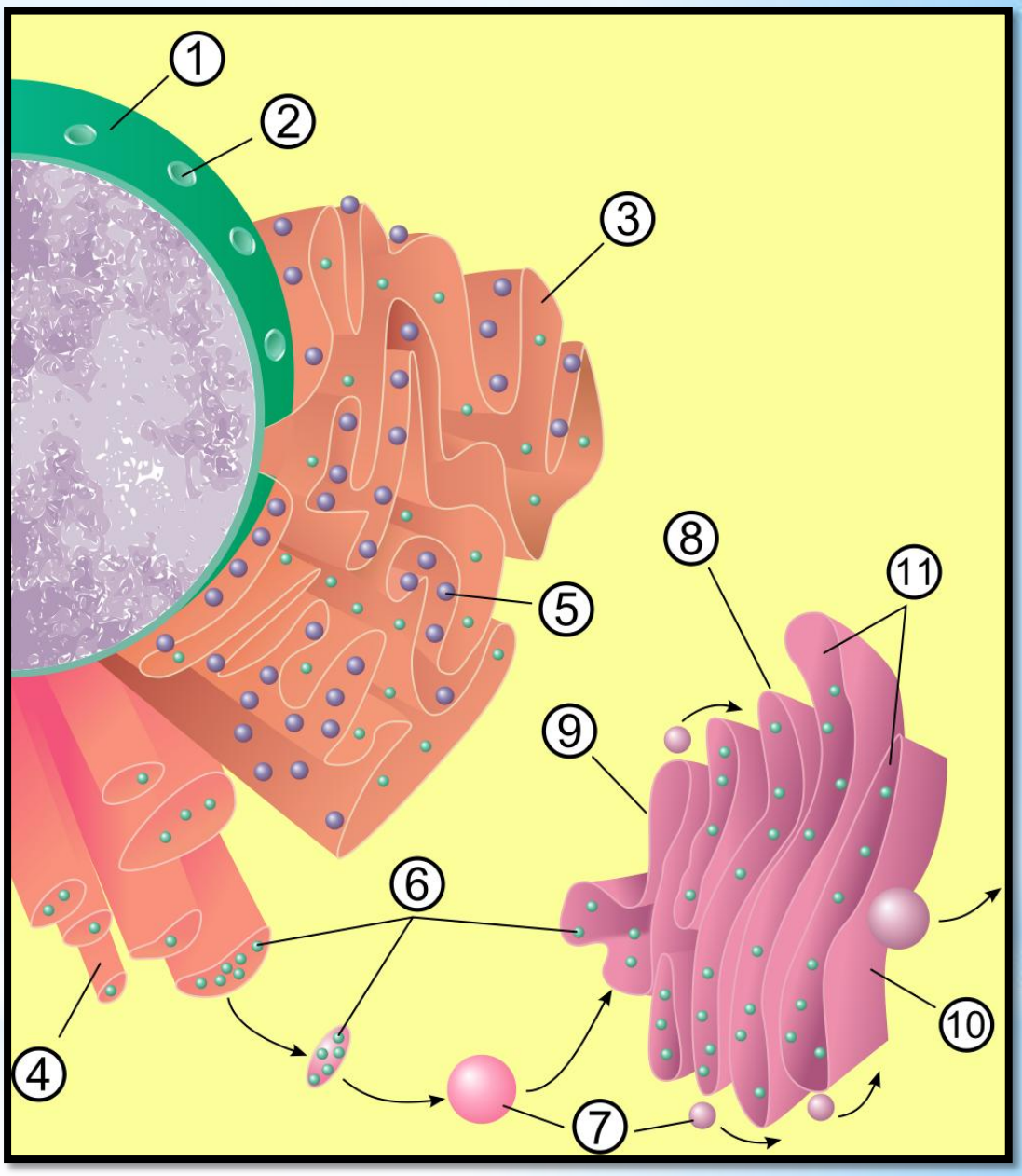


*Golgi Apparatus

A series of flattened membranous compartments that receive material from the ER, and modify it before targeting it for delivery to other areas of the cell.

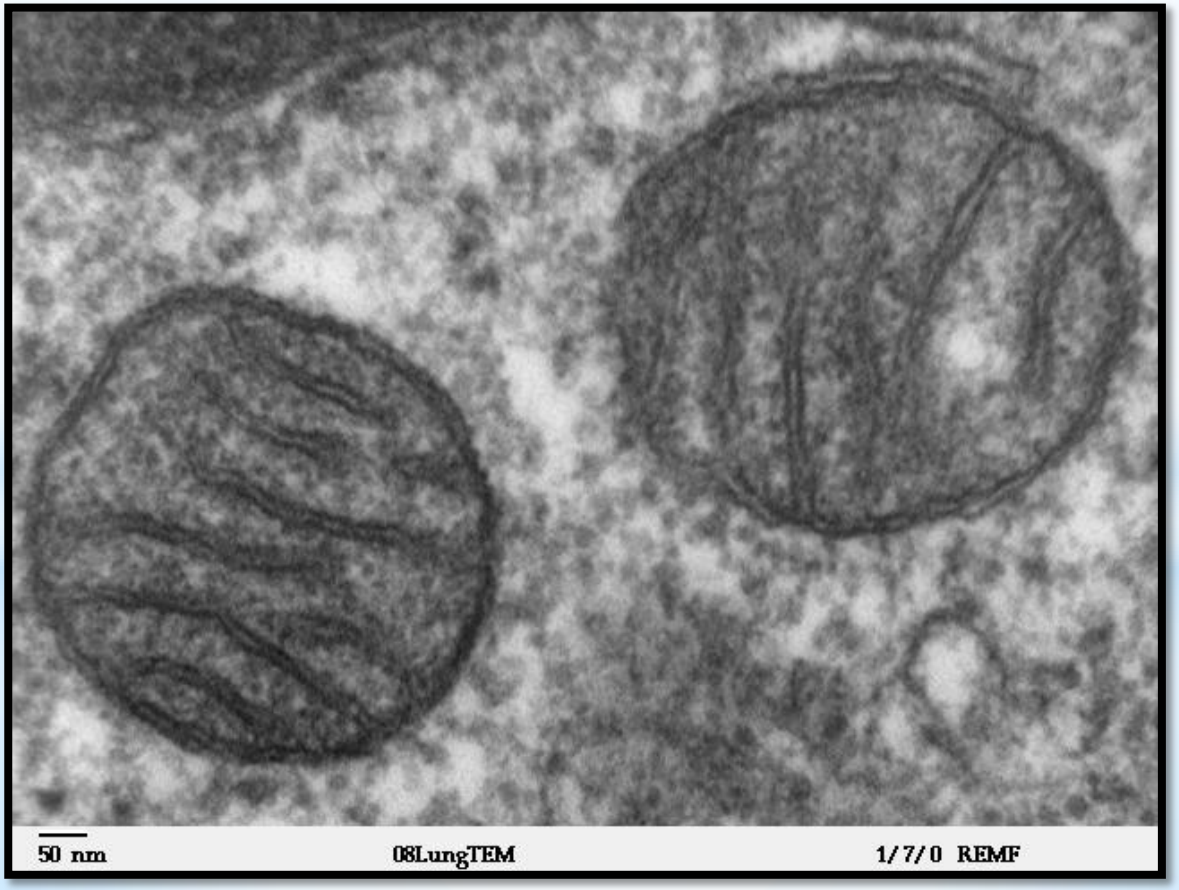


The Golgi Apparatus (#9 - #11) is also a major part of the endomembrane system, receiving material from the endoplasmic reticulum before sending it elsewhere in the cell.

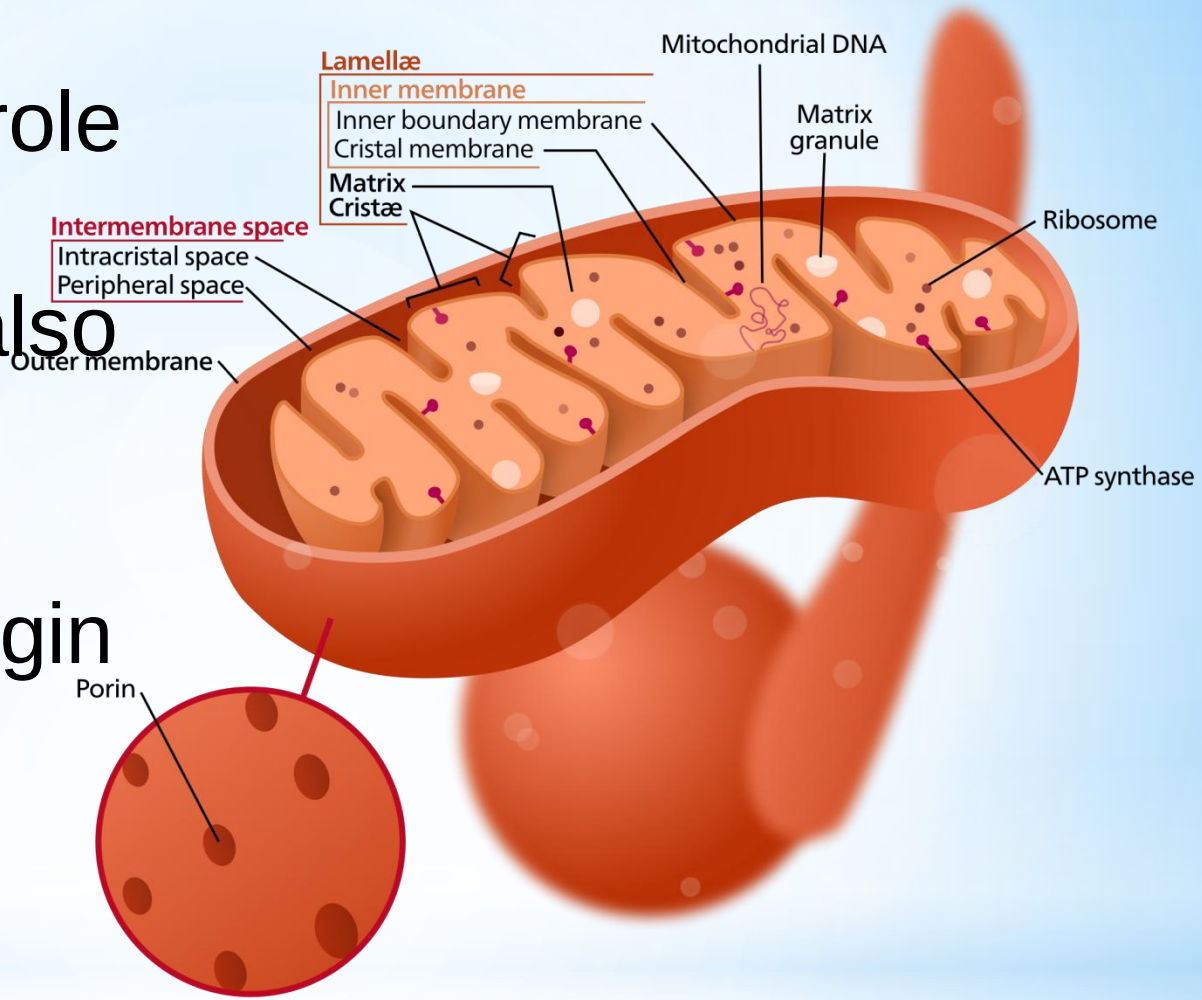


*Mitochondria

The site of **Aerobic Cellular Respiration.** Double membrane. Highly folded inner membrane (a surface area adaptation)

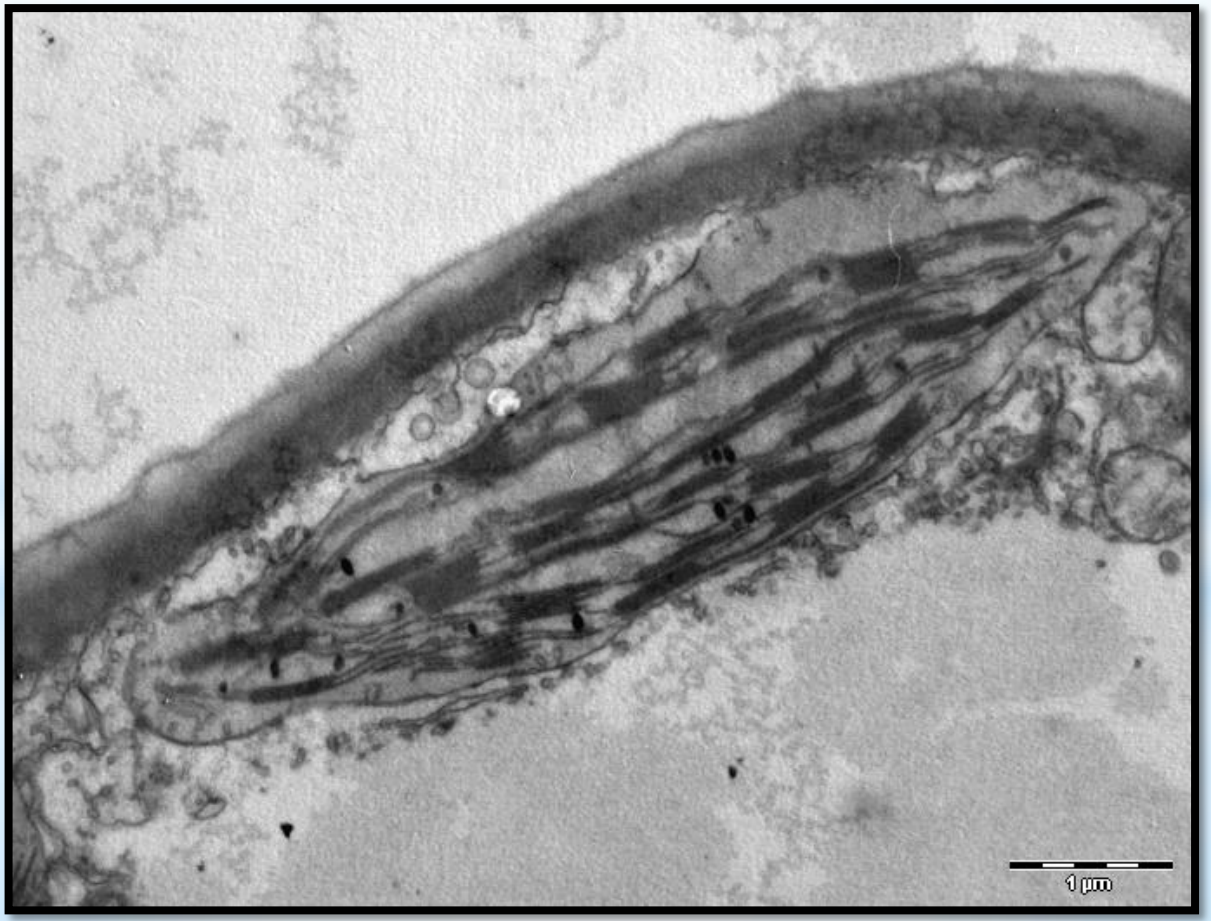


Mitochondria are adapted for their role in cellular metabolism and also posses structural remnants of their endosymbiotic origin

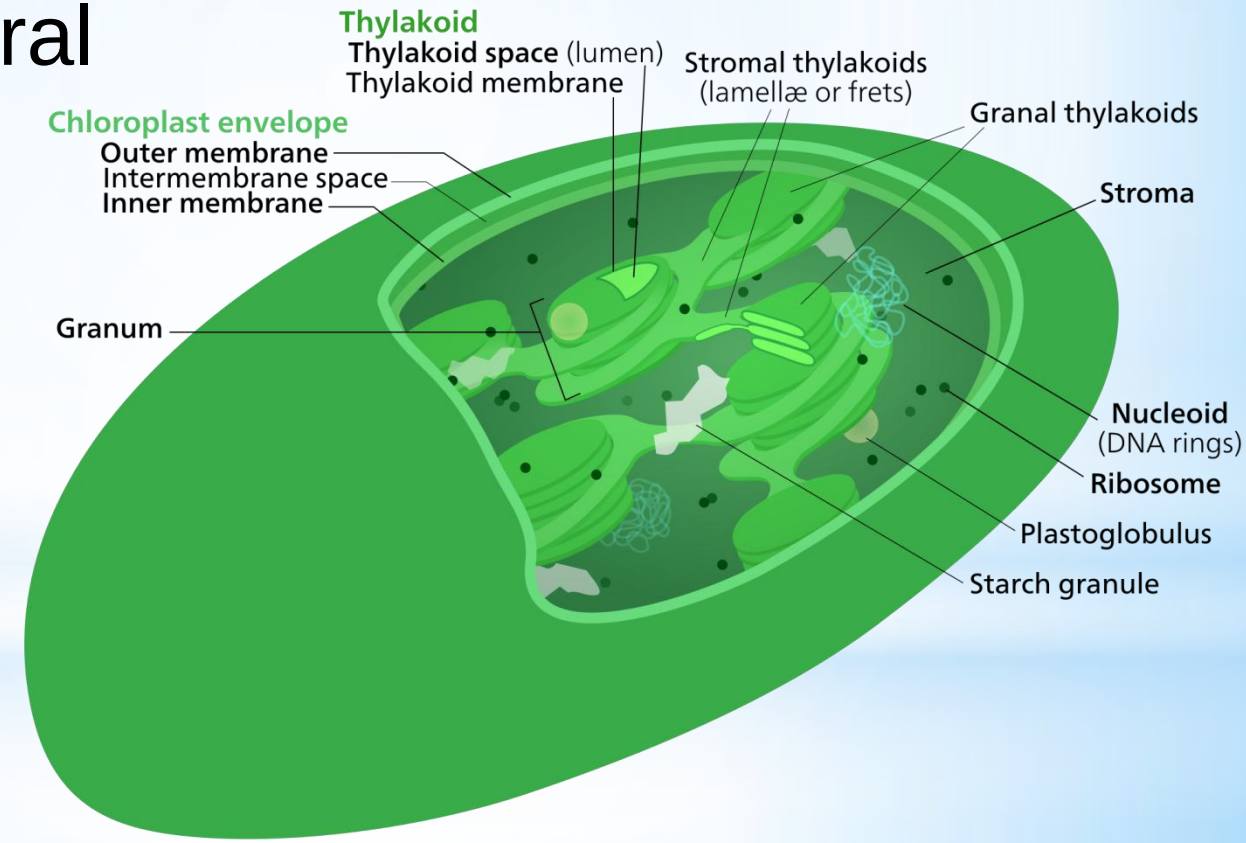


*Chloroplasts

The site of **Photosynthesis.** Double membrane. Inner membrane is stacked (a surface area adaptation)



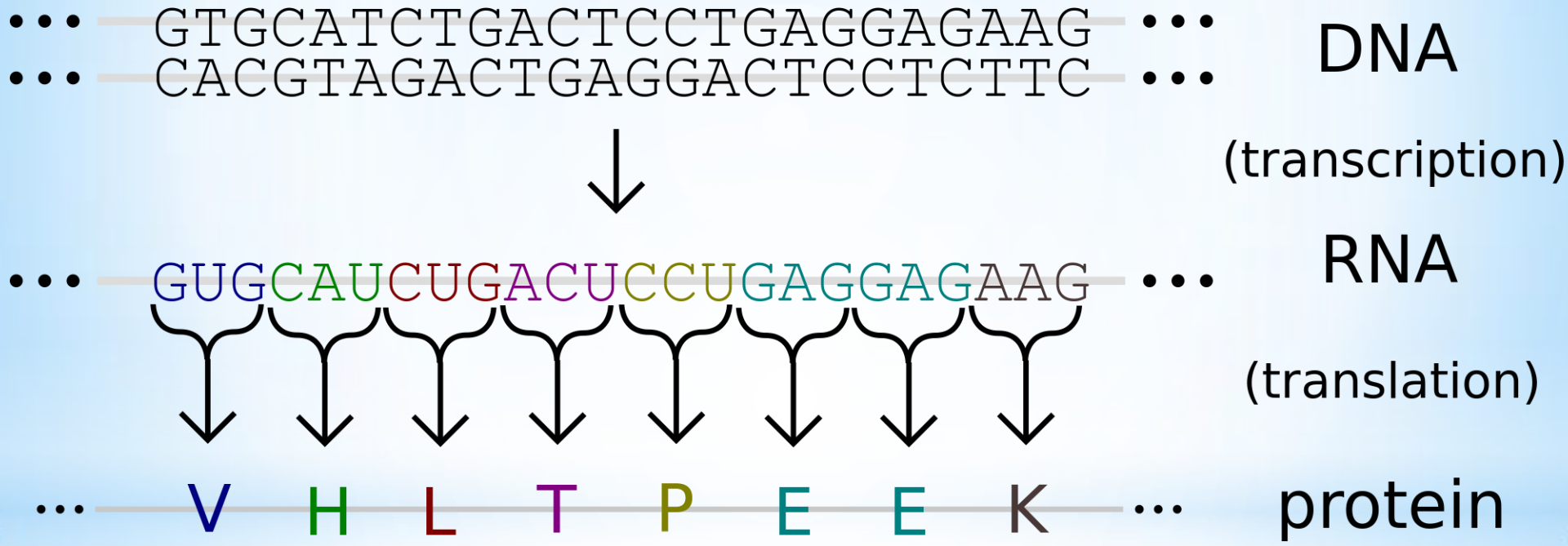
Chloroplasts are adapted for their role in cellular metabolism and also posses structural remnants of their endosymbiotic origin



1. Organelle structure and function- information processing

2.7: The structure and function of subcellular components, and their interactions, provide essential cellular processes.

*Cellular Information Flow



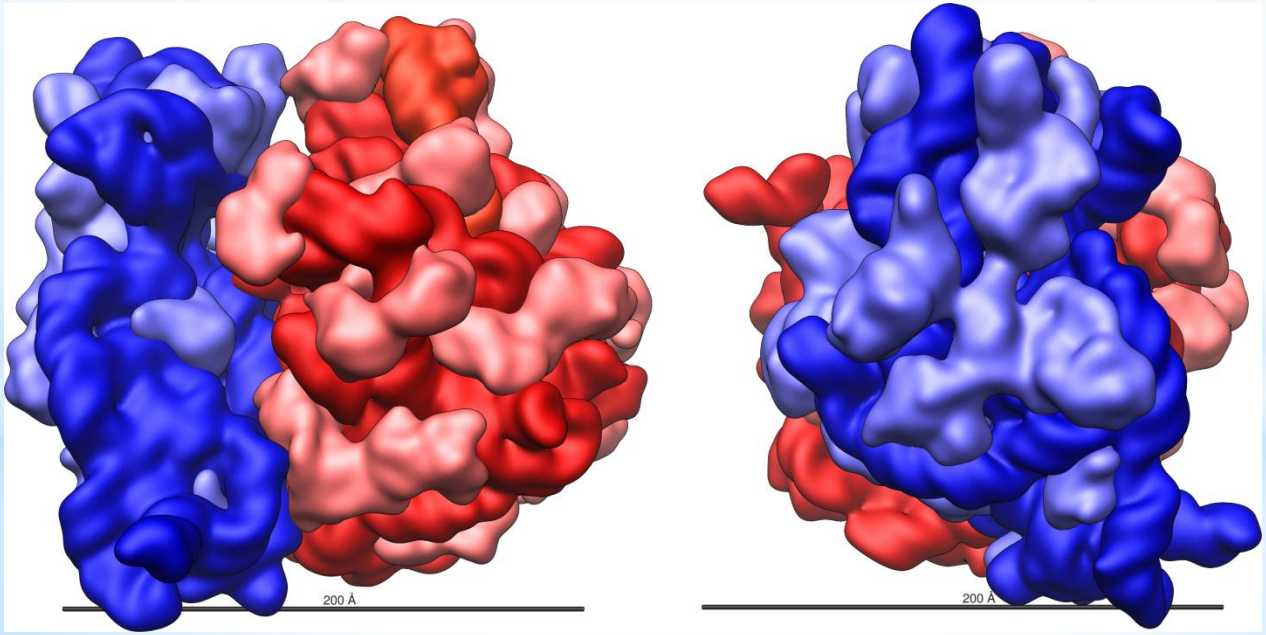
A change in DNA sequence can affect all levels of organism function.

*Ribosomes

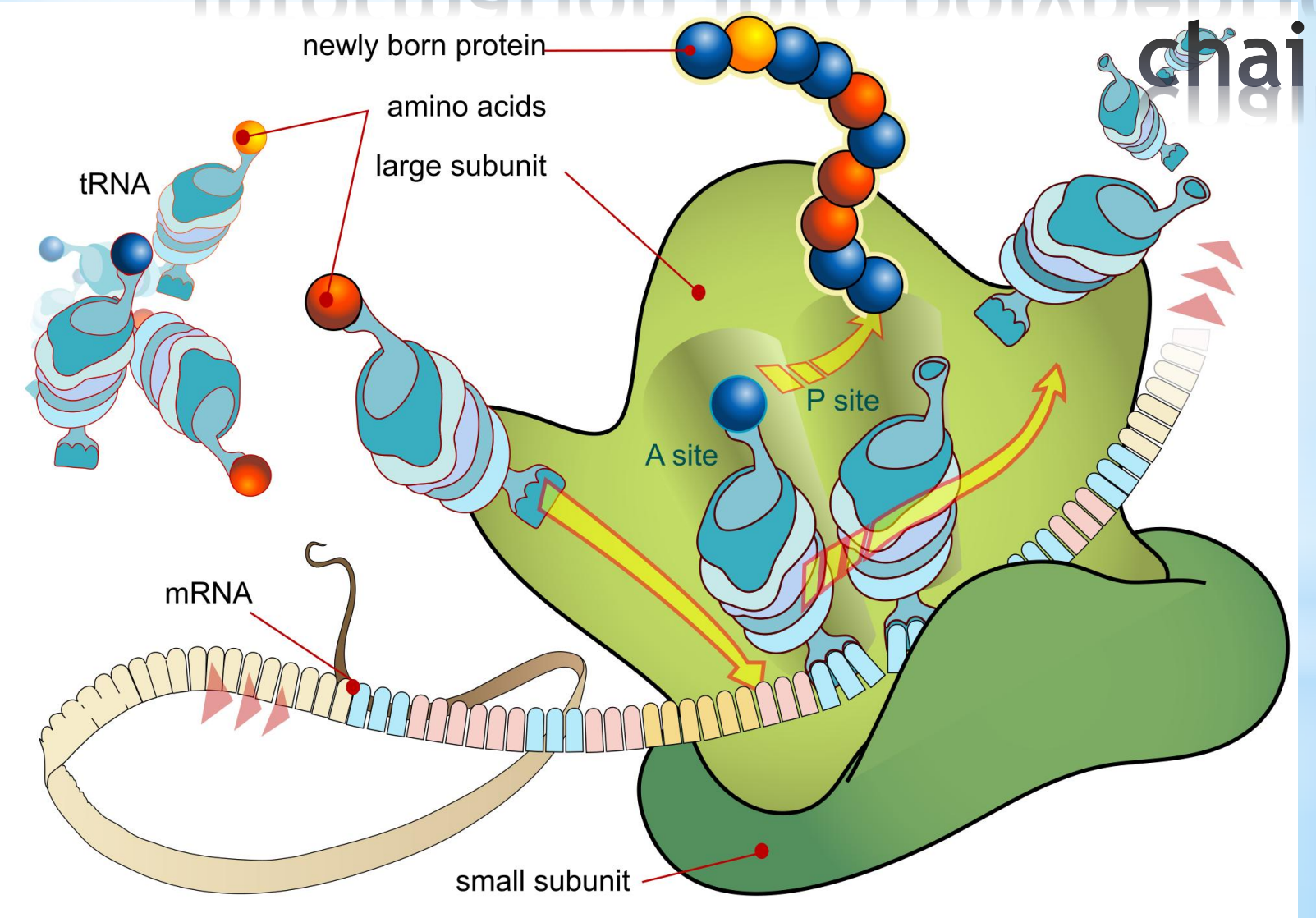
Universal in all cells.

Two subunits made of RNA and protein.

Exist “**free**” in cytoplasm, and “**bound**” to the ER in eukaryotes.



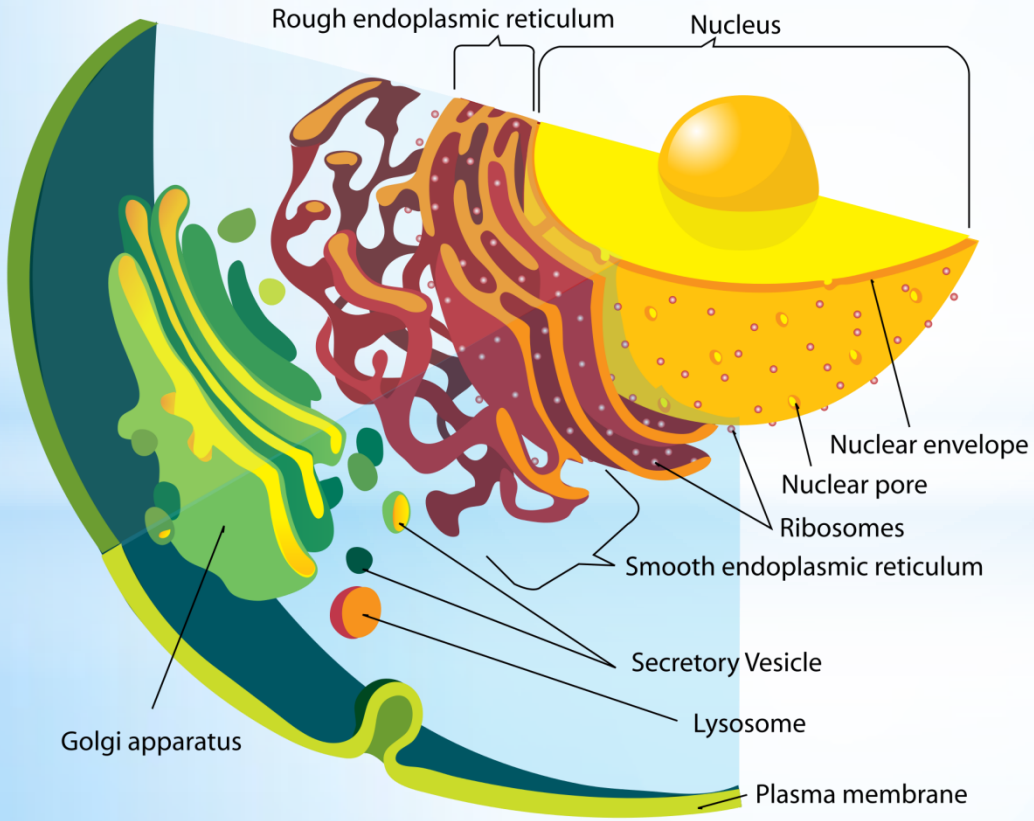
Ribosomes convert nucleic acid information into polypeptide chains



*The Endomembrane System

The flow of information from the nucleus to proteins.

Nucleus → ER → Golgi → Final Destination



Note: Cytoplasmic proteins are made by "free" ribosomes and may not move into the ER/ endomembrane system.

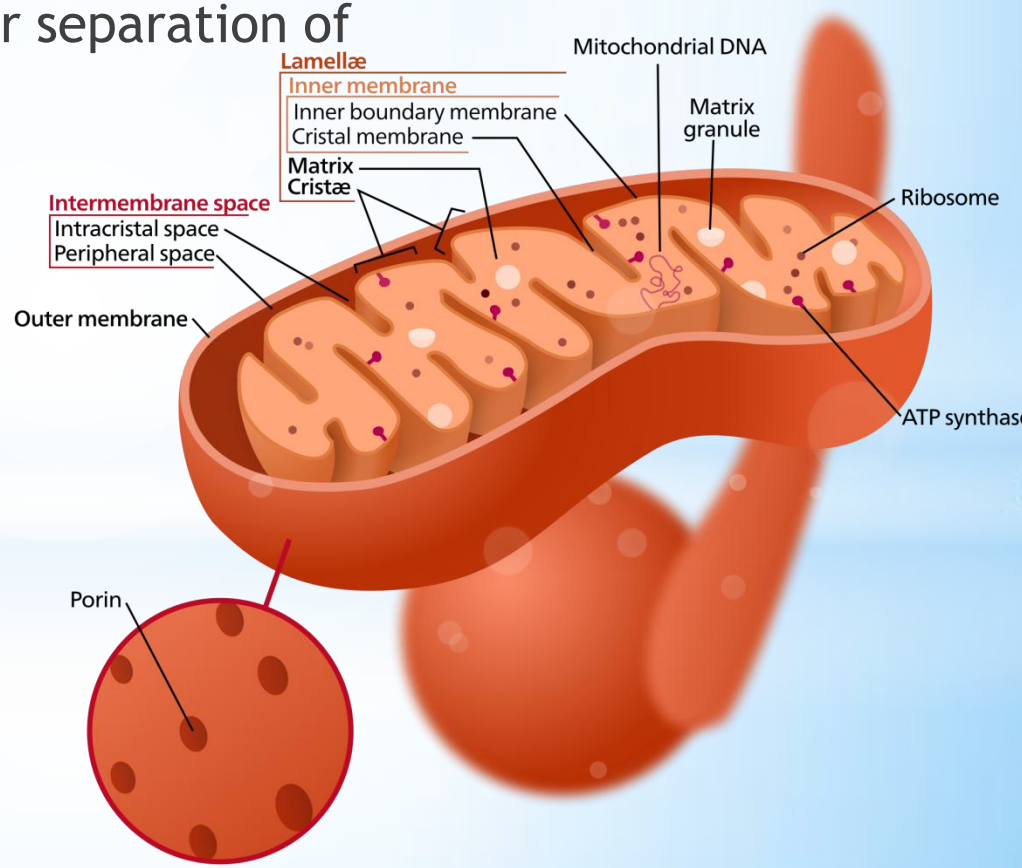
2. Organelle structure and function- matter and energy processing

2.7: The structure and function of subcellular components, and their interactions, provide essential cellular processes.

Mitochondrial Anatomy

A double membrane which allows for separation of different processes.

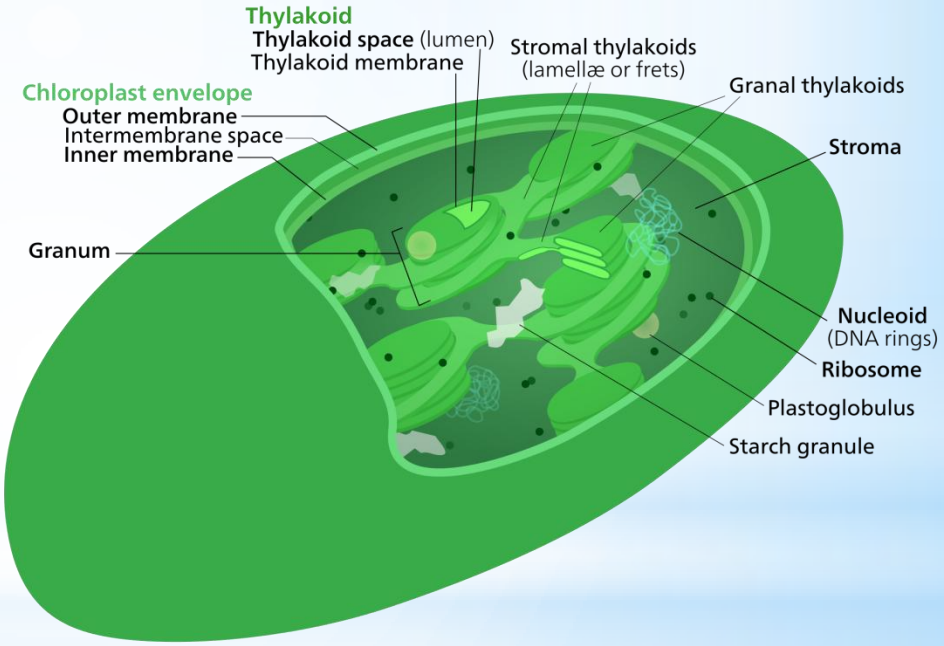
The inner membrane (the "**cristae**") contains many copies of the enzymes needed to produce ATP, with maximized surface area.



*Chloroplast Anatomy

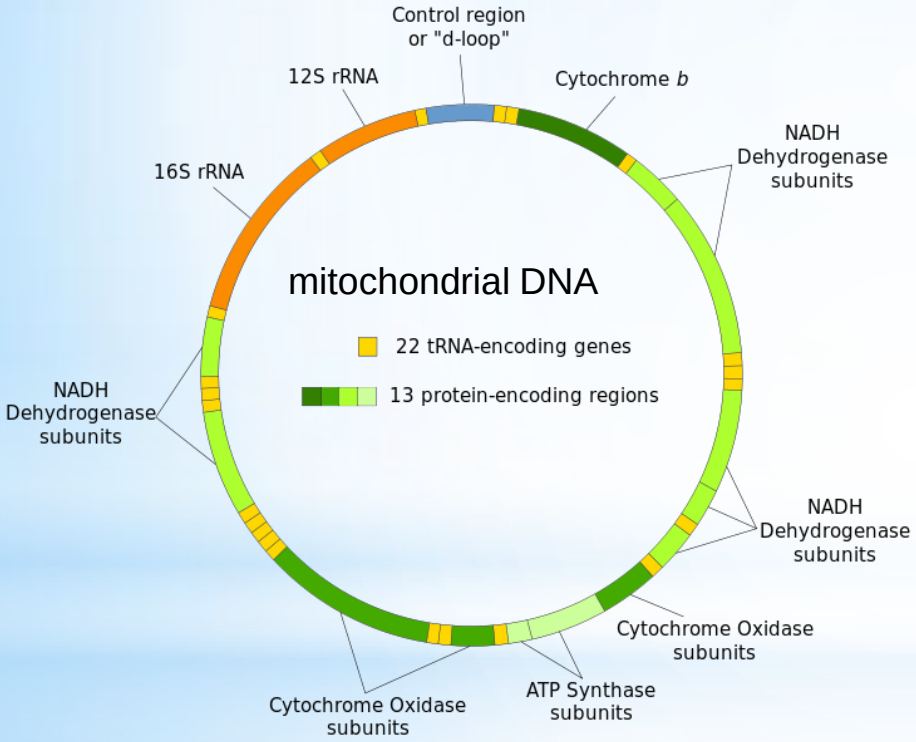
A double outer membrane with inner membranous stacks called **“thylakoids”**

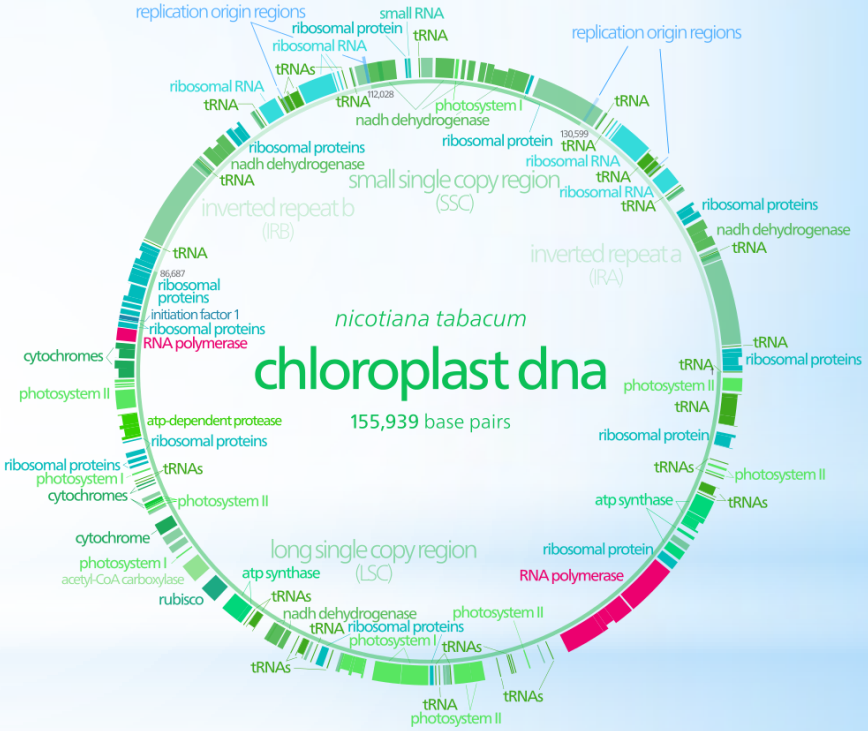
The thylakoid membrane contains many copies of the enzymes and chlorophyll needed to produce chemical energy from solar radiation.



The stroma contains the enzymes needed to produce organic compounds

Mitochondria and chloroplasts contain their own circular DNA, and their own ribosomes.

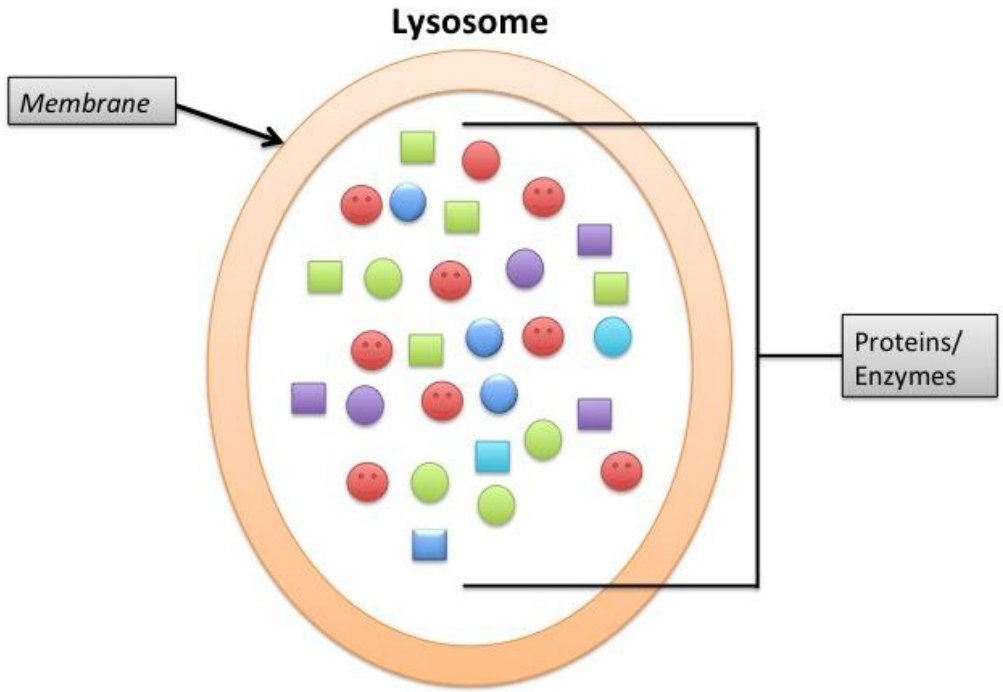




*Lysosomes

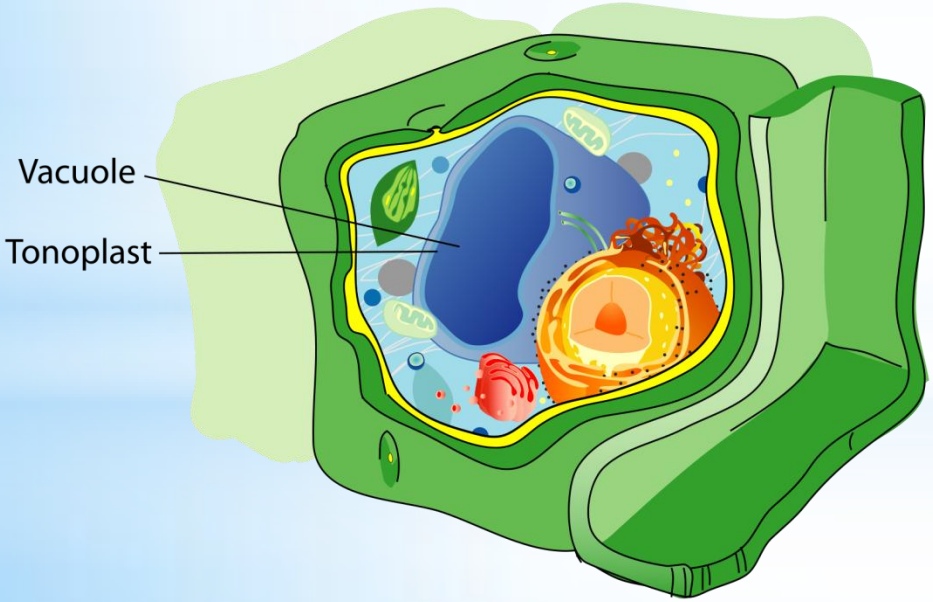
Membrane-enclosed sacs that contain collections of digestive, **hydrolytic** enzymes.

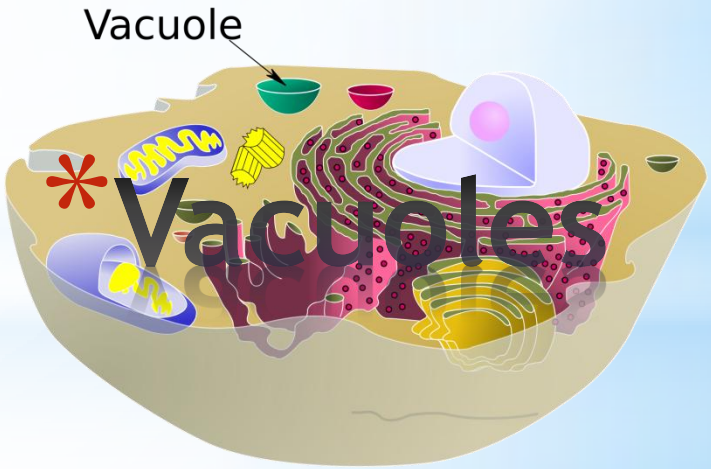
Have roles in digestion of molecules, recycling a cell's damaged components, and programmed cell death.



A membrane-bound sac that stores material.

Plants have a large central vacuole that increases the cells surface area: volume ratio by decreasing the active volume





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