Biology 1
Bio 103

Cell Structure and Function

- Organelles description

Cell structure and function

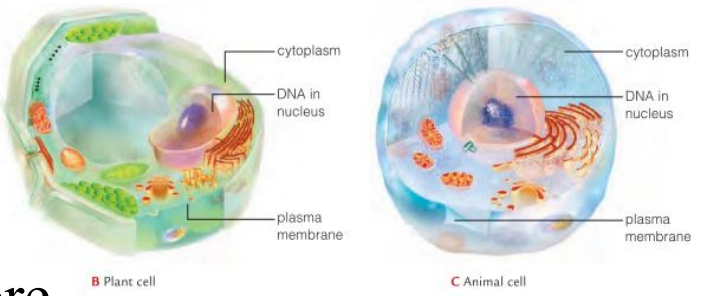
Cells

- A cell is the smallest unit of life.
- Cells can survive and reproduce on its own.
- Some cells live and reproduce independently. Others do so as part of a multicelled organism.

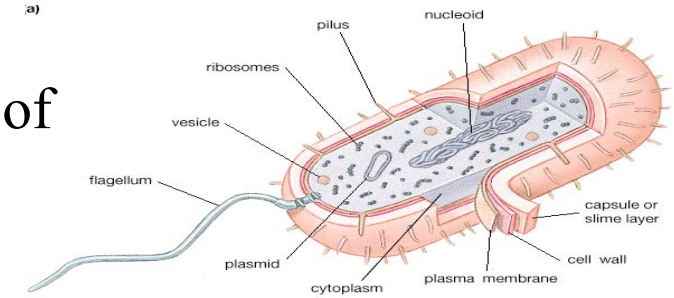
Discovery of cells

- In the middle of the 17th century, one of the pioneers of microscopy, Robert Hooke (1635–1703), decided to examine a piece of cork tissue with his home-built microscope. He saw numerous box shaped structures that he thought resembled row of empty boxes or rooms, so he called them ‘cells’.

The Cell Theory



- Every organism is composed of one or more cells
- Cell is the smallest unit having properties of life
- Continuity of life arises from growth and division of single cells.



CELL TYPES

Biologists have categorized cells into two general types:

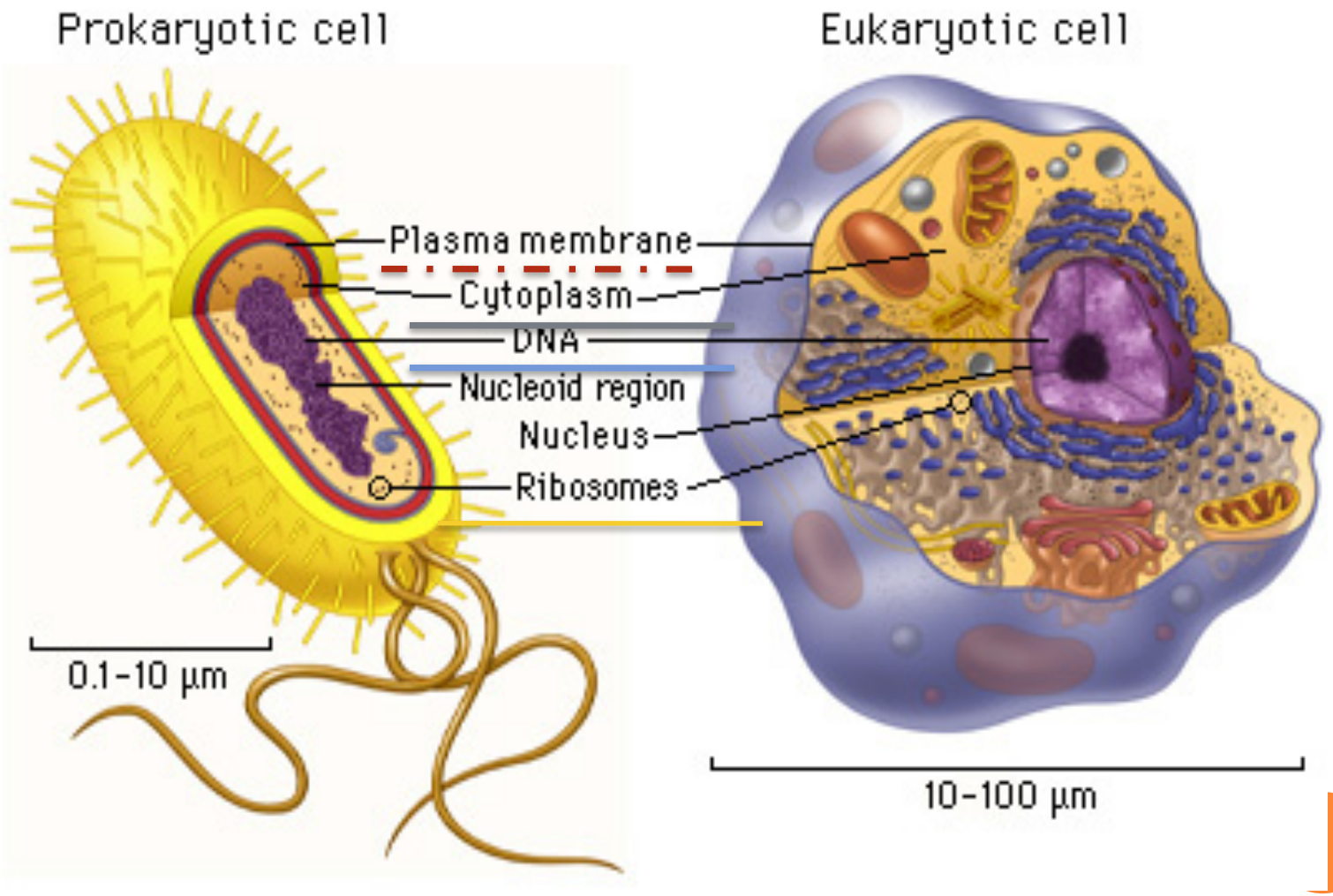
- **Eukaryotic Cells**
- **Prokaryotic Cells**

Prokaryotic and Eukaryotic Cell

Prokaryote	Eukaryote
Usually unicellular	Usually multicellular
No True Nucleus	Membrane bound nucleus
Organelles absent	Organelles present
Smaller ribosomes	Larger ribosomes
Example: bacteria, Archaea.	Example: animal, plant, fungi, algae.

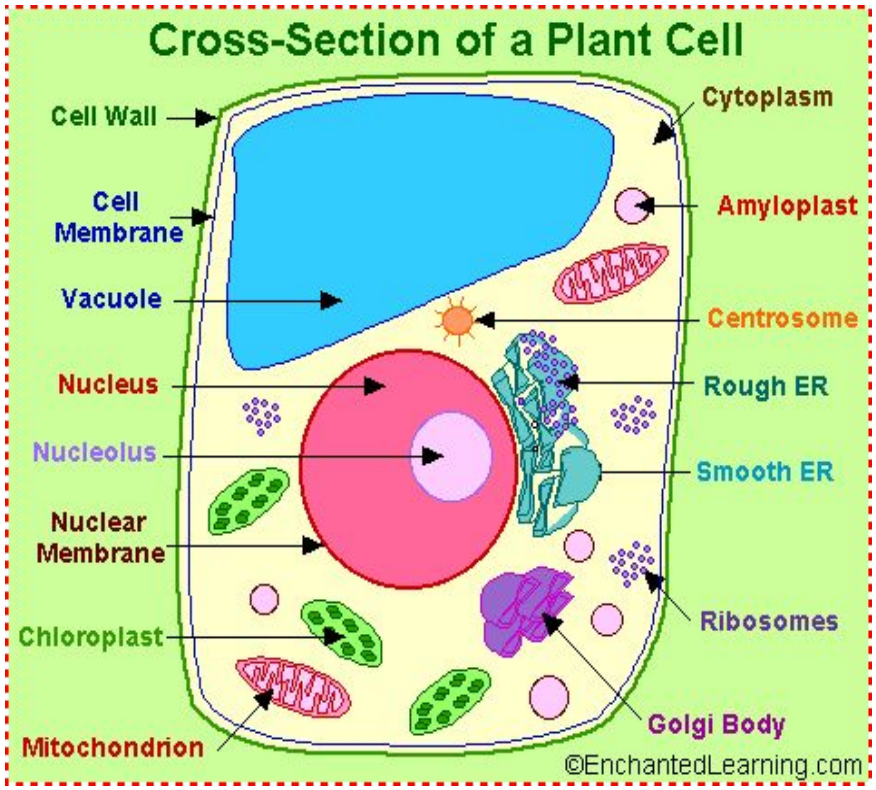
More differences from handout

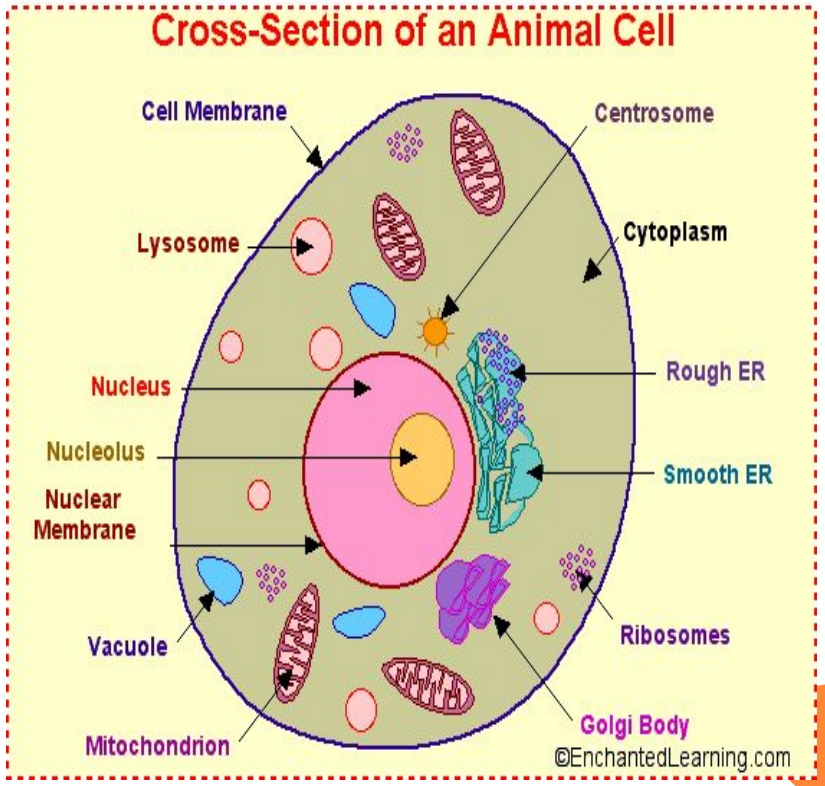
Prokaryotic and Eukaryotic Cell



DRAW BY YOURSELF….

Can you find the difference between animal and plant cell?





Cell Structure

Bacterial cells (Prokaryote)

- **Cell/Plasma membrane**
- **Genetic Material(Nucleoid)**
- **Ribosomes (small)**
- **Cytoplasm**
- Cell Wall
- Capsules
- Flagella
- Pili

Animal cells (Eukaryotes)

- **Plasma membrane**
- **Genetic material (Nucleus)**
- **Ribosomes**
- **Cytoplasm**
- Endoplasmic reticulum
- Golgi body
- Vesicles

Unique to plants

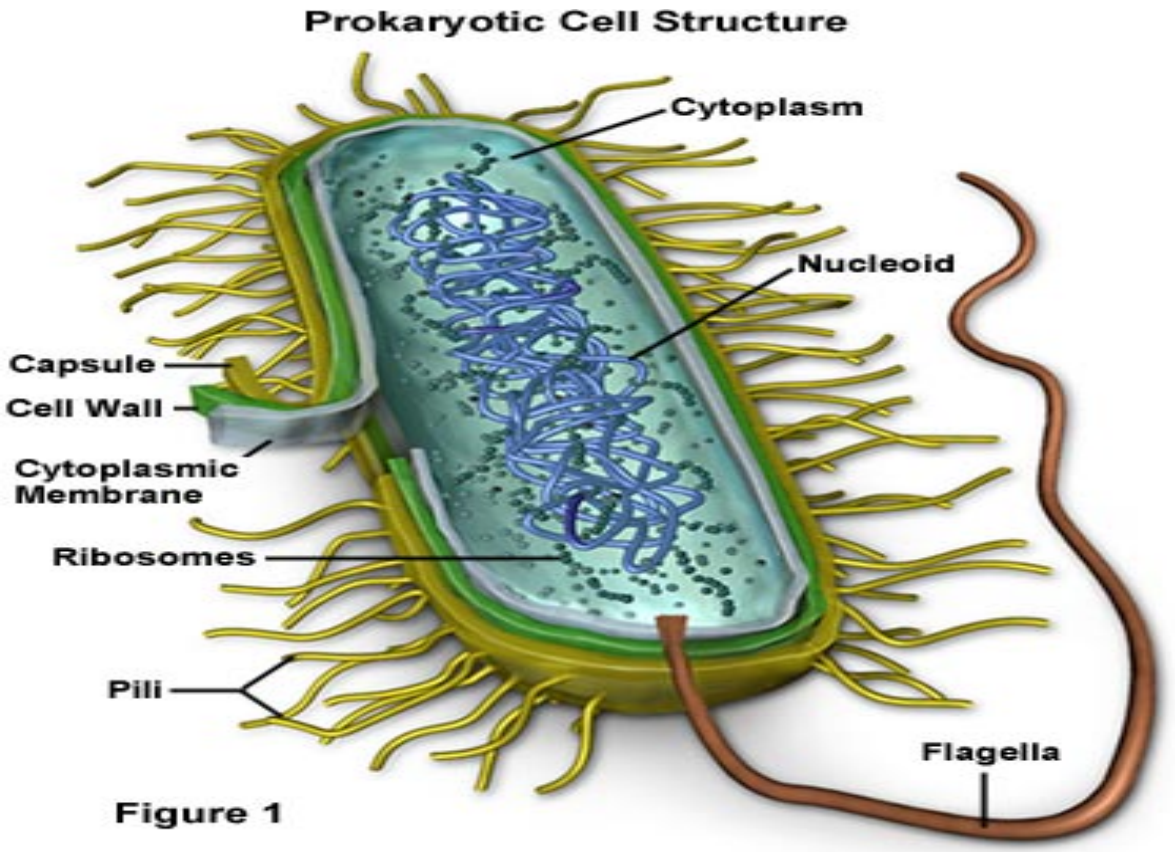
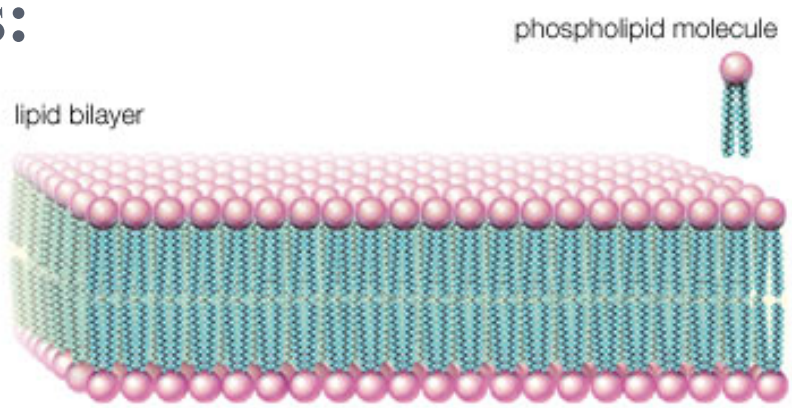

Prokaryotic Cell Structure
Cytoplasm
Nucleoid
Capsule
Cell Wall
Cytoplasmic Membrane
Ribosomes
Pili
Flagella

Figure 1

Structure common to all cells:

Plasma Membrane



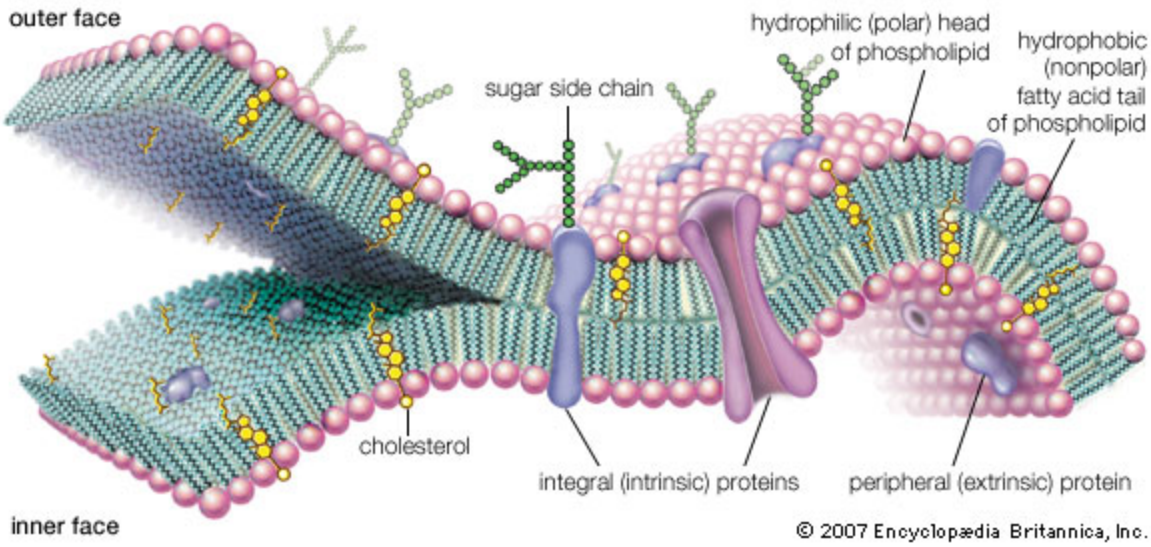
- The plasma membrane is the boundary between the cell and its environment.
- It isolates the cell, regulates what enters and leaves the cell.
- It allows interaction with other cells. It comprises of **lipids and proteins**.

Lipid Bilayer

- Lipids—mainly phospholipids—make up the bulk of a cell membrane.
- A phospholipid consists of a phosphate containing head and two fatty acid tails. The polar head is hydrophilic, which means that it interacts with water molecules. The nonpolar tails are hydrophobic, so they do not interact with water molecules, but they do interact with the tails of other phospholipids.
- Lipid bilayers are the basic structural and functional framework of all cell membranes, gives membrane it's fluidity

Functions of Plasma membrane

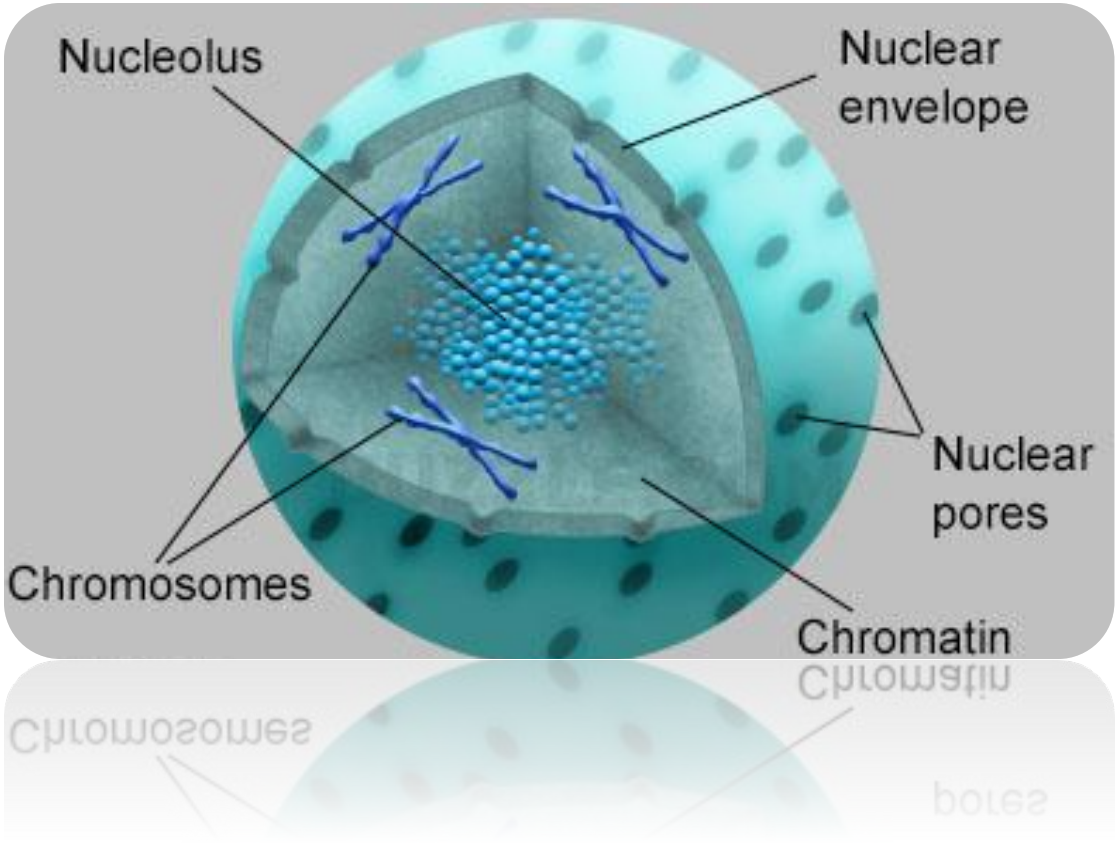
- A cell must exchange materials with its surroundings, a process controlled by the plasma membrane
- Plasma membranes are **selectively permeable**, regulating the cell's molecular traffic.
- Hydrophobic (nonpolar) molecules, such as hydrocarbons, can dissolve in the lipid bilayer and pass through the membrane rapidly.



Structure common to all cells: Eukaryotic Cell: Nucleus

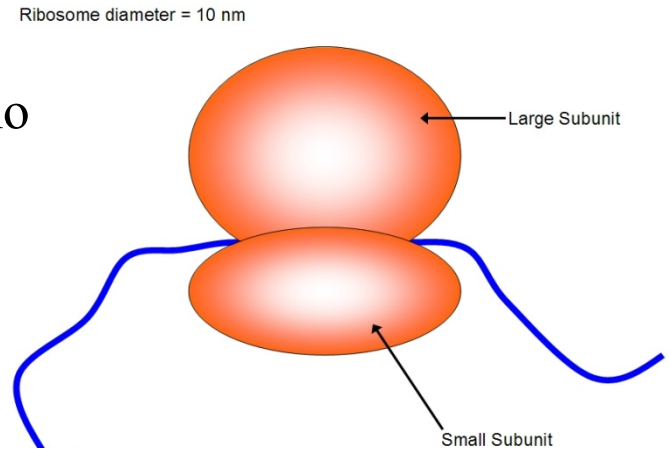
- The nucleus is the defining organelle of eukaryotic cells.
- The nucleus is separated from the cytoplasm by a double membrane (two phospholipid bilayers); known as the *nuclear envelope*.
- The nuclear envelope controls the passage of molecules between the nucleus and cytoplasm.
- The nucleus contains the DNA, the stored genetic instructions of each cell. In addition, important reactions for interpreting the genetic instructions occur in the nucleus.
- In the nucleus, DNA is organized into discrete units called **chromosomes**
- Each chromosome is composed of a single DNA molecule associated with proteins

Structure – Nucleus



Structure common to all cells: Ribosomes

- Ribosomes are non-membranous organelles responsible for the synthesis of proteins from amino acids.
- They are composed of RNA and protein.
- Each ribosome is composed of two subunits—a large one and a small one.

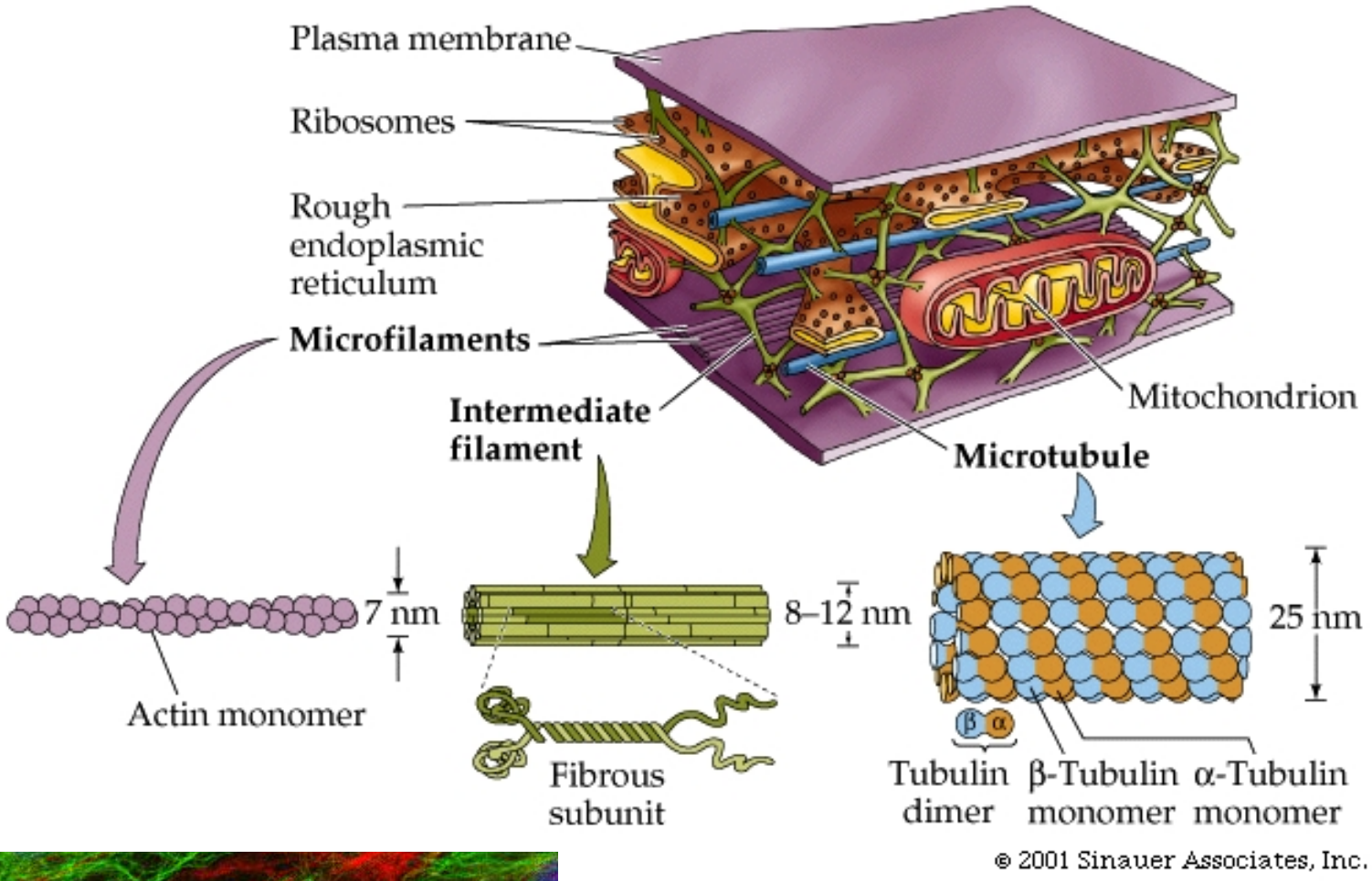


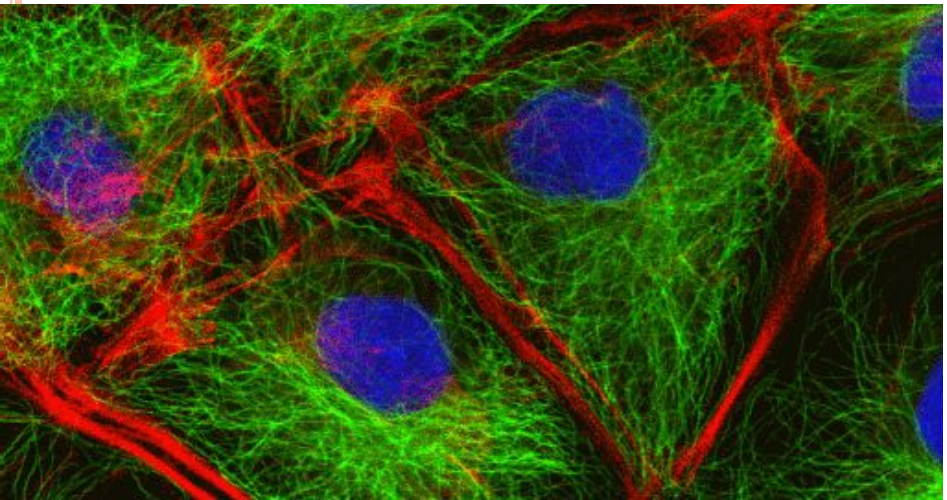
Two types:

- **Bound ribosomes:** Many ribosomes are attached to the endoplasmic reticulum. Areas of rough ER are active sites of protein production.
- **Free ribosomes**: Many ribosomes are also found floating freely in the cytoplasm wherever proteins are being assembled. Cells that are actively producing protein (e.g., liver cells) have great numbers of free and attached ribosomes.

Structure common to all cells: Cytoplasm

- In prokaryotes, cytoplasm inside the membrane is a jelly-like substance comprises of water, enzymes and some proteins. It also contains the **genetic material.**
- In eukaryotes, the cytoplasm is a network of fibers that organizes structures and activities in the cell and known as **cytoskeleton.**
- Between the nucleus and plasma membrane of all eukaryotic cells is a system of interconnected protein filaments collectively called the **cytoskeleton.**
- The **cytoskeleton** is a network of fibers extending throughout the cytoplasm. Elements of the cytoskeleton reinforce, organize, and move cell structures, anchoring many organelles.





Components of Cytomembrane System- Endoplasmic Reticulum

- Part of the cytomembrane system is an extension of the nuclear envelope called endoplasmic reticulum, or ER.
- ER forms a continuous compartment that folds into flattened sacs and tubes.
- The space inside the compartment is the site where many new polypeptide chains are modified.
- Two kinds of ER:

Rough ER

- Ribosomes on surface give it a rough appearance
- Some polypeptide chains enter rough ER and are modified
- Cells that specialize in secreting proteins have lots of rough ER

Smooth ER

- No ribosomes on surface
- Lipids assemble

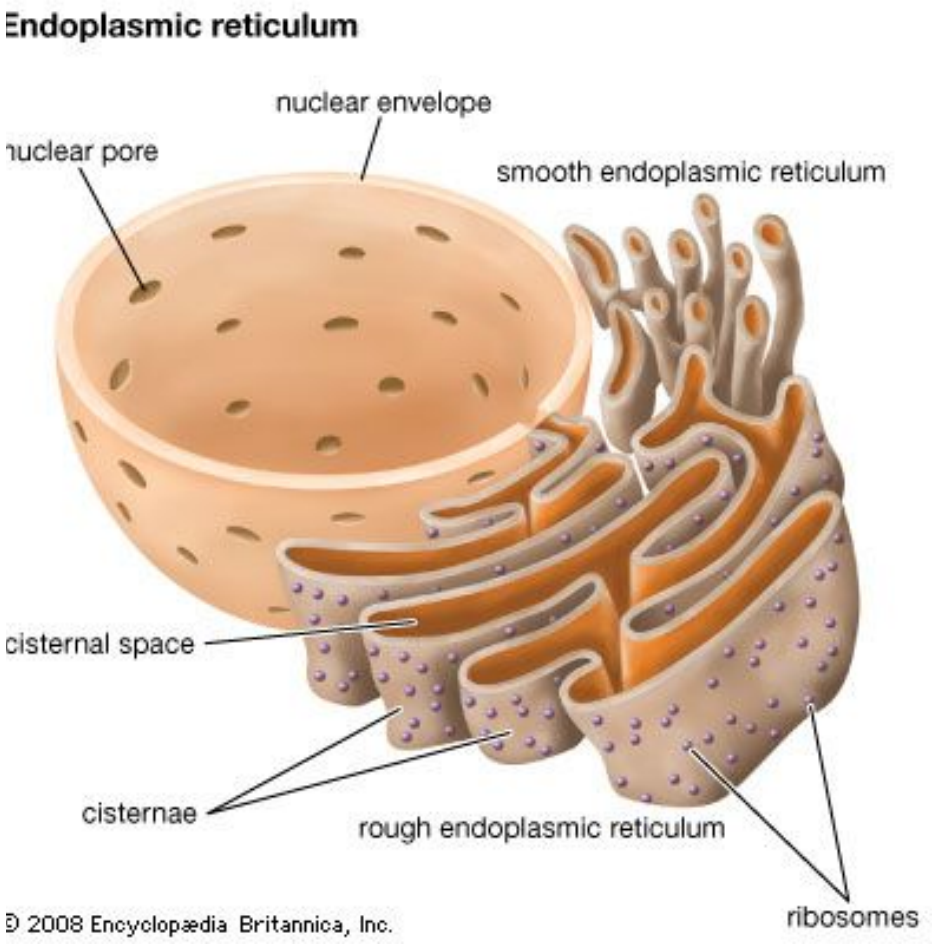
Functions of ER

- **The smooth ER**

1. Synthesizes lipids
2. Metabolizes carbohydrates
3. Detoxifies drugs and poisons
4. Stores calcium ions

- **The rough ER**

1. Has bound ribosomes
2. Distributes **transport vesicles,** proteins surrounded by membranes
3. Is a membrane factory for the cell

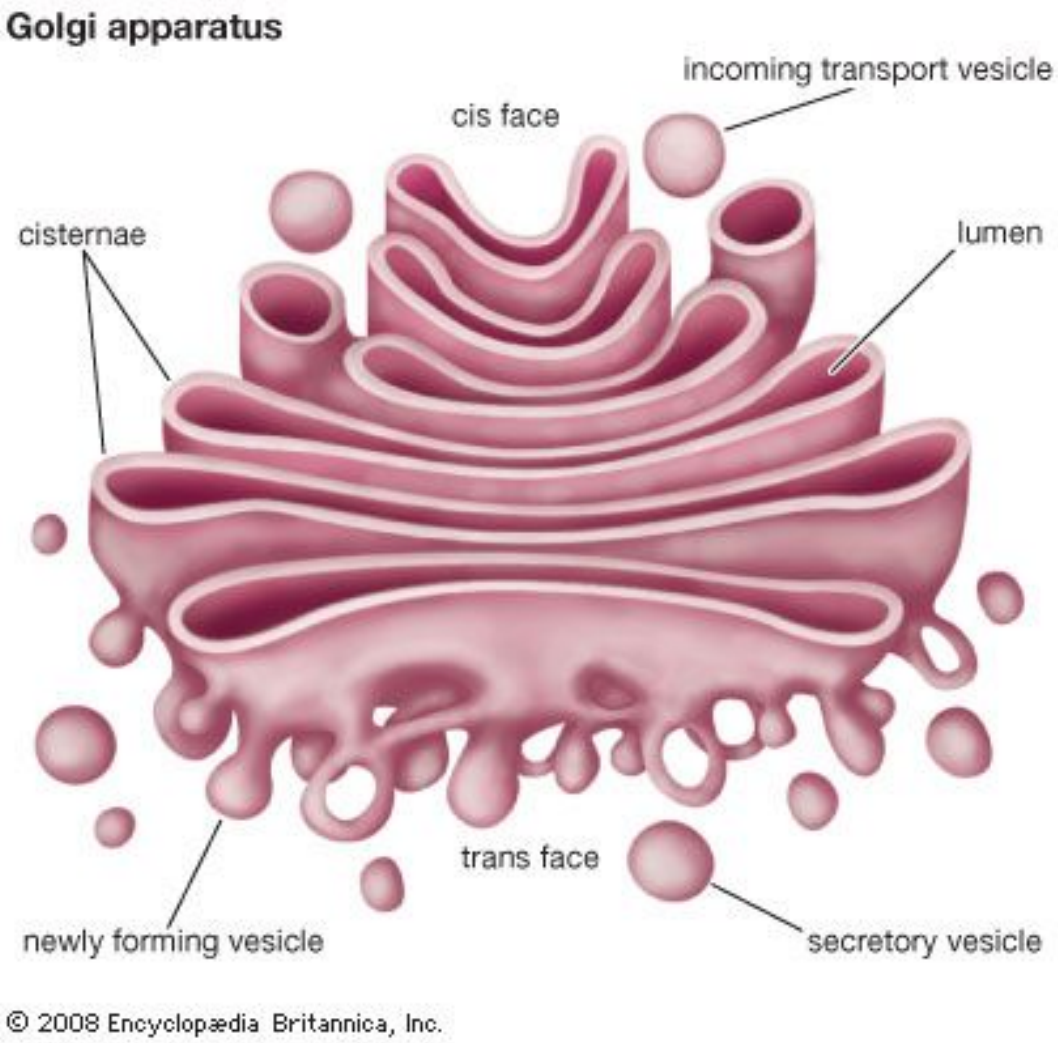


Components of Cytomembrane System- Golgi Bodies

- The Golgi is a series of flattened membrane compartments, whose purpose is to process and package proteins produced in-the rough endoplasmic reticulum.
- The processed molecules are packaged into membrane vesicles, then targeted and transported to their final destinations.

Functions of the Golgi apparatus

- Modifies products of the ER
- Manufactures certain macromolecules
- Sorts and packages materials into transport vesicles.


Golgi apparatus
incoming transport vesicle
cis face
cisternae
lumen
trans face
newly forming vesicle
secretory vesicle
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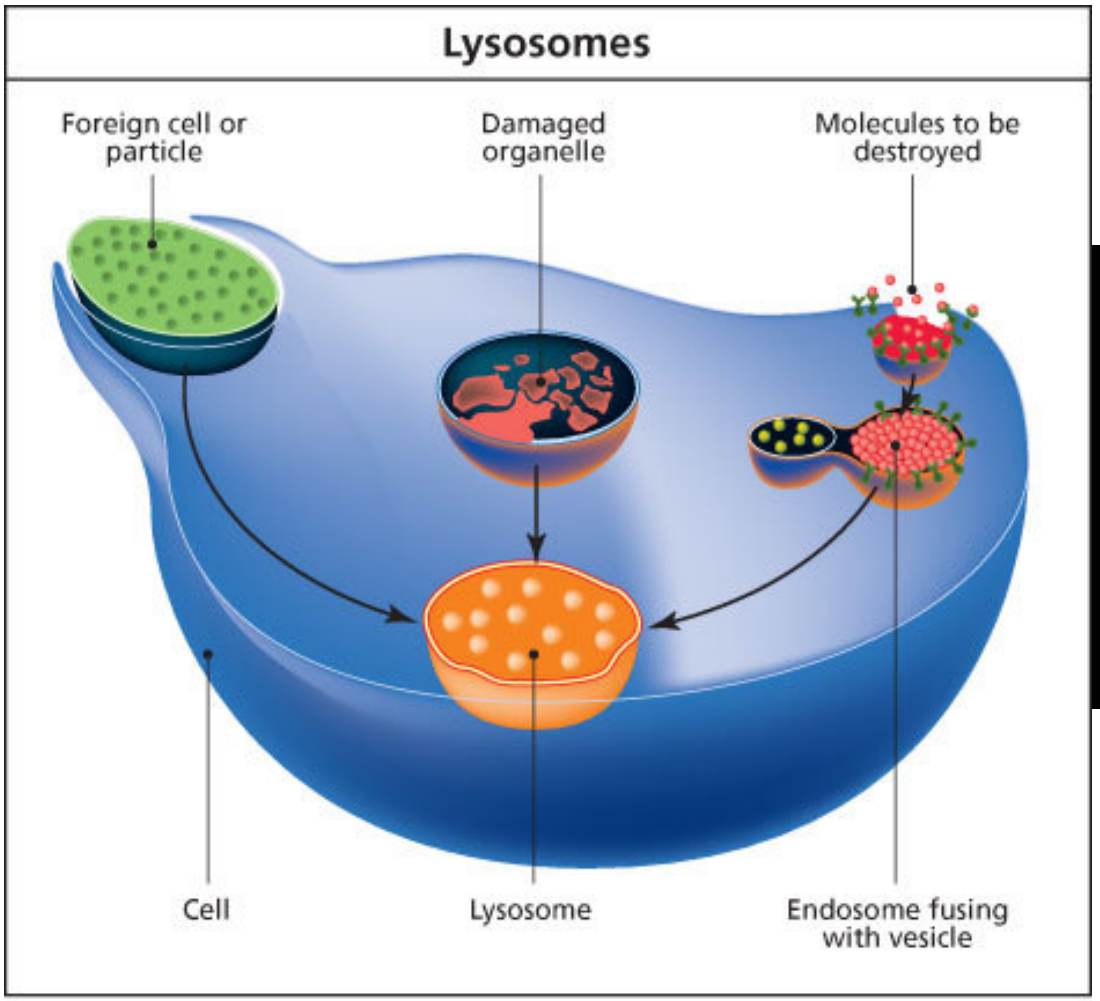
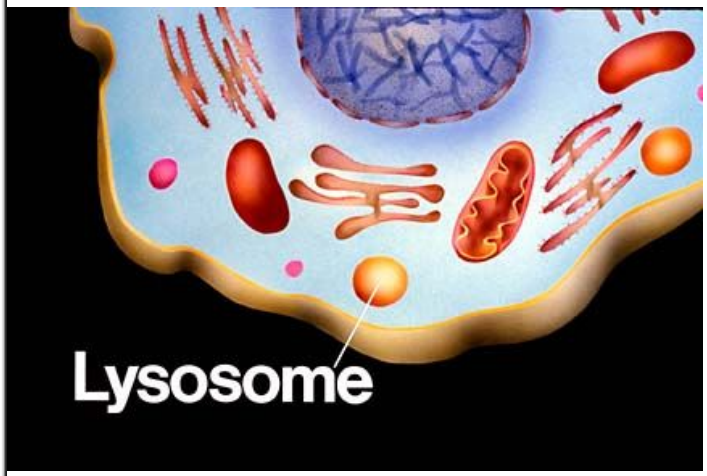
Components of Cytomembrane System- Vesicles

Small, membrane-enclosed, saclike vesicles form in great numbers, in a variety of types, either on their own or by budding. There are many types but two main are:

i) Lysosomes: Digestion & recycling centers

- That bud from Golgi bodies take part in intracellular digestion.
- They contain powerful enzymes that can break down carbohydrates, proteins, nucleic acids, and lipids.
- The enzymes work best in the acidic environment inside the lysosome.
- Lysosomes break down worn out cell parts or molecules so they can be used to build new cellular structures

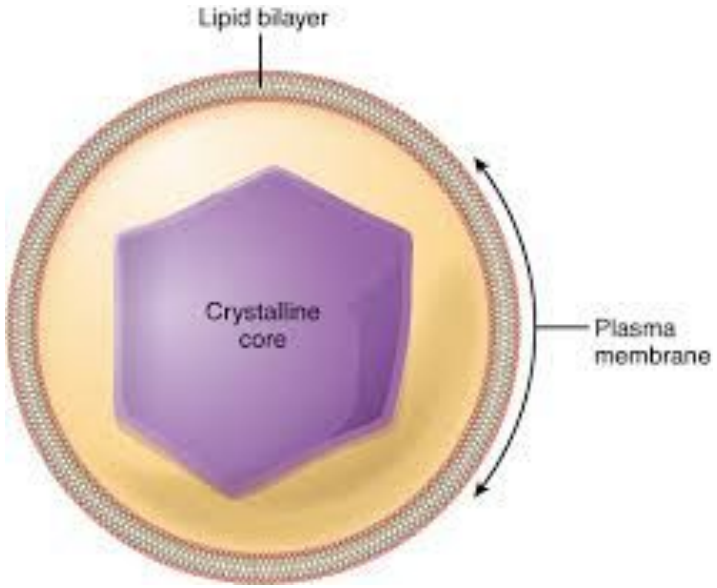




Components of Cytomembrane System- Vesicles

ii) Peroxisomes:

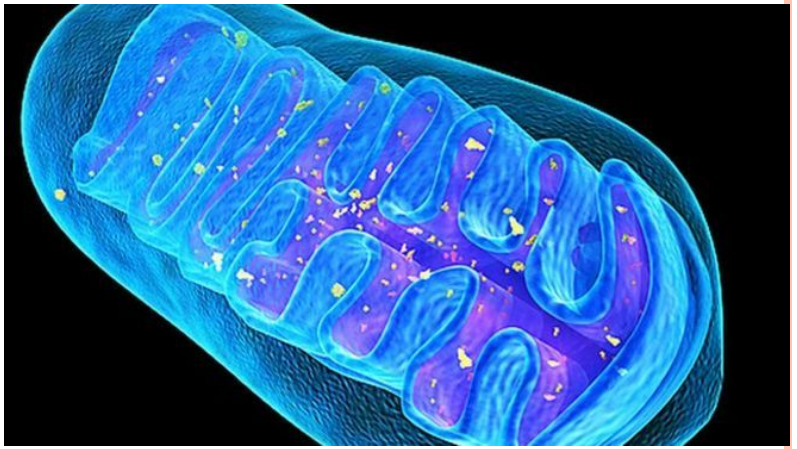
- In plants and animals, vesicles called peroxisomes.
- Peroxisomes contain enzymes that digest **fatty acids and amino acids.**
- Peroxisome enzymes convert hydrogen peroxide to water and oxygen, or use it in reactions that break down alcohol and other toxins.



Energy Related Organelles: Mitochondria

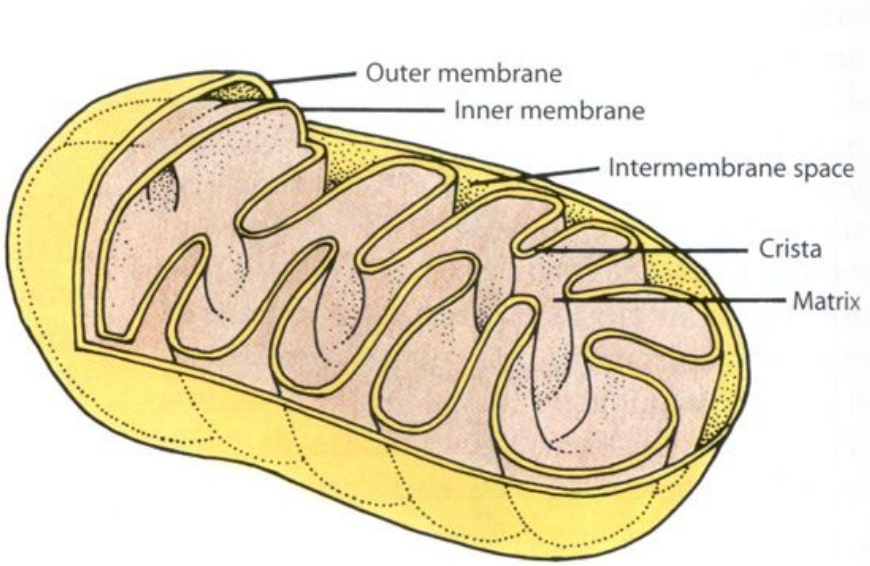
- The mitochondrion (plural, mitochondria) is a type of organelle that specializes in making ATP (molecule used by cells as main energy source).
- They have various enzymes to catalyze cellular respiration.
- Cells that have a very high demand for energy tend to have many mitochondria *e.g.* liver needs more because needs more energy.
- Mitochondria, like most organelles, can move within the cell and they grow and divide independently.

Mitochondria structure



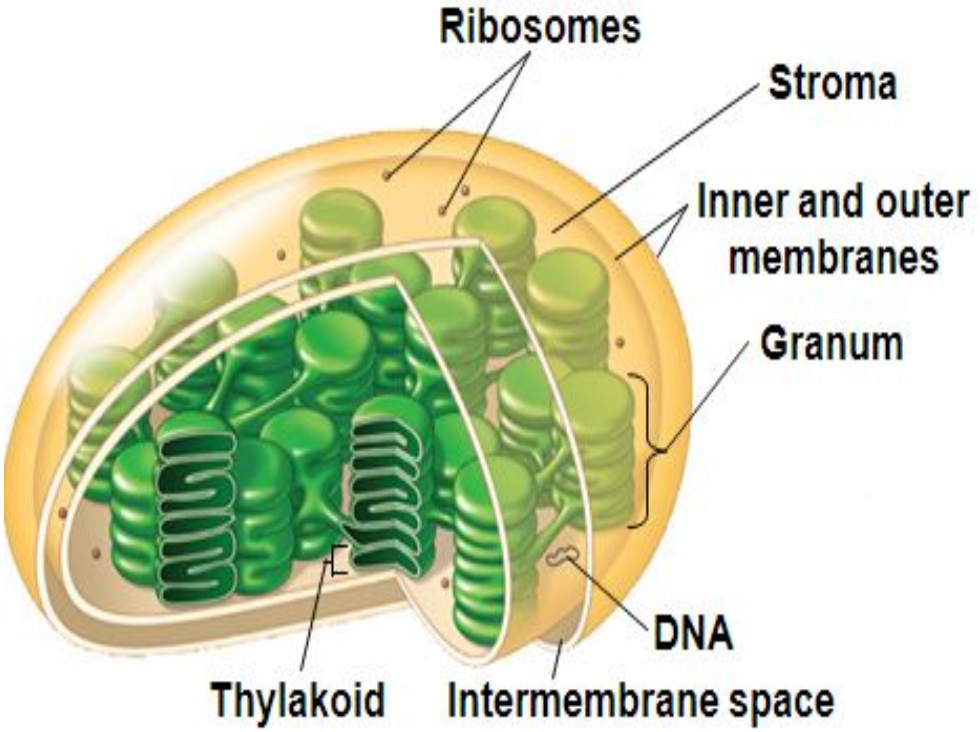
Double membrane system:

- **Smooth outer membrane** facing cytoplasm
- **Inner membrane (cristae)** where chemical reactions to make ATP takes place.



Energy Related Organelle: Chloroplast

- Plastids are a category of membrane-enclosed organelles that function in photosynthesis or storage in plant and algal cells.
- Plastids called chloroplasts are organelles specialized for photosynthesis which contain the green pigment chlorophyll, as well as enzymes and other molecules that function in photosynthesis.



Energy Related Organelle: Chloroplast

Chloroplast structure includes

- **Stroma**: Each has two outer membranes enclosing a semifluid interior, the stroma, that contains enzymes and the chloroplast‘s own DNA.
- **Thylakoids**: Inside the stroma, a third, highly folded membrane forms a single, continuous compartment (Thylakoid membrane) which resembles stacks of flattened disks and the disks are called grana (singular, granum).

  - By the process of photosynthesis, chlorophylls and other molecules in the thylakoid membrane harness the energy in sunlight to drive the synthesis of ATP. The ATP is then used inside the stroma to build carbohydrates from carbon dioxide and water.

Energy Related Organelle: Mitochondria & Chloroplast

- Mitochondria and chloroplasts have similarities with bacteria:
  - Double membrane envelope
  - Free ribosome and circular DNA
  - Independent growth and reproduction

- They may have evolved from ancient bacteria that were engulfed but not digested.
- Mitochondria and chloroplasts developed because as a prokaryote it gained protection by living inside the eukaryote and in turn produced energy for the eukaryote (symbiotic relationship).

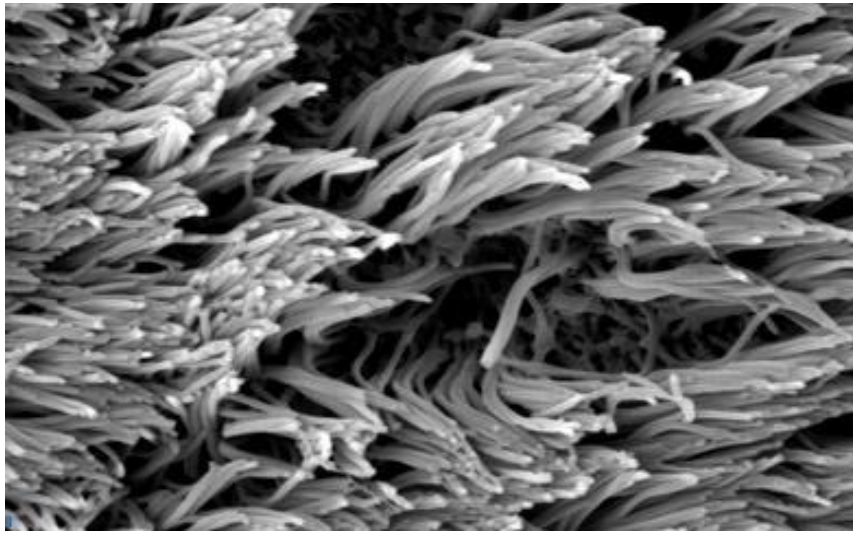
Locomotor appendages: Cilia & Flagella

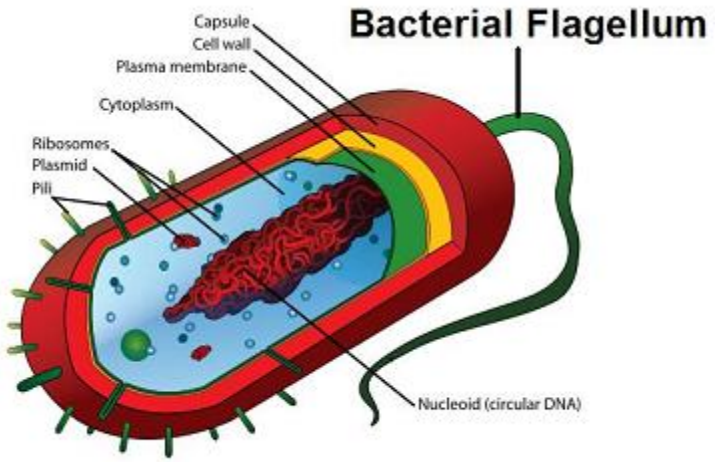
- **Cilia** – Cilia (singular, cilium) are short, hair-like structures that project from the surface of some cells. Mainly found in **eukaryotic** cells.
  - The coordinated waving of many cilia propels cells through fluid, and stirs fluid around stationary cells.

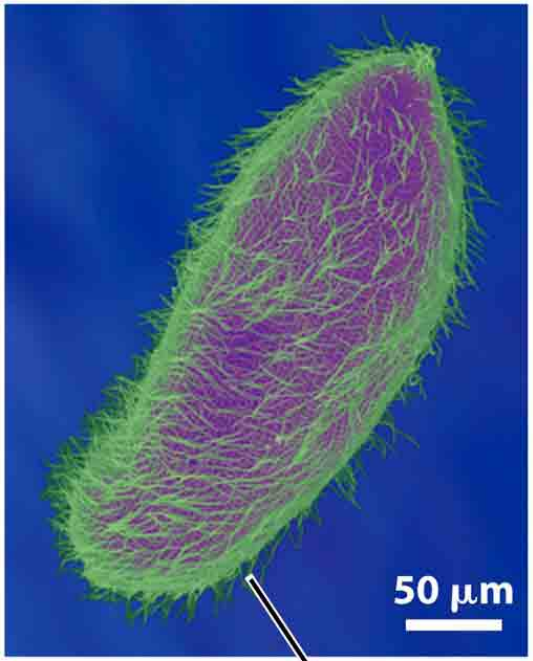
- **Flagella** –Flagella are long hair-like structure and present in both **prokaryotic and eukaryotic** cells.

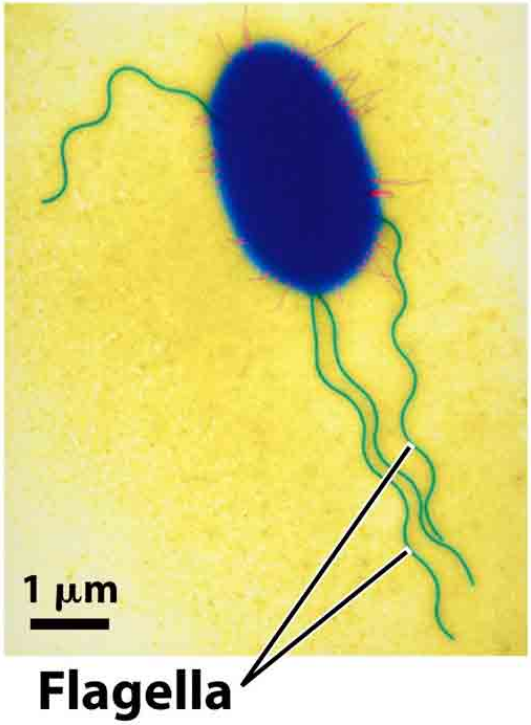
  - In prokaryotes flagellum projects from the cell wall and enables a cell to move. In eukaryotes, flagellum structure is different from the prokaryotic cells and whip back and forth to propel cells such as sperm through fluid. They have a different internal structure and type of motion than flagella of bacteria.

Cilia




Bacterial Flagellum
Capsule
Cell wall
Plasma membrane
Cytoplasm
Ribosomes
Plasmid
Pili
Nucleoid (circular DNA)


50 µm
Cilia


1 µm
Flagella

QUESTIONS?

THANK YOU