The Cell

The Cell Theory

1) All organisms are composed of one or more cells

2) The cell is the simplest structure that can perform all activities required for life

3) All cells come from other pre-existing cells by cell division

Microscopes:

- A variety of microscopes have been developed for a clearer view of cells and cellular structure

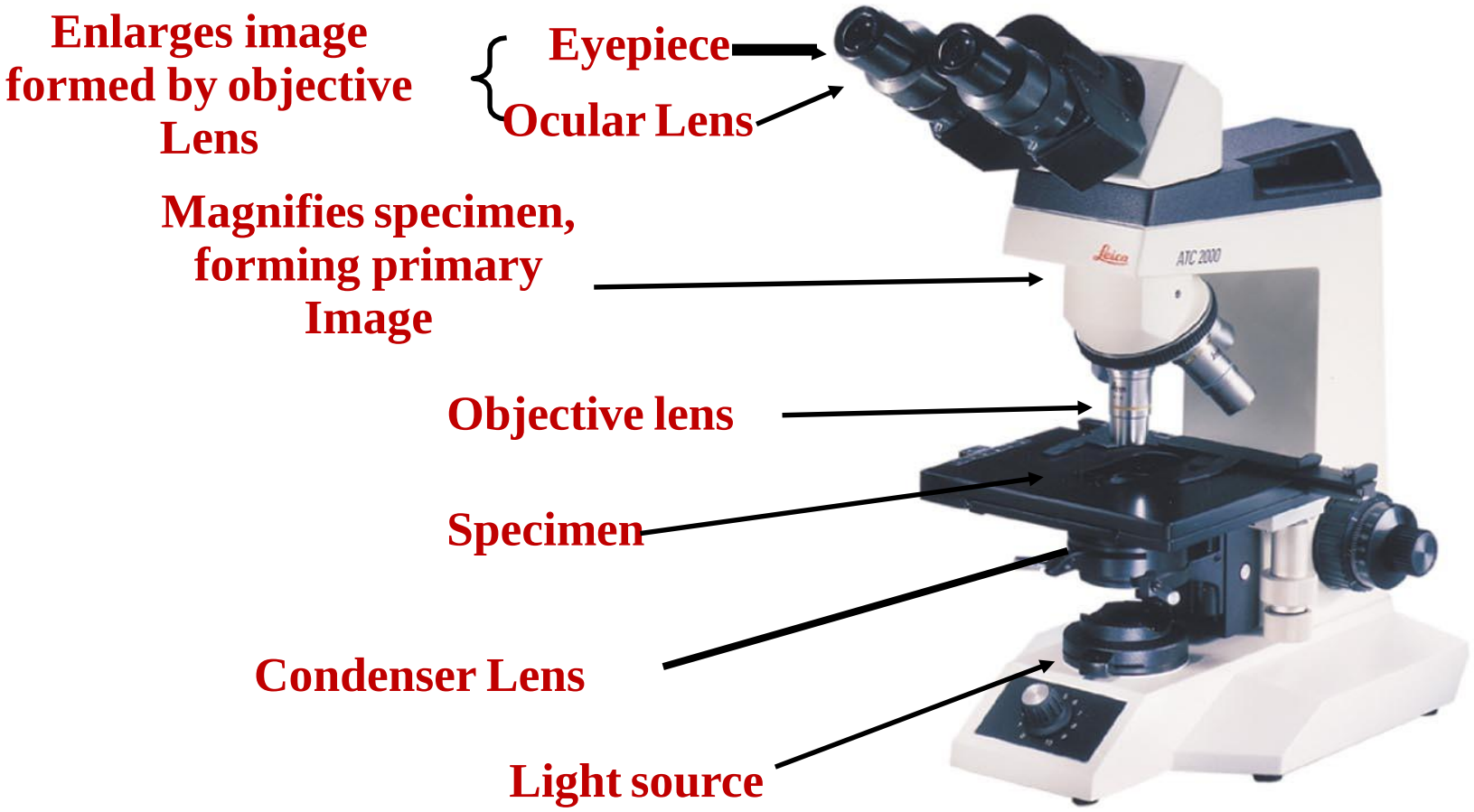
- The most frequently used microscope is the light microscope (LM) — like the one used in biology laboratories

- Light passes through a specimen then through glass lenses into the viewer's eye

- Specimens can be magnified up to 1,000 times the actual size of the specimen

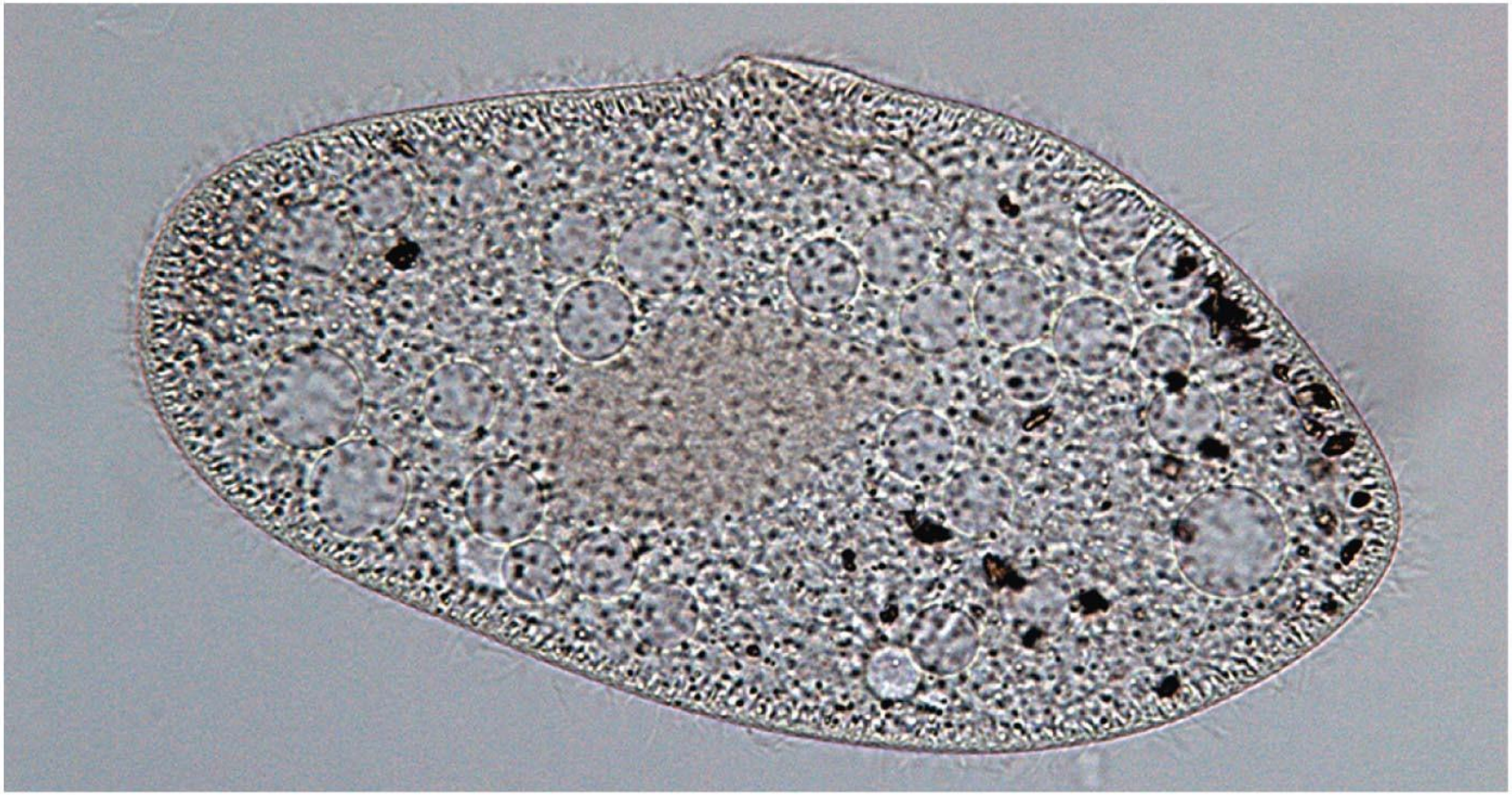
Microscopes

Light microscope (LM)



Microscopes

Light Micrograph (LM) of a protist, *Paramecium*.



Microscopes reveal the world of the cell

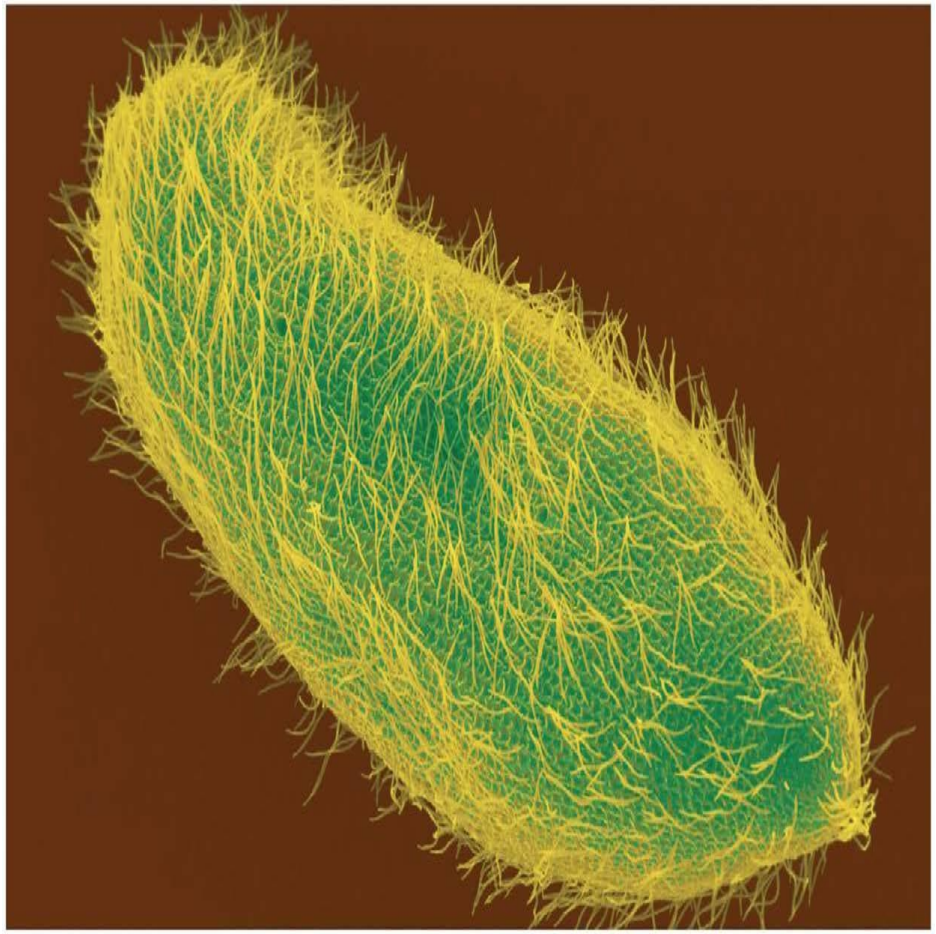
- **Biologists often use a very powerful microscope called the electron microscope (EM) to view the ultrastructure of cells**

- **It can resolve biological structures as small as 2 nanometers (nm) and can magnify up to 100,000 times**

- **Instead of light, the EM uses a beam of electrons**

Microscopes

Scanning Electron Micrograph (SEM) of *Paramecium*



Transmission Electron Micrograph (TEM) of *Paramecium*

Most cells are microscopic

- **The surface area of a cell is important for carrying out the cell's functions, such as acquiring adequate nutrients and oxygen**
  - **A small cell has more surface area relative to its cell volume and is more efficient**

Number of Cells

Organisms may be:

1) ***Unicellular*** **– composed of one cell like bacteria**

2) ***Multicellular*** **- composed of *manycells* that may organize**

Type of Cells

There are two major types of cells

1. **Prokaryotic cells include bacteria & lack a nucleus or membrane-bound structures called organelles**

2. **Eukaryotic cells include most other cells & have a nucleus and membrane-bound organelles (plants, fungi, & animals)**

Cells are the structural and functional units of life

Prokaryotic cells

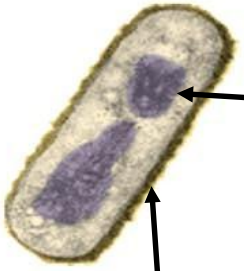
1) **Genetic material is not surrounded by a nuclear membrane**
2) **Simple and small**
3) **No membrane-bound organelles**
4) **Single celled organisms.**
5) **Bacteria and Archaea**

Eukaryotic cells

1) **Genetic material is surrounded by a nuclear membrane**
2) **Possess organelles surrounded by membranes**
3) **Plants, animals, and fungi are eukaryotic**

Prokaryotic cell

Eukaryotic cell



DNA
(no nuclear envelop)

Membrane

Contrasting the size and complexity of prokaryotic and eukaryotic cells

Nucleus
(contains DNA surrounded by nuclear membrane)

Organelles

Prokaryotic cells are structurally simpler than eukaryotic cells

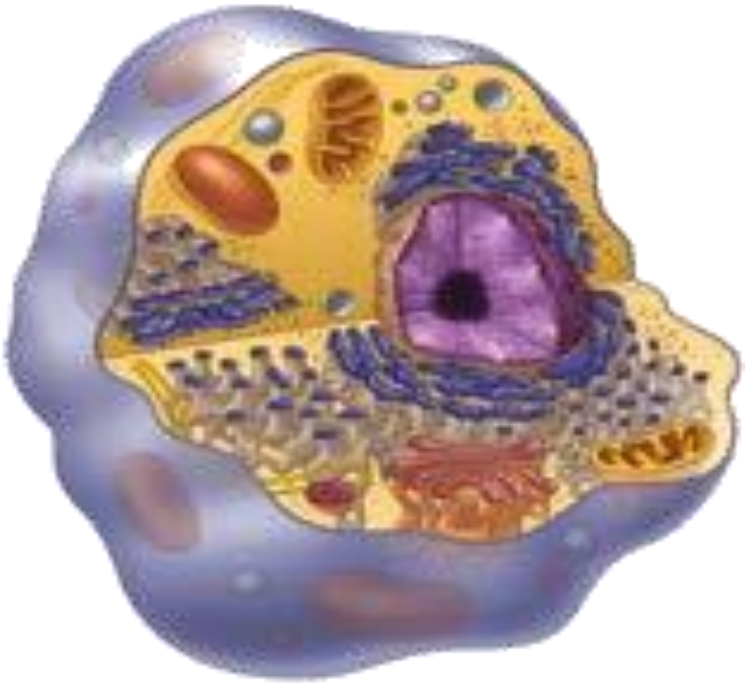
Bacteria and Archaea have prokaryotic cells All other forms of life have eukaryotic cells

- **Both prokaryotic and eukaryotic cells have a plasma membrane and one or more chromosomes and ribosomes**
- **Eukaryotic cells have a membrane-bound nucleus and a number of other organelles, whereas prokaryotes have a nucleoid and no true organelles**

Eukaryotic Cell

Contains 3 basic cell structures:

1) **Cell Membrane**
1) **Nucleus**
2) **Cytoplasm with organelles**



Organelles

1) Very small (Microscopic)

2) Perform various functions for a cell

3) Found in the cytoplasm

4) May or may not be membrane-bound

Organelles Found in Cells: Examples of Organelles include:

1) Endoplasmic reticulum (rough & smooth) Function in Synthesis of cell products & Transport

2) Golgi Bodies: wrap & export proteins

3) Nucleolus: makes ribosomes

4) Lysosomes: digest & get rid of wastes

5) Ribosomes: make proteins

Eukaryotic cells

There are four life processes in eukaryotic cells that depend upon structures and organelles

1) **Manufacturing**

2) **Breakdown of molecules**

3) **Energy processing**

4) **Structural support, movement, and communication**

Cell Structures

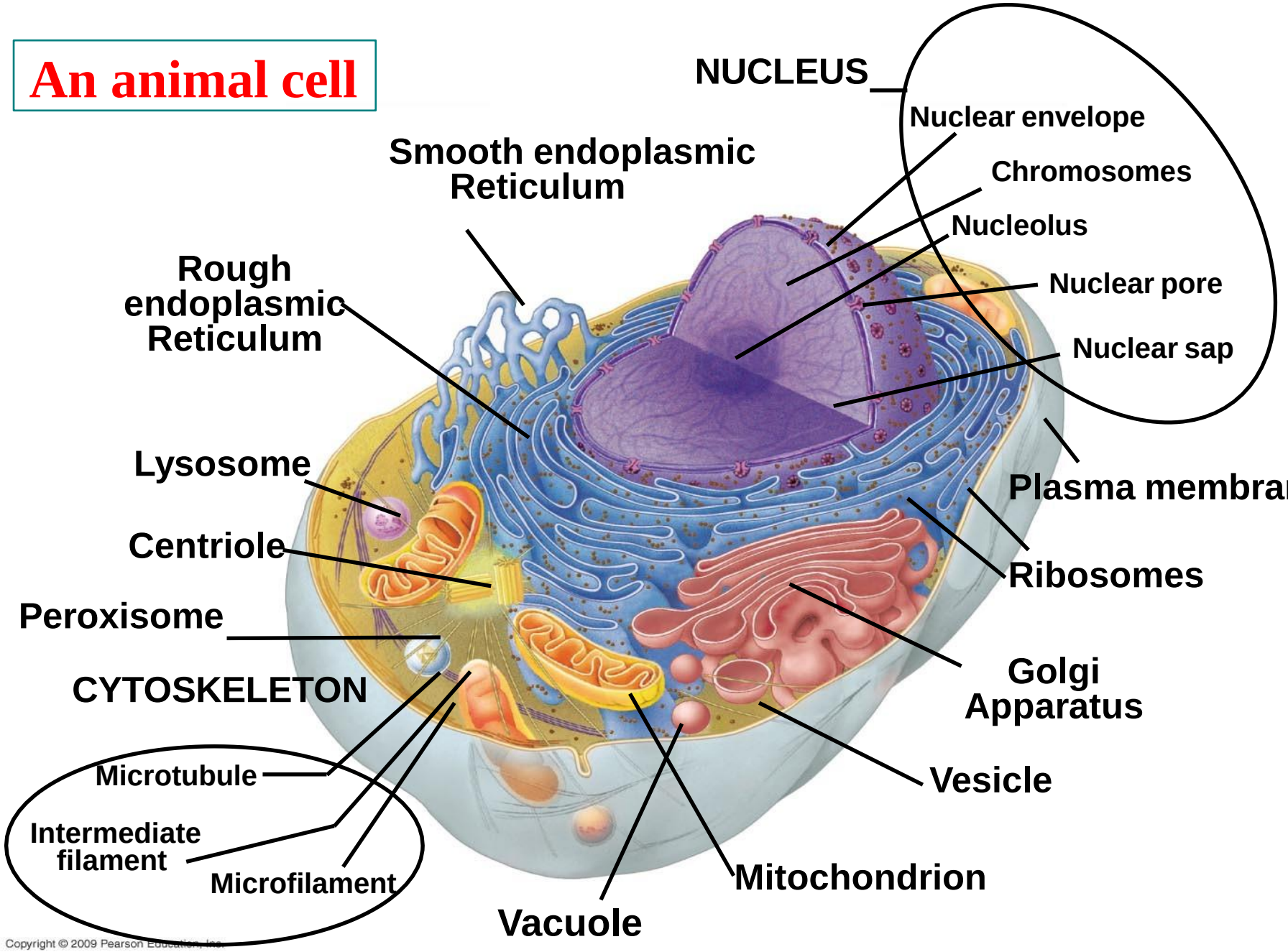
1. Plasma membrane
2. Nucleus
3. Cytoplasm with organelles

An animal cell

Organelles

1. Ribosomes
2. Endoplasmic Reticulum – ER
3. Golgi apparatus
4. Lysosomes
5. Mitochondria
6. Cytoskeleton
7. Vacuoles
8. Vesicles
9. Centrioles

An animal cell



The structure of plasma membranes

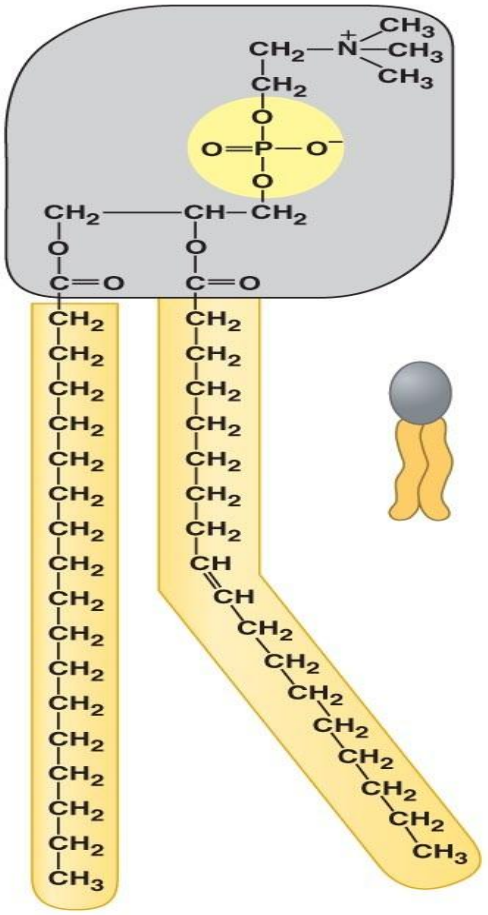
The plasma membrane controls the movement of molecules into and out of the cell, a trait called Selective Permeability

The structure of the membrane with its component molecules is responsible for this characteristic

Membranes are made of lipids, proteins, and some carbohydrates, but the most abundant lipids are phospholipids

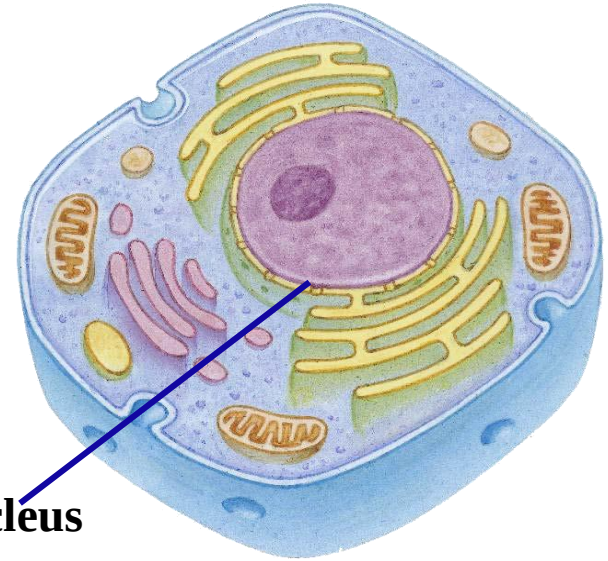
Phospholipids

- 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)



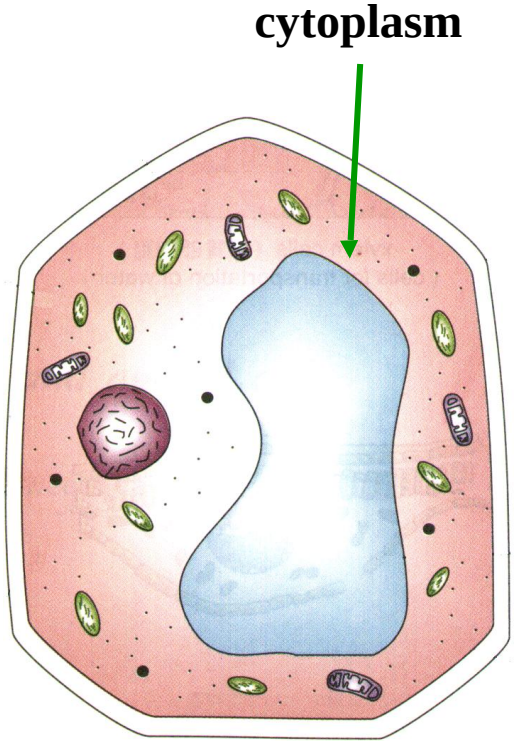
Nucleus

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



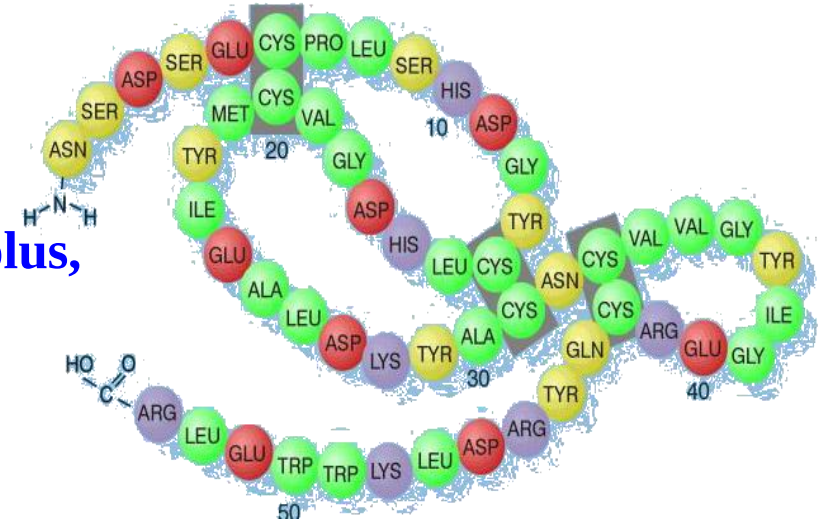
Cytoplasm

- Jelly-like substance enclosed by cell membrane
- Provides a medium for chemical reactions to take place
- Contains organelles to carry out specific jobs
- Found in ALL cells



Organelles: Ribosomes

- Made of Proteins and rRNA
- Ribosomes are synthesized in the nucleolus, which is found in the nucleus
- "Protein factories" for cell
- Join amino acids to make proteins, Process called protein synthesis
- Cells that synthesize large amounts of protein have a large number of ribosomes



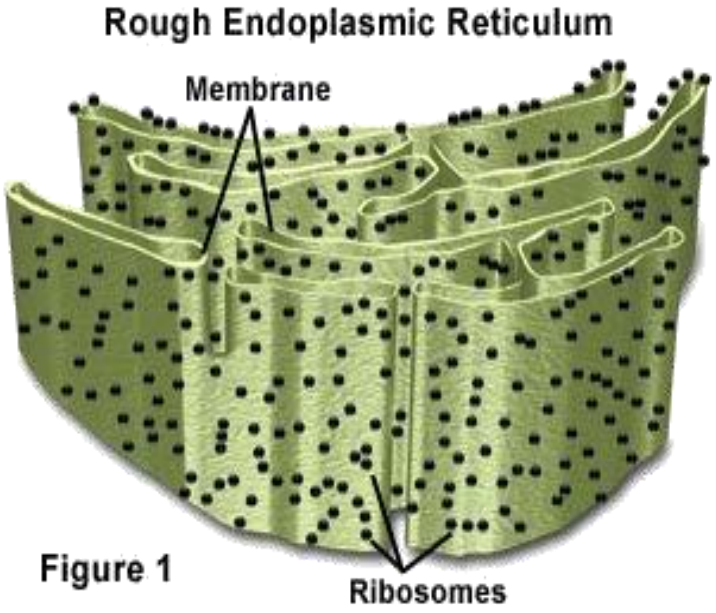
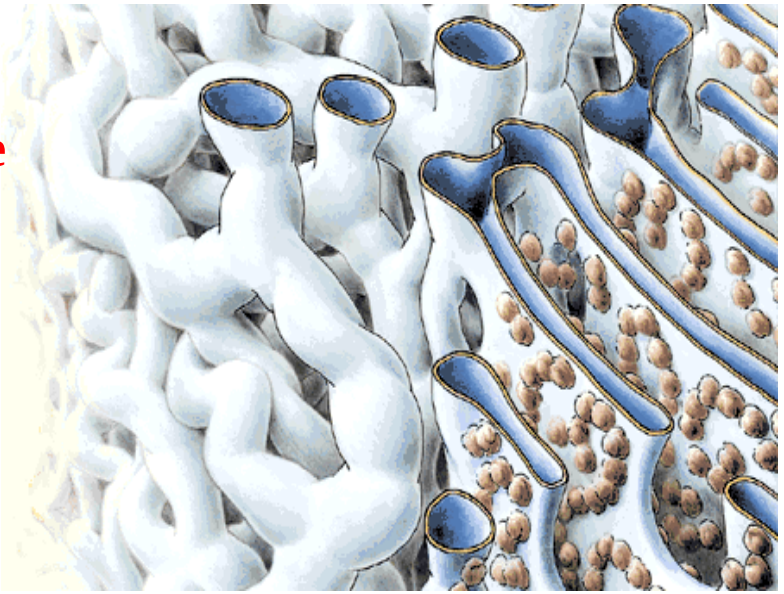


Figure 1

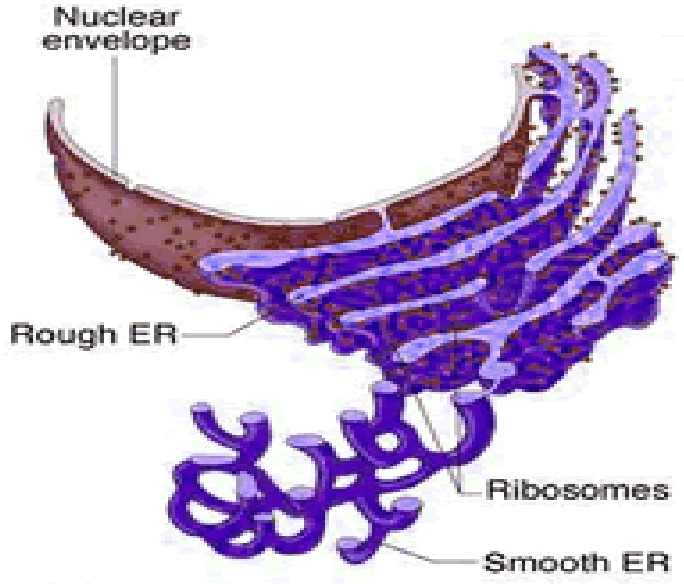
Endoplasmic Reticulum - ER

- Network of hollow membrane tubules
- Connect to nuclear envelope & cell membrane
- Function in Synthesis of cell products & Transport



Smooth & Rough Endoplasmic Reticulum

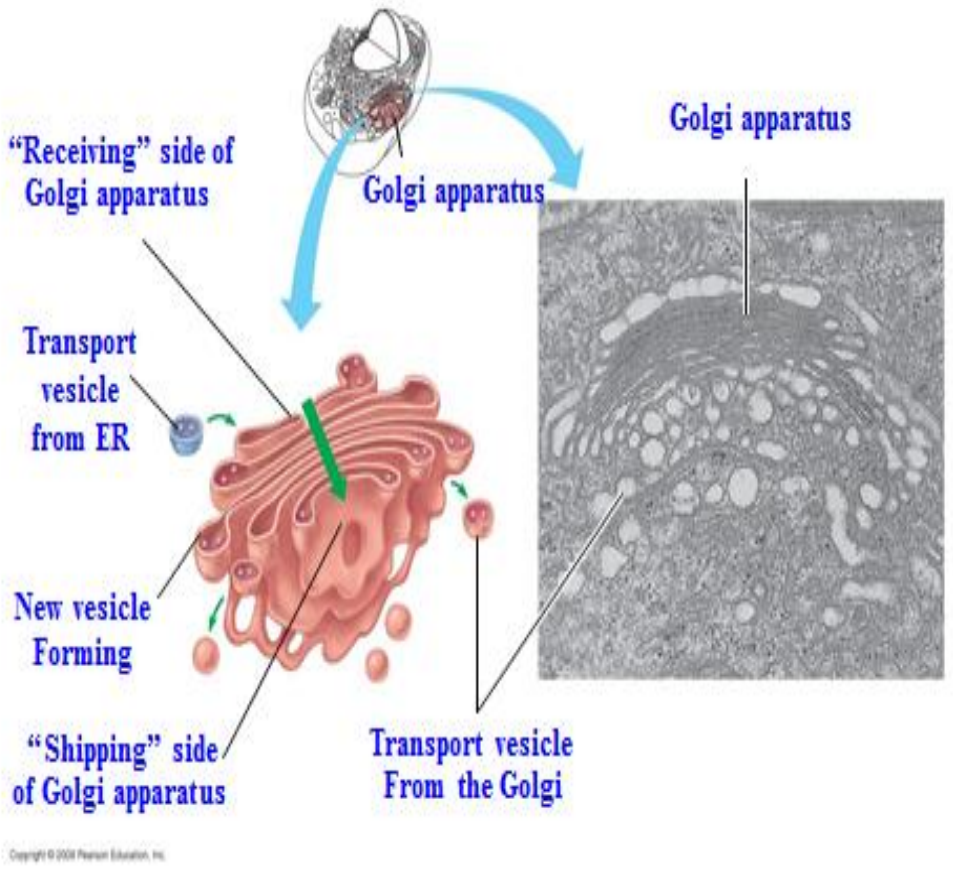
- There are two kinds of endoplasmic reticulum - smooth and rough
- *Smooth ER* lacks ribosomes
- *Rough ER* has ribosomes on its surface



The Golgi apparatus

- The Golgi apparatus is Stacks of flattened sacs
- Functions in conjunction with the ER
- Receive & modify proteins made by ER

- Products travel in transport vesicles from the ER to the Golgi apparatus
- Products are modified as they go from one side of the Golgi apparatus to the other and travel in vesicles to other sites

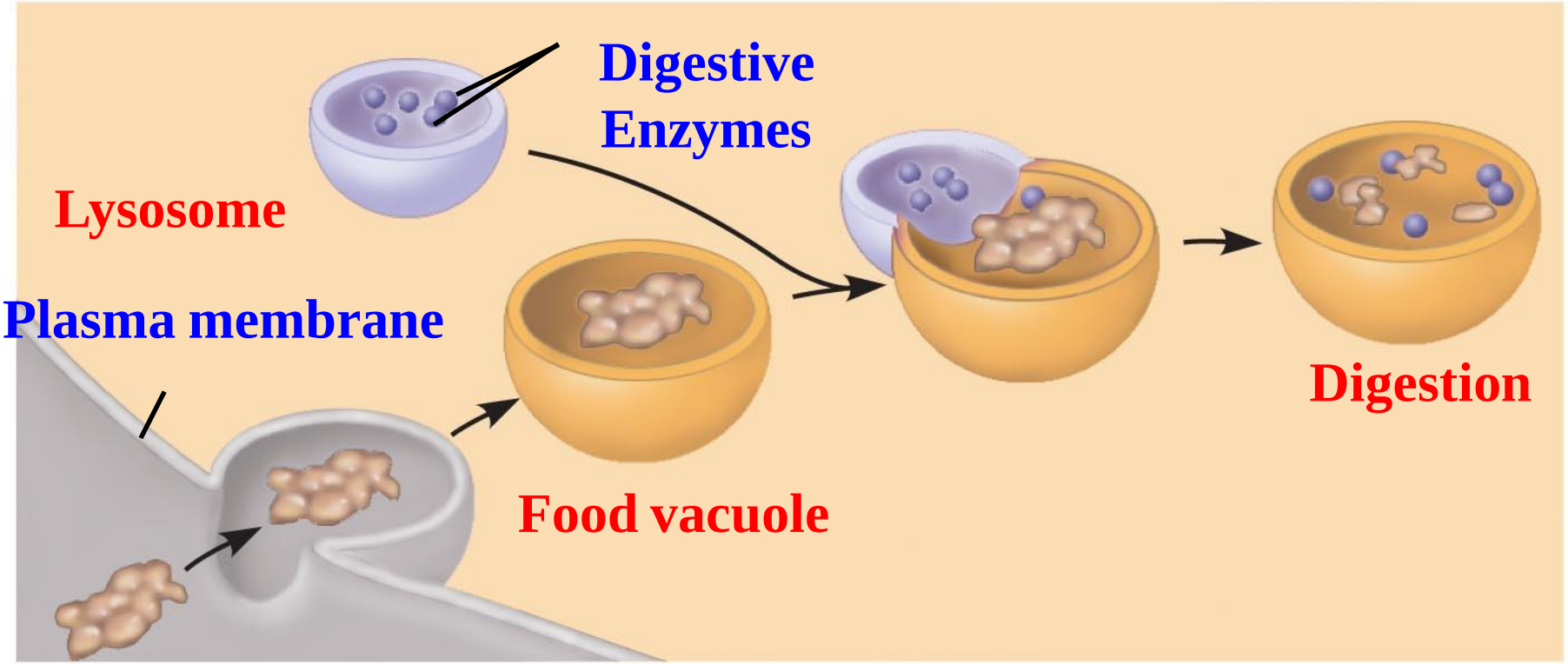


Lysosomes

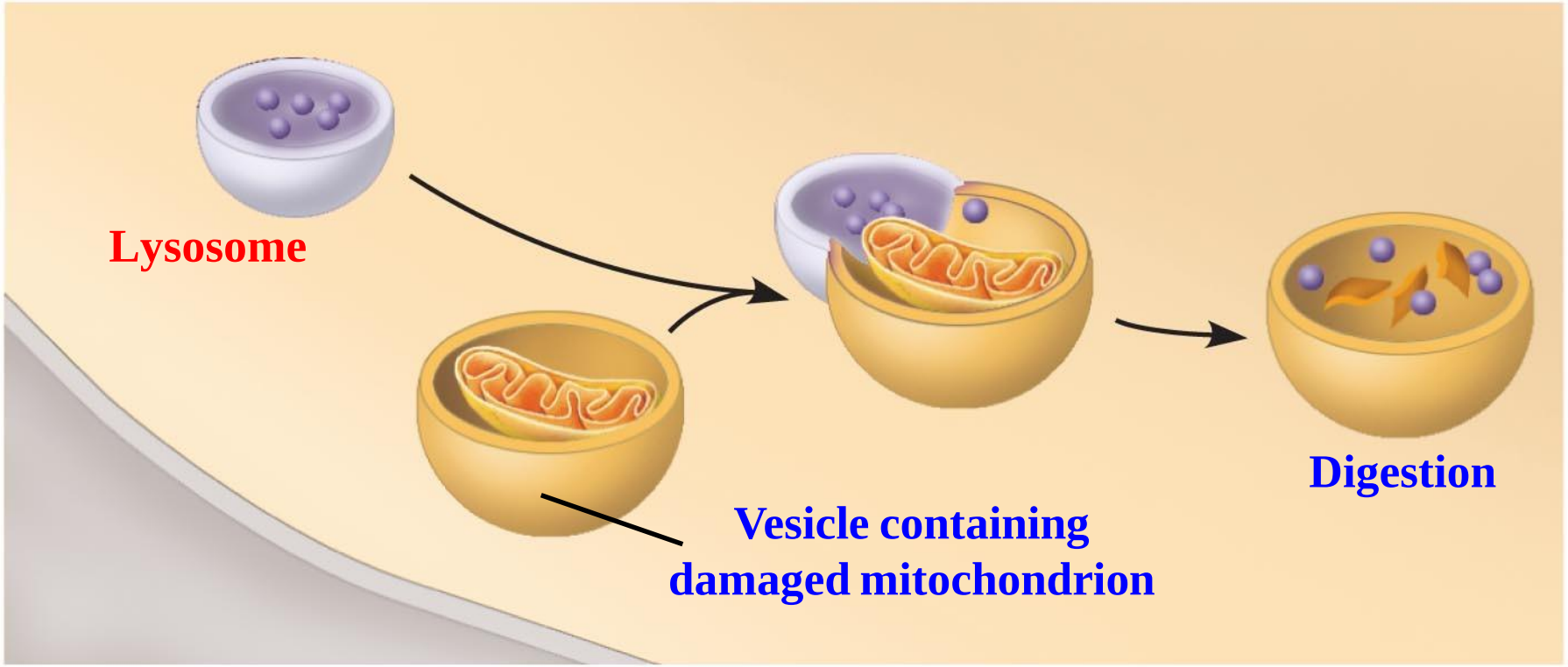
- A lysosome is a membranous sac;
- Contains digestive enzymes
- Breaks down food, bacteria, and worn out cell parts
- Breaks down and recycles cell parts

Lysosomes are digestive compartments

- The enzymes and membrane are produced by the ER and transferred to the Golgi apparatus for processing
- The membrane serves to safely isolate these potent enzymes from the rest of the cell
- One of the several functions of lysosomes is to remove or recycle damaged parts of a cell
  - The damaged organelle is first enclosed in a membrane vesicle
  - Then a lysosome fuses with the vesicle, dismantling its contents and breaking down the damaged organelle



Lysosome fusing with a food vacuole and digesting food



Lysosome fusing with vesicle containing damaged organelle and digesting and recycling its contents

Mitochondria

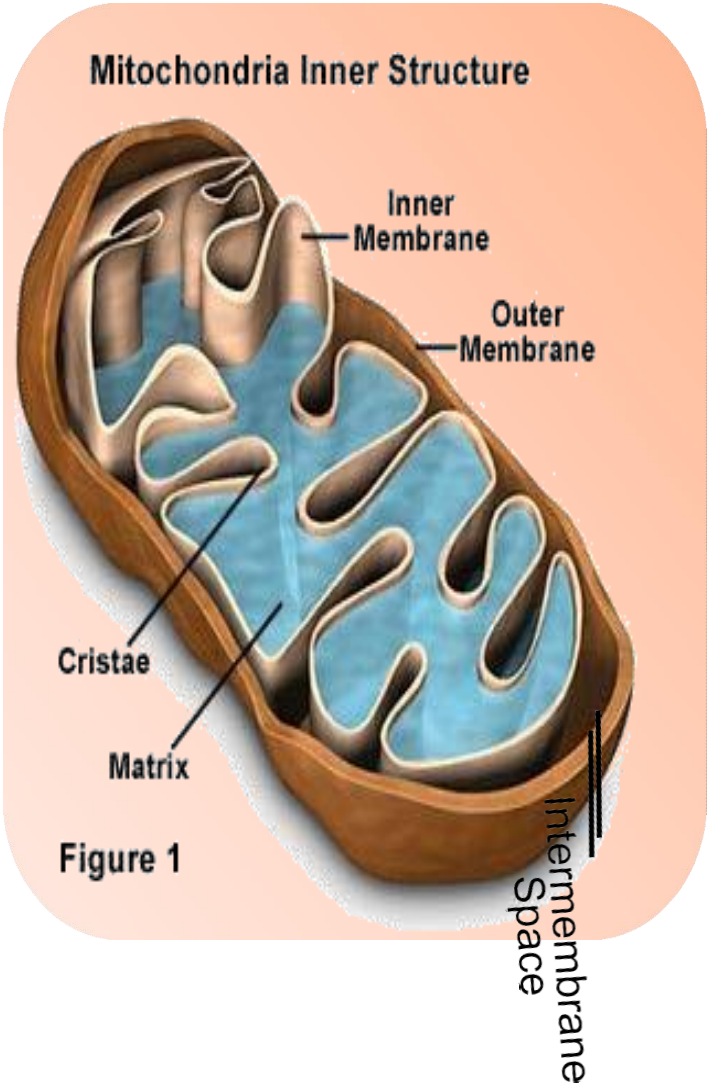
- "Powerhouse" of the cell
- Generate cellular energy (adenosine triphosphate) (ATP)
- More active cells like muscle cells have more mitochondria
- Both plants & animal cells have mitochondria
- Site of cellular respiration (burning glucose)

-Surrounded by a DOUBLE membrane

-Has its own DNA

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

Interior called matrix



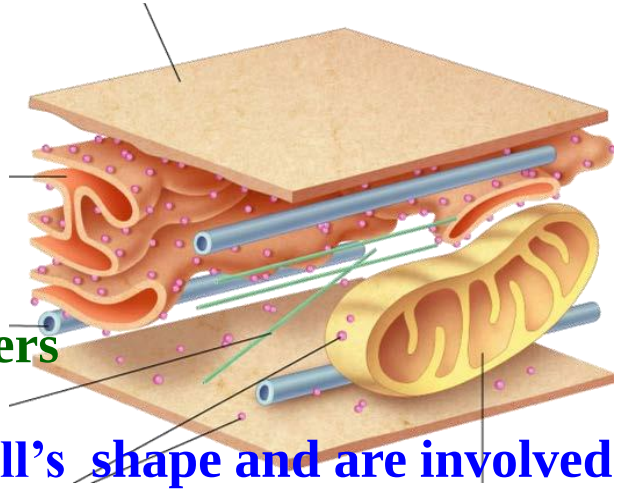
Mitochondria harvest chemical energy from food

- **Cellular respiration is accomplished in the mitochondria of eukaryotic cells**
  - **Cellular respiration involves conversion of chemical energy in foods to chemical energy stored in ATP (adenosine triphosphate)**
  - **Mitochondria have two internal compartments**
  - **The intermembrane space, which encloses the mitochondrial matrix where materials necessary for ATP generation are found**

Cytoskeleton

❖ Cells contain a network of protein fibers, called the cytoskeleton, that functions in

- Helps cell maintain cell shape
- Also, helps move organelles around



- The cytoskeleton is composed of three kinds of fibers
  - Microfilaments (*actin filaments*) support the cell's shape and are involved in motility made of *ACTIN*
  - Intermediate filaments reinforce cell shape and anchor organelles
  - Microtubules (made of *TUBULIN*) shape the cell and act as tracks for motor protein

Vacuoles

- **Vacuoles are membranous sacs that are found in a variety of cells and possess an assortment of functions**
- some animal cells have small vacuoles
  - **Examples are the central vacuole in plants with hydrolytic functions**
  - **Contractile vacuoles in some cells to expel water from the cell**

Vesicles

Vesicles are small compartments separated from the cytosol by at least one lipid bilayer.

- Store, transport, or digest cellular products and waste.
- Vesicles form while taking in (endocytosis) or discharging (exocytosis) materials.
- REVIEW: Animation on endocytosis and exocytosis.

Centrioles

- used during cell division to move and separate chromosomes

- only found in animal cells