Unit I: Biomolecules in their Cellular Environment

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SEMESTER-3

C5 GENERAL BIOCHEMISTRY

Paper Code (BBT 3001)

(Credits: Theory-4, Practicals-2)

THEORY Lectures: 40

Unit 1 Biomolecules in their cellular environment (05 lectures)

The cellular basis of life. Cellular structures — prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water in design of biomolecules.

Unit 2 Amino acids and peptides (05 lectures)

Types of amino acids and their chemistry, derivatives of amino acids and their biological role. Introduction to biologically important peptides. h

Unit 3 Sugars and polysaccharides (05 lectures)

Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role.

Unit 4 Nucleosides, nucleotides and nucleic acids (05 lectures)

Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

Unit 5 Lipids (10 lectures)

Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments.

Unit 6 Vitamins, coenzymes and metal ions (05 lectures)

Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7 Signalling molecules (05 lectures)

Second messengers - cAMP, cGMP, IP3, diacyl glycerol, Ca2+, NO. Brief account of their importance and role in signalling and signal transduction.

Overview

- Introduction to Cellular Basis of Life
- Cell structures – Prokaryotes and Eukaryotes
- Chemical principles in biomolecular structure
- Major Classes of biomolecules
- Role of water in design of biomolecules

Introduction to Cellular Basis of Life

Facts Known:

- ✓ The average of human being is composed of around 100 Trillion individual Cells.
- ✓ Each cells has 10,000 times as many molecules as the Milky Way has stars.
- ✓ Three hundred- million cells die in the human body every minute

Cellular Foundations

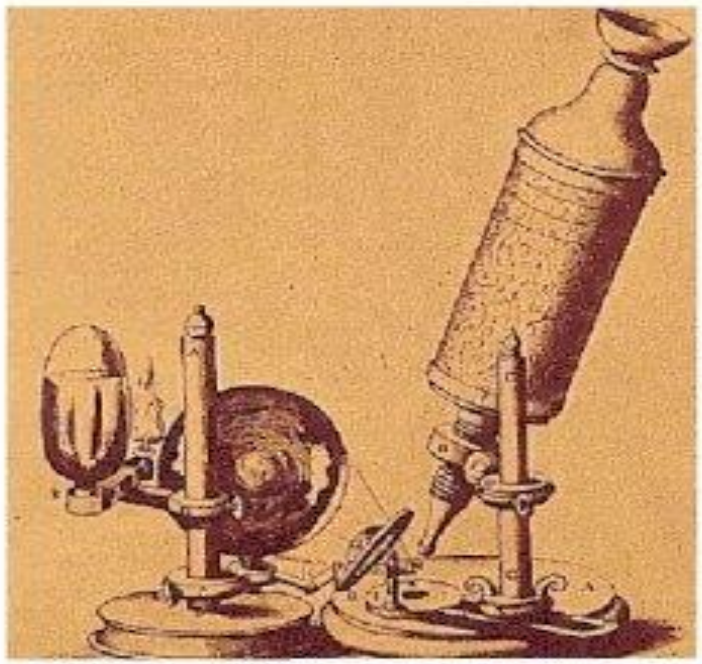
- ✓ The unity and diversity of organisms become apparent even at the cellular level. The smallest organisms consist of single cells and are microscopic.
- ✓ Larger, multicellular organisms contain many different types of cells, which vary in size, shape, and specialized function.
- ✓ Despite these obvious differences, all cells of the simplest and most complex organisms share certain fundamental properties, which can be seen at the biochemical level.

Cells of all kinds share certain structural features:

- ✓ The **plasma membrane** defines the periphery of the cell, separating its contents from the surroundings.
- ✓ It is composed of lipid and protein molecules that form a thin, tough, pliable, hydrophobic barrier around the cell.
- ✓ The membrane is a barrier to the free passage of inorganic ions and most other charged or polar compounds.
- ✓ Transport proteins in the plasma membrane allow the passage of certain ions and molecules; receptor proteins transmit signals into the cell; and membrane enzymes participate in some reaction pathways.
- ✓ Because the individual lipids and proteins of the plasma membrane are not covalently linked, the entire structure is **remarkably flexible**, allowing changes in the shape and size of the cell.
- ✓ As a **cell grows**, newly made lipid and protein molecules are inserted into its plasma membrane; cell division produces two cells, each with its own membrane.
- ✓ This growth and cell division (fission) occurs without loss of membrane integrity

Discovery of Cells

- 1665- English Scientist, **Robert Hooke**, discovered cells while looking at a thin slice of cork.
- He described the cells as tiny boxes or a honeycomb
- He thought that cells only existed in plants and fungi



Anton van Leuwenhoek

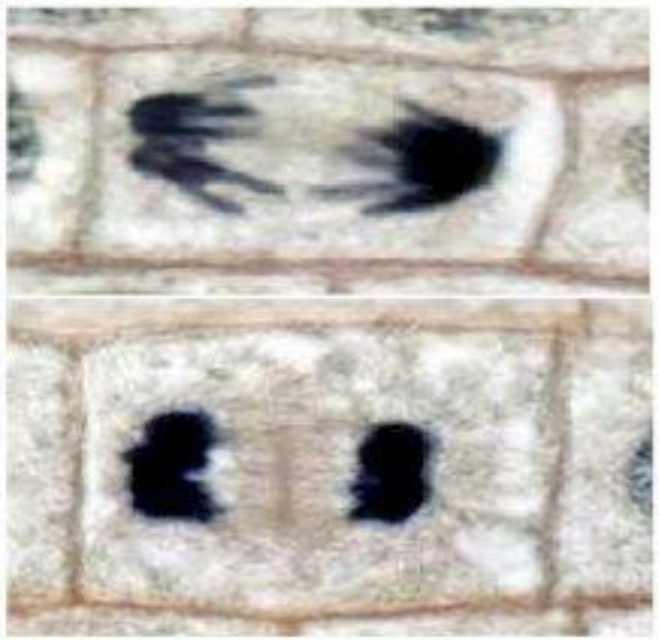
- 1673- Used a handmade microscope to observe pond scum & discovered single-celled organisms
- He called them *"animalcules"*
- He also observed blood cells from fish, birds, frogs, dogs, and humans
- Therefore, it was known that cells are found in animals as well as plants
- Father of Microscopy

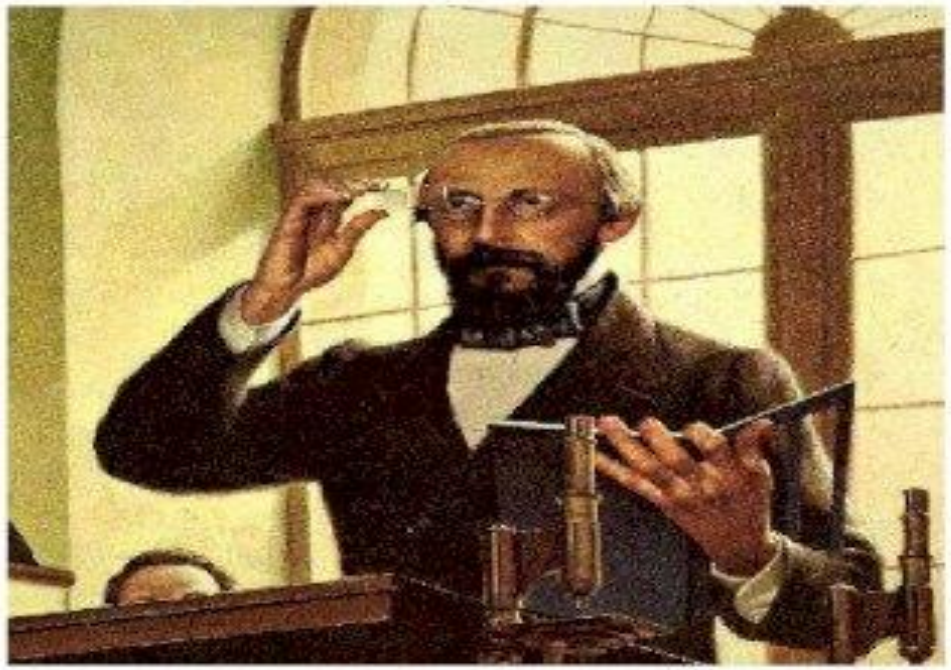
Development of Cell Theory

- 1838- German Botanist, **Matthias Schleiden**, concluded that all plant parts are made of cells
- 1839- German physiologist, **Theodor Schwann**, who was a close friend of Schleiden, stated that all animal tissues are composed of cells.

Development of Cell Theory

- 1858- **Rudolf Virchow**, German physician, after extensive study of cellular pathology, concluded that cells must arise from preexisting cells.



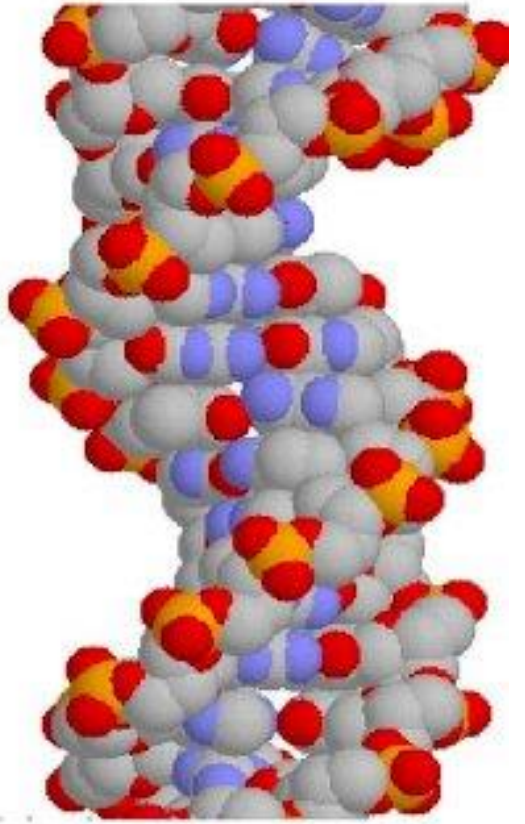


The Cell Theory

- ✓All organisms are composed of one or more cells. – Schleiden and Schwann (1838-39)
- ✓The cell is the basic unit of life in all living things. – Schleiden and Schwann (1838-39)
- ✓All cells are produced by the division of pre-existing cells. – Virchow (1858)

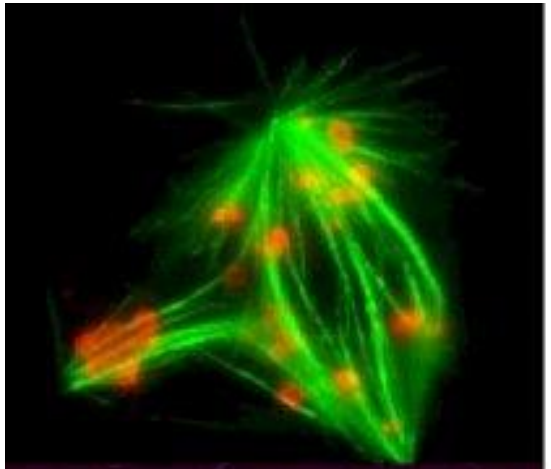
THIS IS IMPORTANT BECAUSE IT SHOWS THAT ALL LIVING THINGS SHARE A SIMILAR STRUCTURE

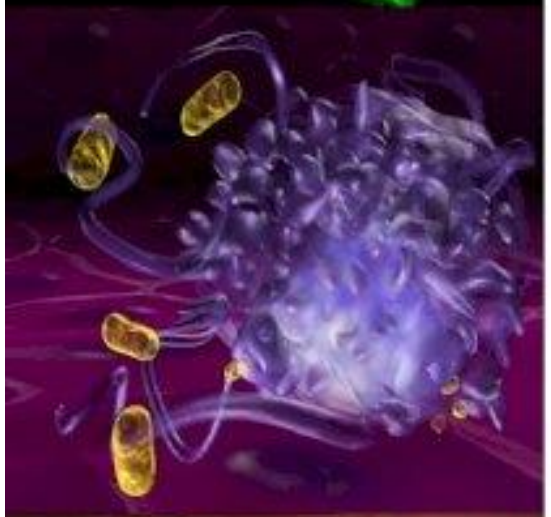
Modern Cell Theory

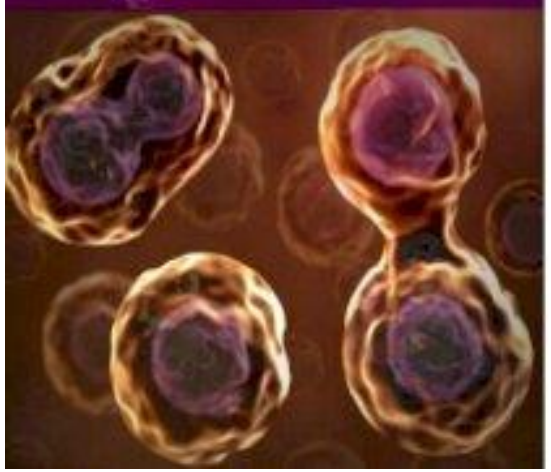


Modern Cell Theory contains 4 statements, in addition to the original Cell Theory:

1. The cell contains hereditary information(DNA) which is passed on from cell to cell during cell division.
2. All cells are basically the same in chemical composition and metabolic activities.







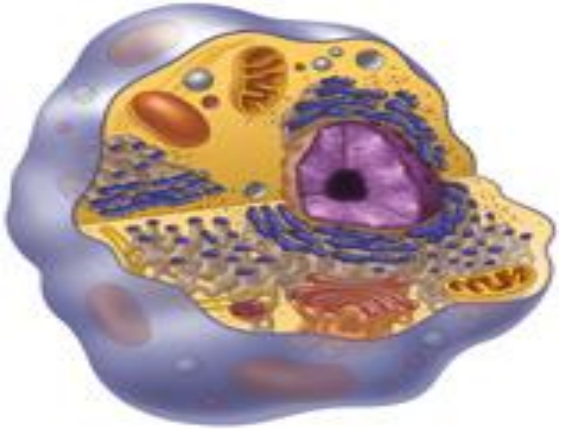
Modern Cell Theory

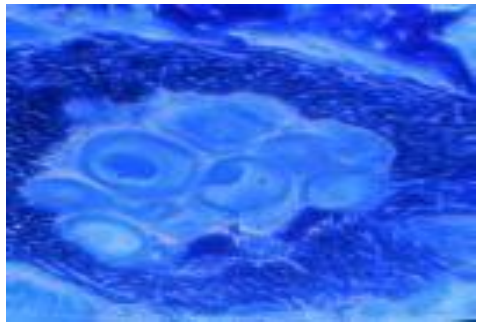
3. All basic chemical & physiological functions are carried out inside the cells.(movement, digestion,etc)

4. Cell activity depends on the activities of sub-cellular structures within the cell(organelles, nucleus, plasma membrane)

What limits the dimensions of a cell?

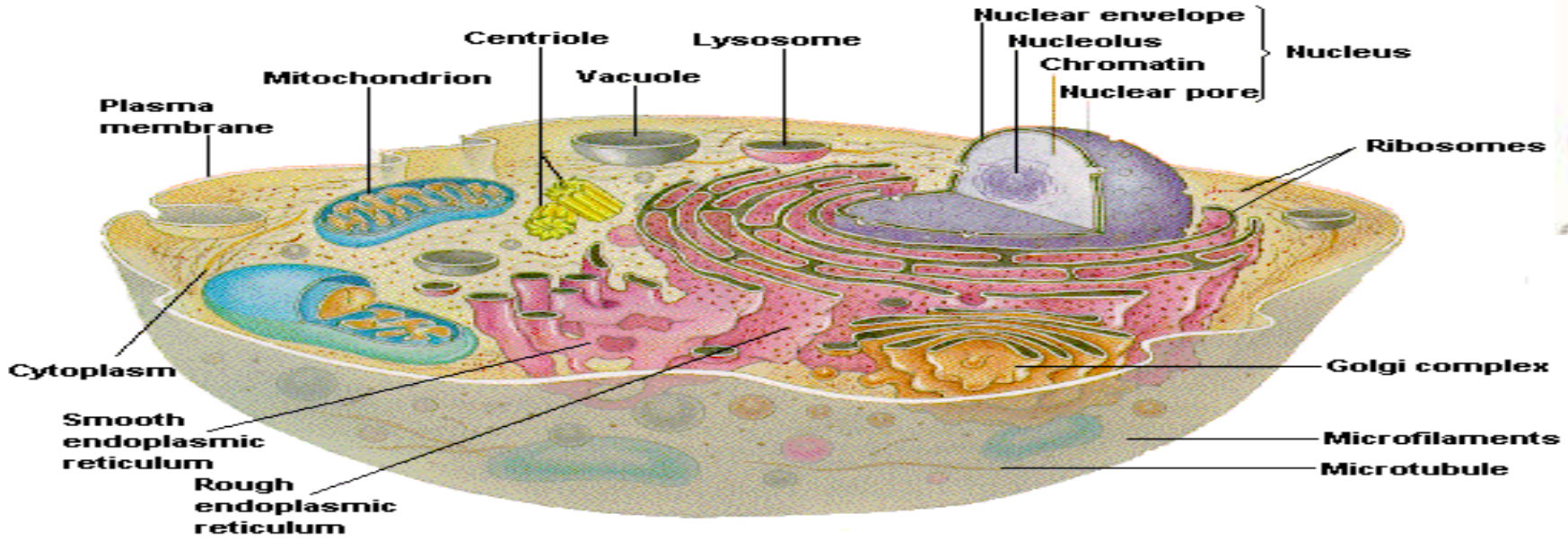
- ✓Most cells are microscopic, invisible to the unaided eye.
- ✓Animal and plant cells are typically 5 to 100 μm in diameter, and many bacteria are only 1 to 2 μm long.
- ✓The lower limit is probably set by the minimum number of each type of biomolecule required by the cell.
- ✓The smallest cells, certain bacteria known as mycoplasmas, are 300 nm in diameter and have a volume of about 10^{-14} mL.
- ✓A single bacterial ribosome is about 20 nm in its longest dimension, so a few ribosomes take up a substantial fraction of the volume in a mycoplasmal cell.



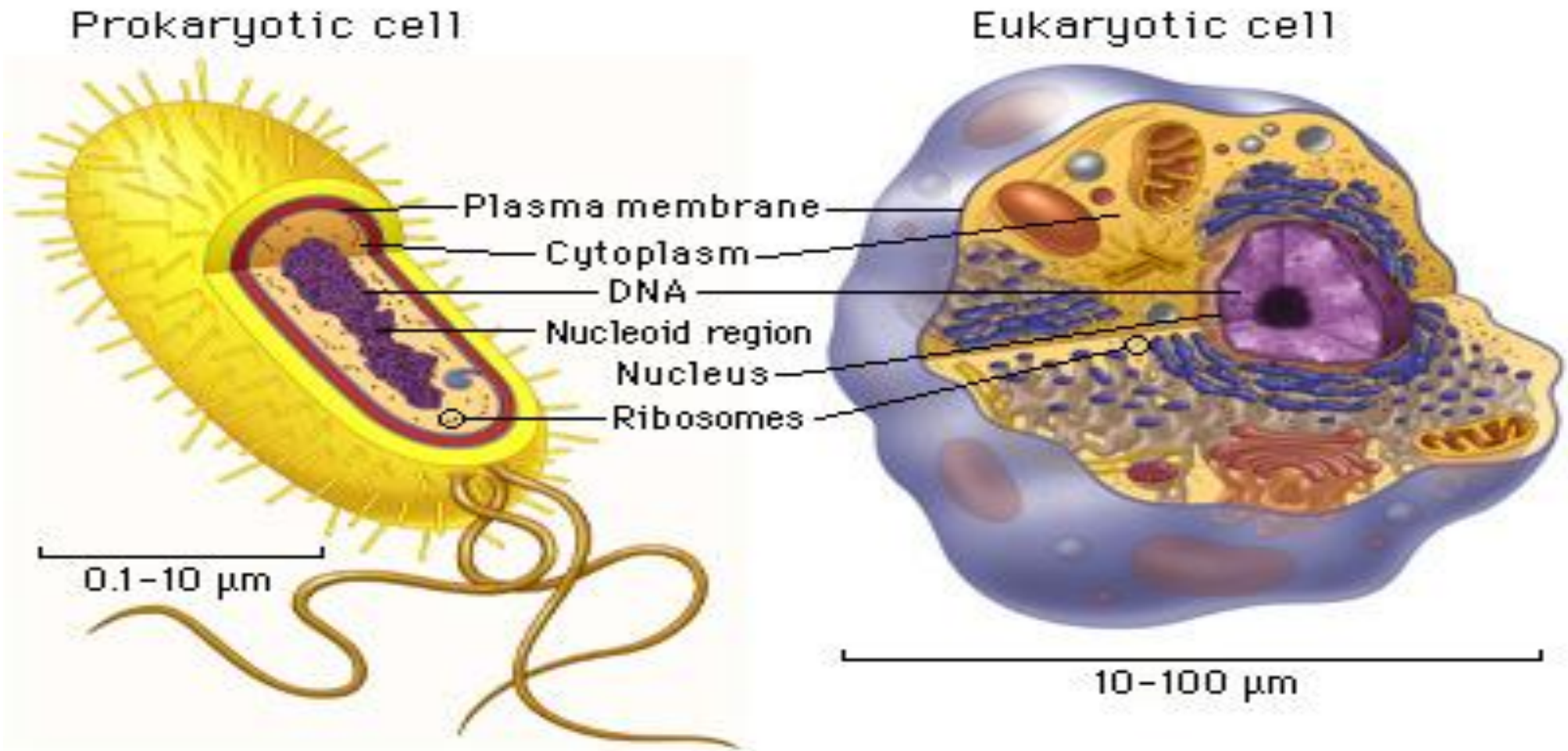


Cells:

The Basic Units of Life



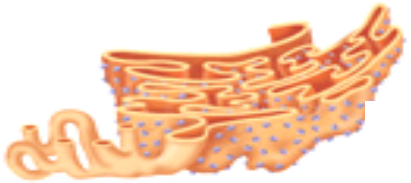
Two Types of Cells



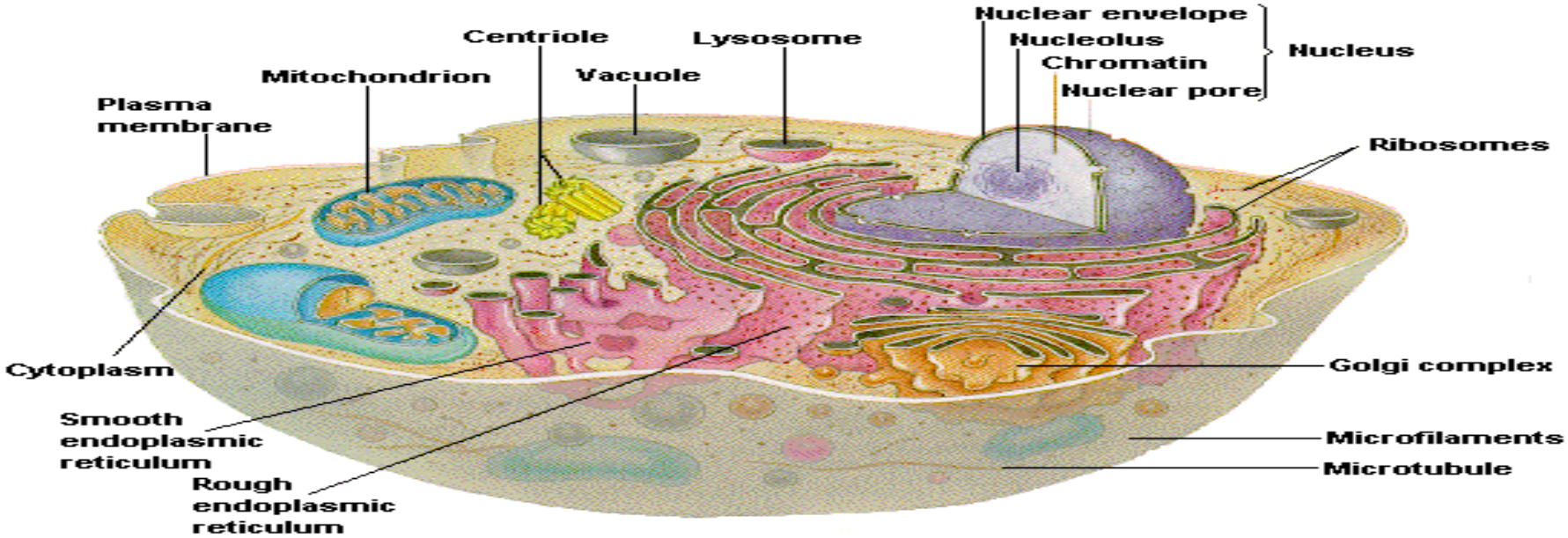
All cells, whether they are prokaryotic or eukaryotic, have some common features

Organelles



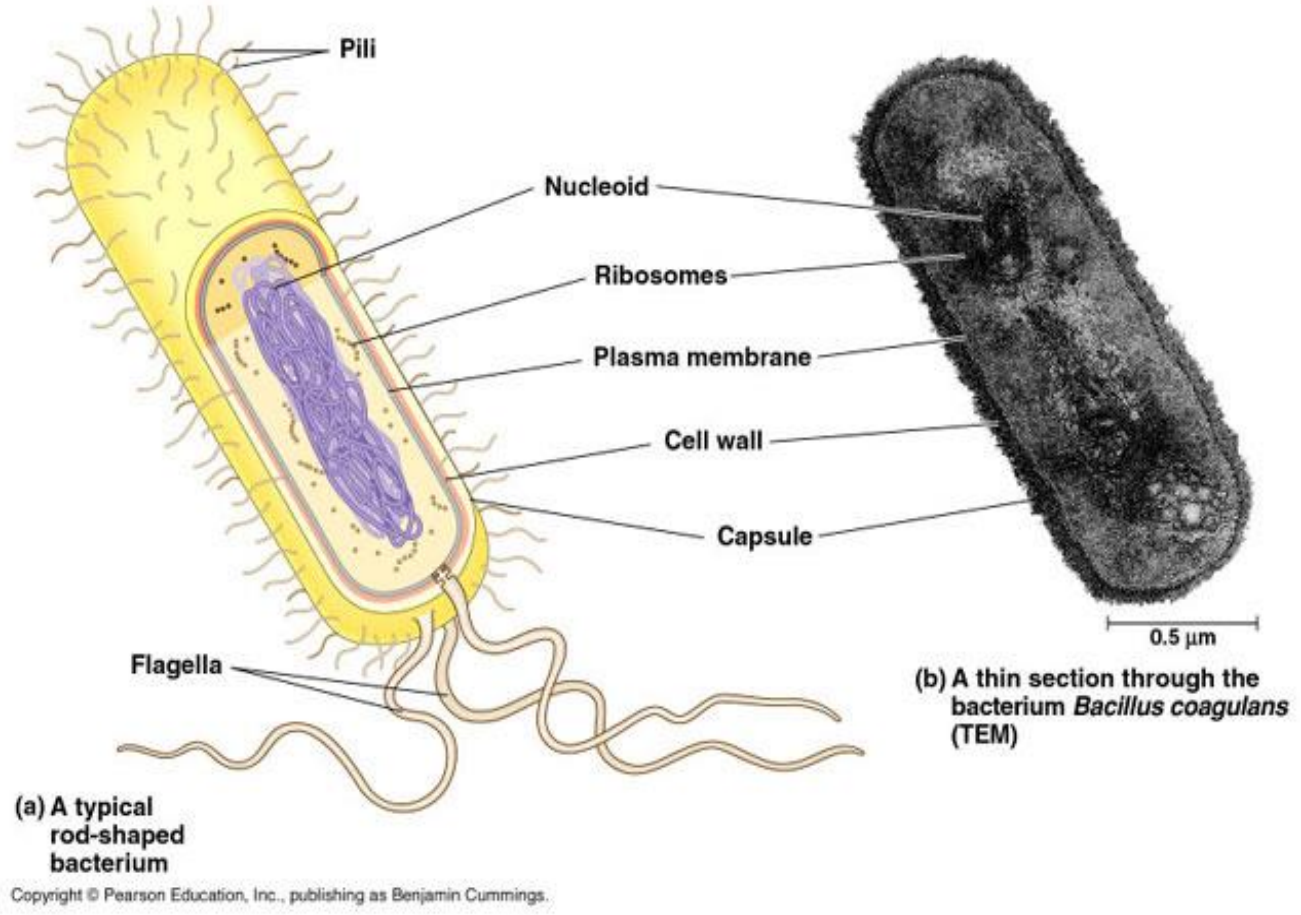

Organelles are structures that enable the cell to live, grow and reproduce.



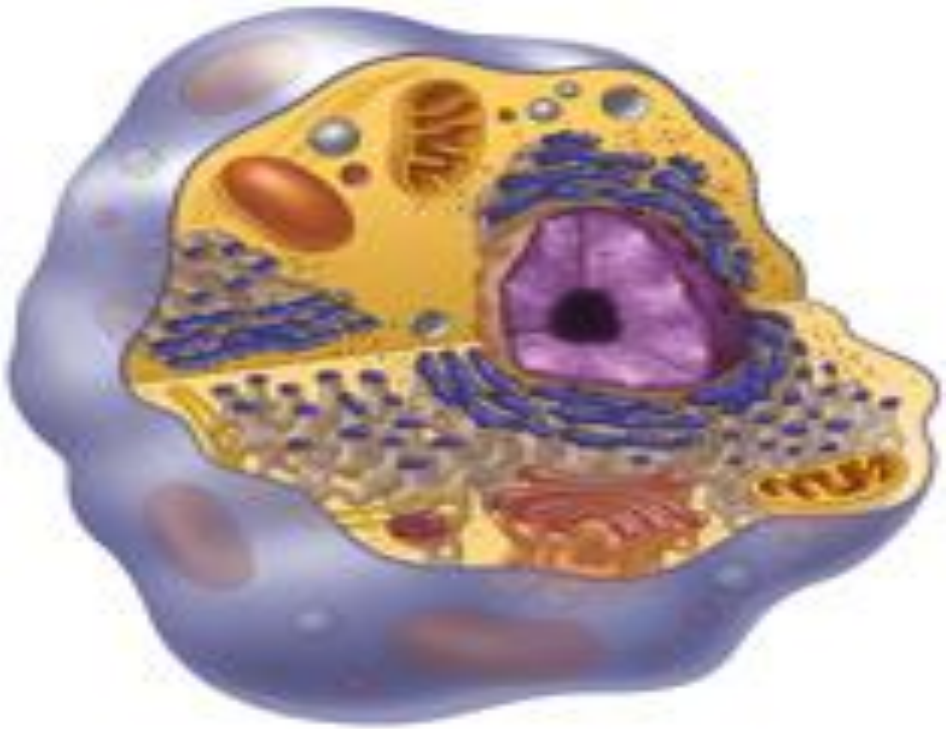
Two Types of Cells

Prokaryotic Cells:

- Have no membrane covered nucleus
- Have no membrane - covered organelles
- Have circular DNA
- Are bacteria



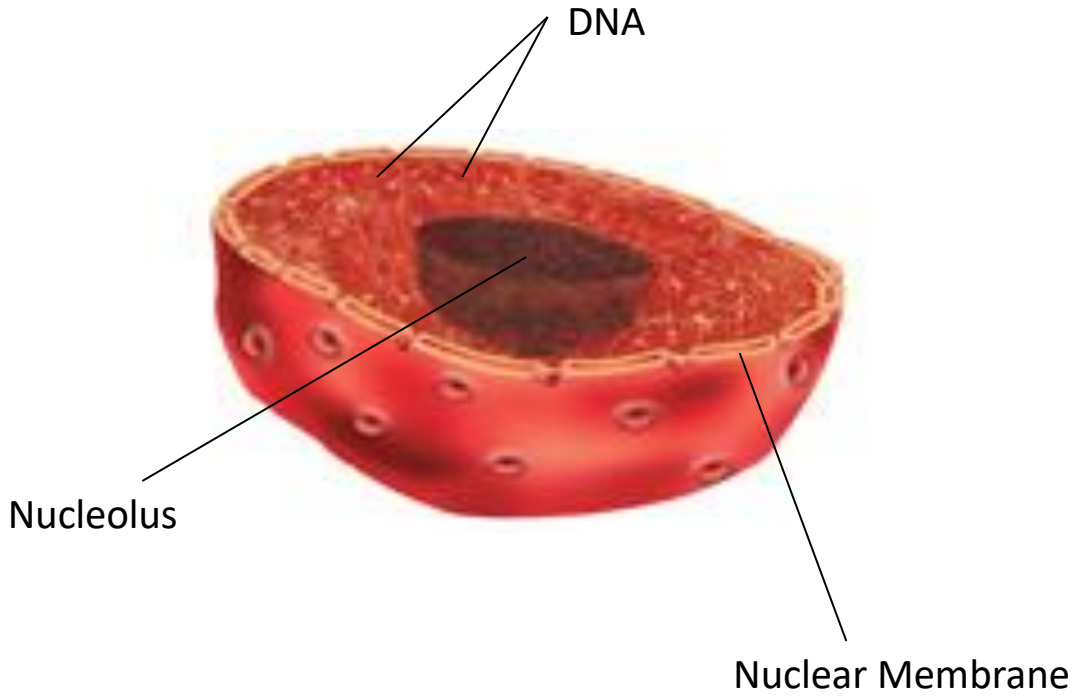
Two Types of Cells



Eukaryotic Cells:

- Have a nucleus
- Have a membrane - covered organelles
- Have linear DNA
- Are all other cells

The Nucleus

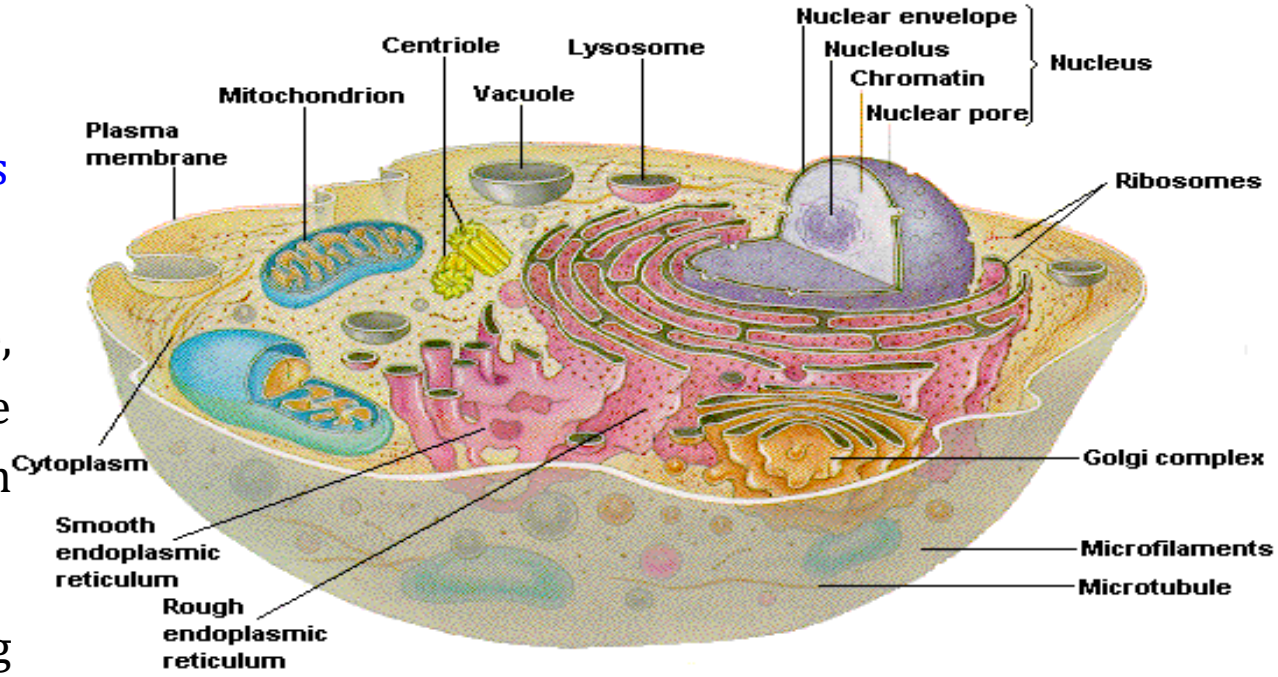


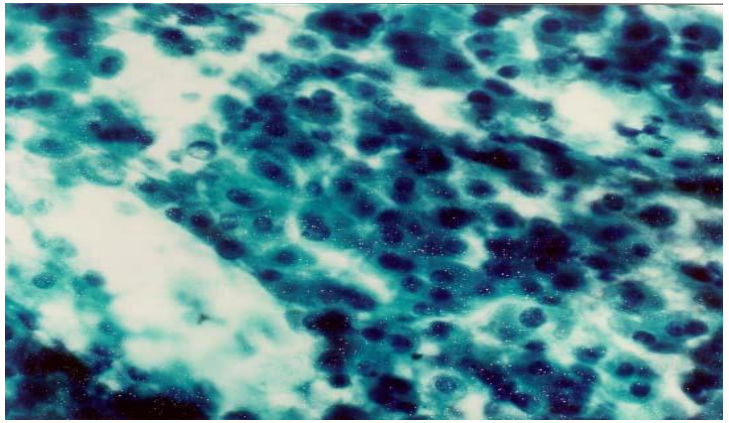
"Mayor's office"

- ✓ The control center of the cell
- ✓ Contains the Cell's DNA
- ✓ All cells have, for at least some part of their life, either a **nucleus** or a **nucleoid,** in which the **genome** the complete set of genes, composed of DNA—is stored and replicated.
- ✓ The nucleoid, in bacteria, is not separated from the cytoplasm by a membrane; the nucleus, in higher organisms, consists of nuclear material enclosed within a double membrane, the nuclear envelope.
- ✓ Cells with nuclear envelopes are called **eukaryotes** (Greek *eu,* "true," and *karyon,* "nucleus"); those without nuclear envelopes—bacterial cells—are **prokaryotes** (Greek *pro,* "before").

Cytoplasm

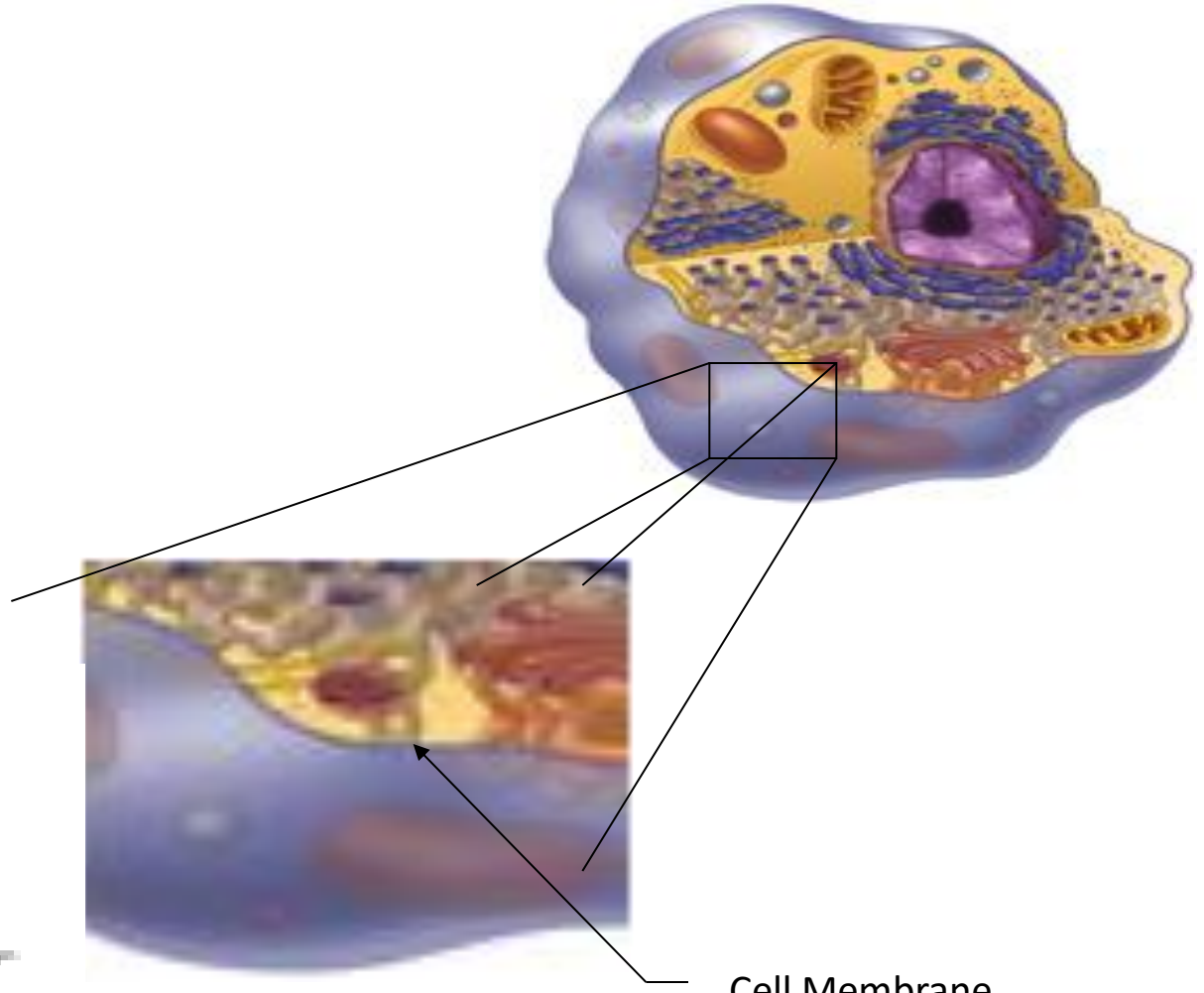
- ✓ Cytoplasm a jelly-like fluid contained in the cell that holds the organelles.
- ✓ The internal volume bounded by the plasma membrane, the **cytoplasm**, is composed of an aqueous solution, the **cytosol,** and a variety of suspended particles with specific functions.
- ✓ The cytosol is a highly concentrated solution containing enzymes and the RNA molecules that encode them; the components (amino acids and nucleotides) from which these macromolecules are assembled; hundreds of small organic molecules called **metabolites,** intermediates in biosynthetic and degradative pathways; **coenzymes,** compounds essential to many enzyme-catalyzed reactions; inorganic ions; and **ribosomes,** small particles (composed of protein and RNA molecules) that are the sites of protein synthesis.



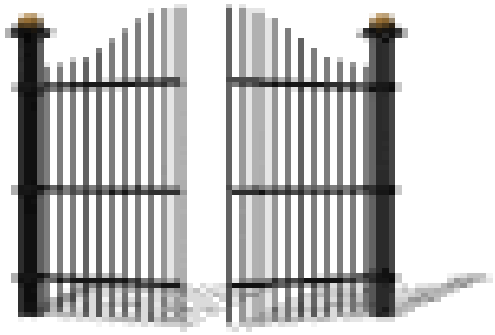


Cell Membrane

- Outer layer of cell
- Allows nutrients into the cell and wastes outside of the cell

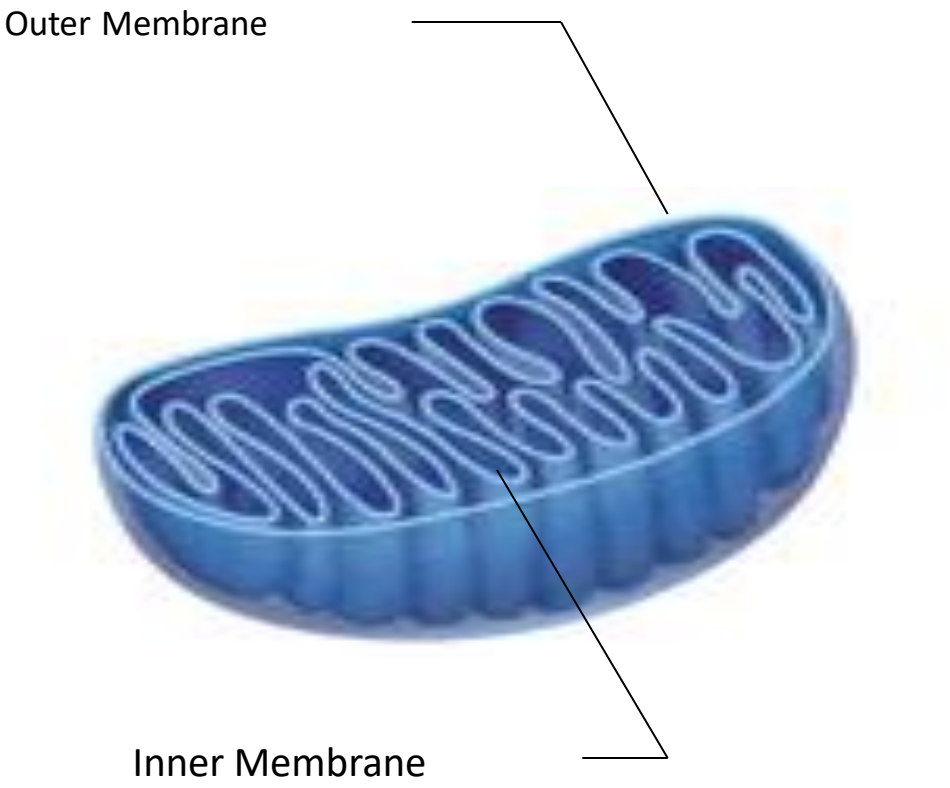


"Gate into the city"



Mitochondria

- Power center of cell
- Provides the energy the cell needs to move, divide, etc.



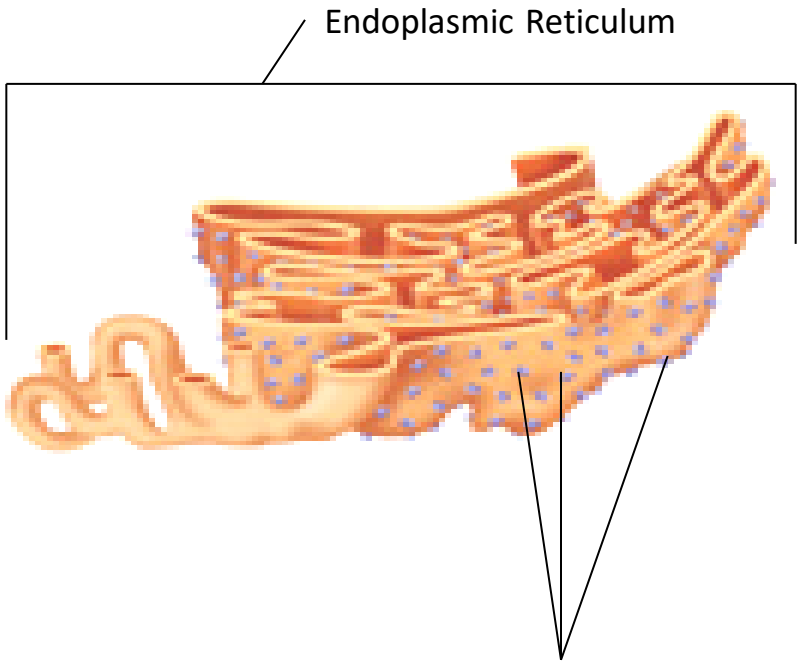
"Electric company of the cell"

Ribosomes

- Site where proteins are made
- Cell parts are made of proteins

"Factories of the cell"

Endoplasmic Reticulum



"Roadways of the cell"

- Transportation system of cell
- Rough ER- ribosome's attached
- Smooth ER- no ribosome's

Golgi Complex

- Packaging house of cell
- Packages, processes, and ships out the stuff the cell makes

"UPS of the cell"

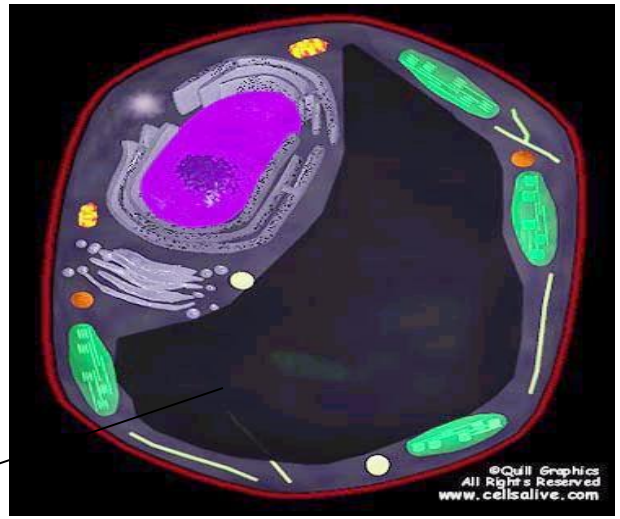
Lysosomes

- Digests food particles and cell parts
  - "Garbage men"
- Protects cell by digesting foreign invaders
  - "Police men

Vacuole

Vacuole

- Stores water, food & wastes



Vacuole is largest organelle in plant

Cell Wall

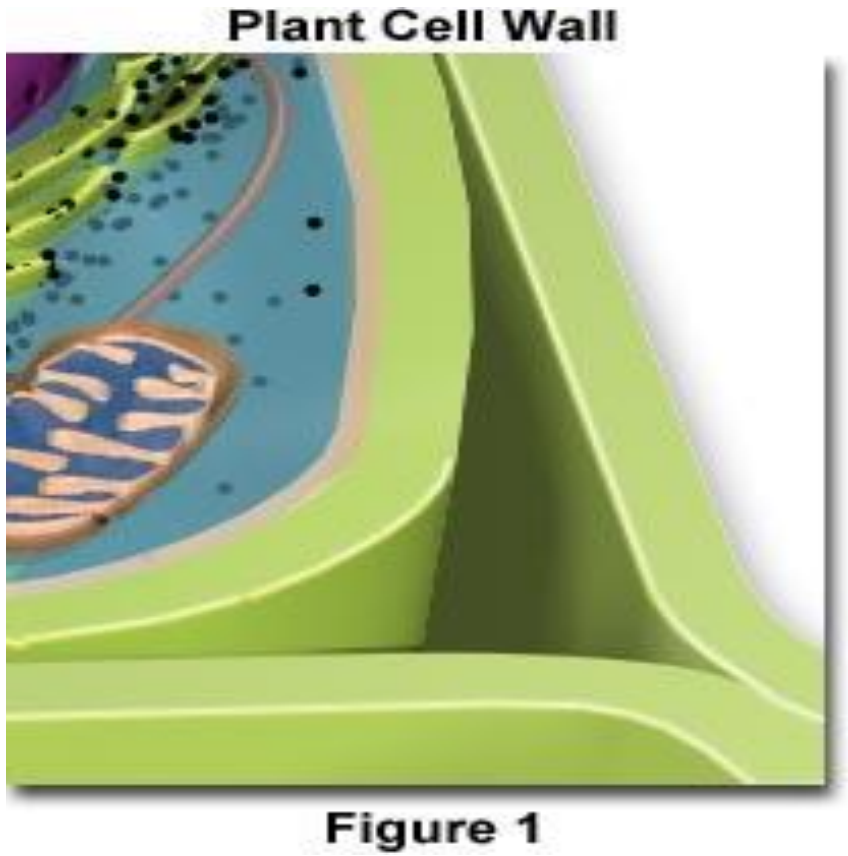
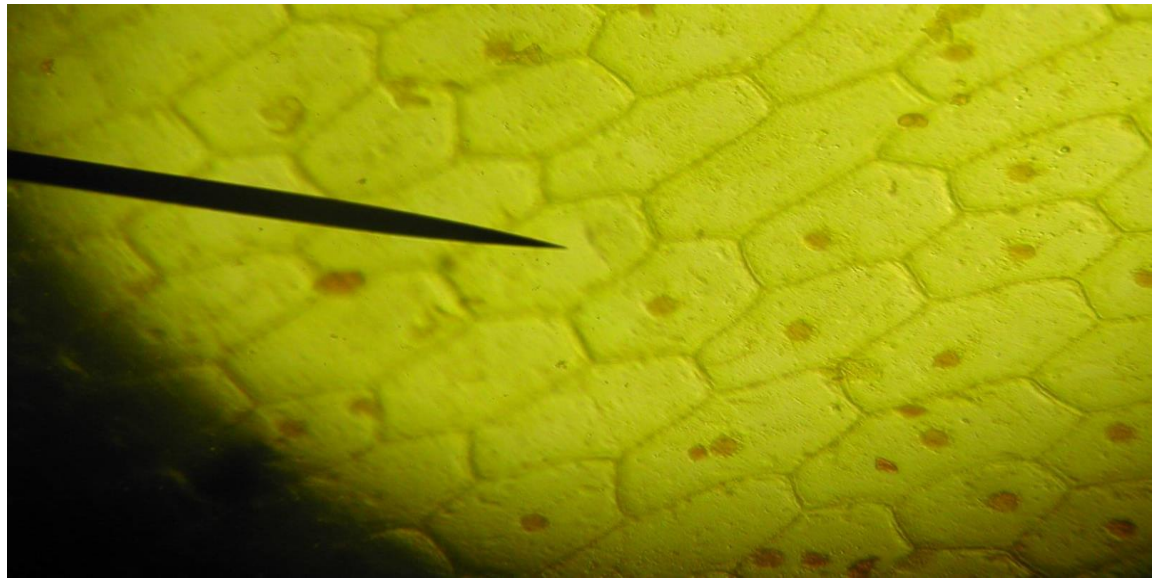


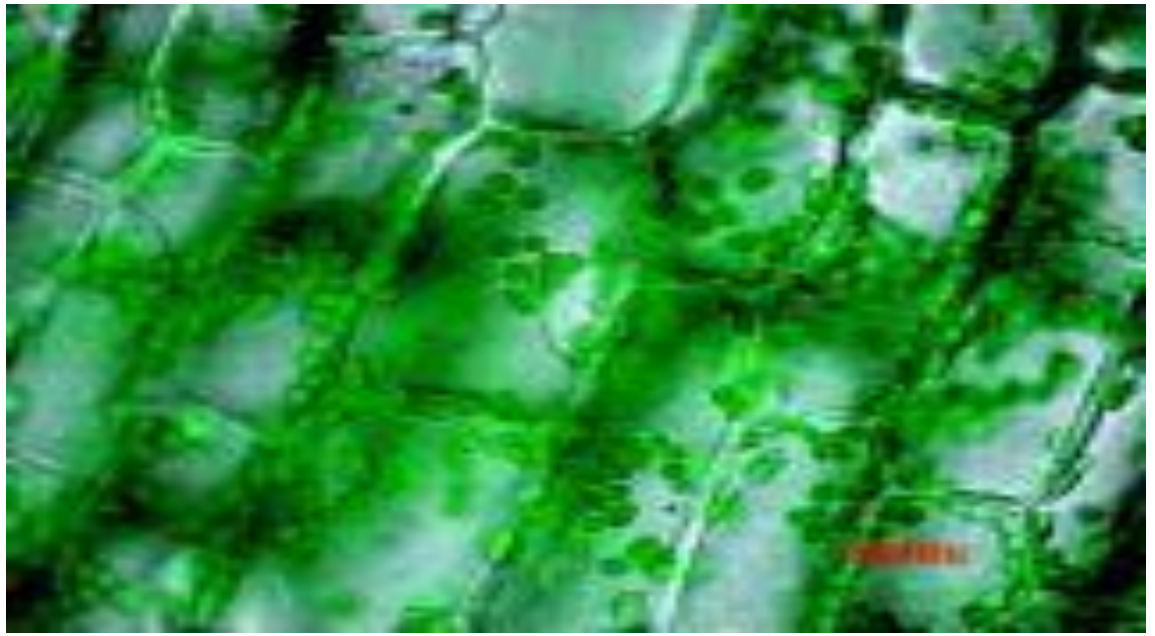
Figure 1

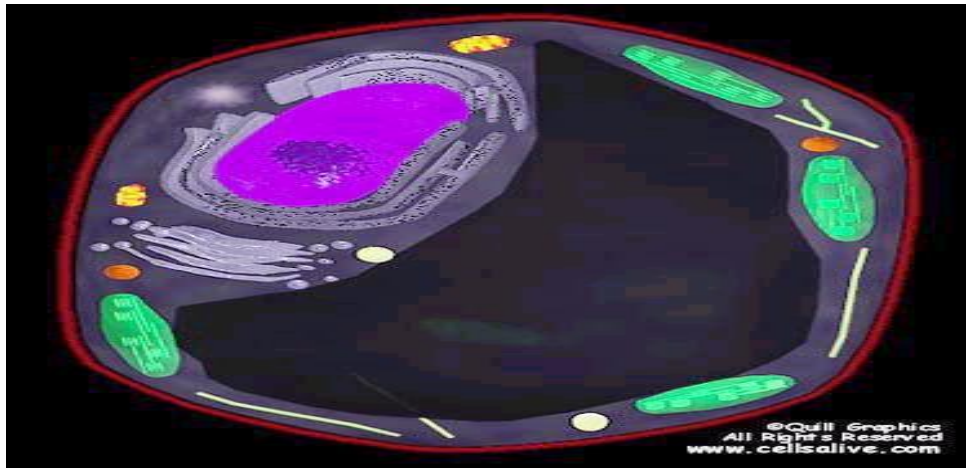


- Found only in plant cells
- Protects and supports the cell

Chloroplasts

- Found only in plant cells
- Contains chlorophyll (makes plants green)
- Where photosynthesis takes place

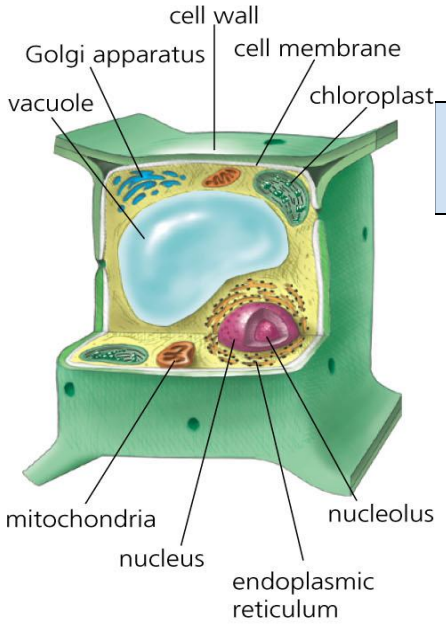


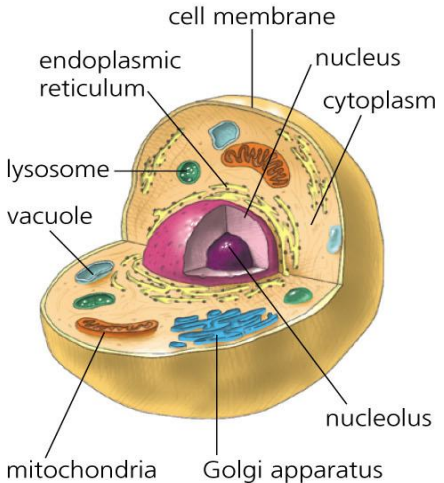


Plant or Animal Cell?

Found in Plant and Animal cells:

- Nucleus
- Golgi Complex
- Mitochondrion
- Lyosomes
- Endoplasmic Reticulum
- Cell Membrane
- Ribosomes
- Vacuoles





Found only in Plant Cells:

- Chloroplasts
- Cell Wall

For Query

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