

Biology 101 Chapter 4 Cells as the Basic Unit of Life

The Cell Theory

Major Contributors:

Galileo = first observations made with a microscope

Robert Hooke = first to observe small compartments in dead plant tissue, coined the term "*cell*"

Antony van Leeuwenhoek = first to observe living, mobile cells and bacteria

Robert Brown = first to observe the nucleus

Rudolf Virchow = every new cell comes from a pre-existing cell

Schleiden and **Schwann** = plants and animals are composed of cells and cell products

Tenements of the Cell Theory:

- 1) All organisms are composed of one or more cells.
- 2) The cell is the smallest unit having the properties of life.
- 3) The continuity of life arises directly from the growth and division of single cells.

Cell size and cell function: Surface area to volume ratio!

- The larger the ratio, the better off the cell!
- Impact of surface area to metabolism

What is the largest cell in the human body? The smallest?

Cell Structures and Their Functions

All cells are placed in one of 2 classes:

Prokaryotic = lack a nucleus (bacteria)

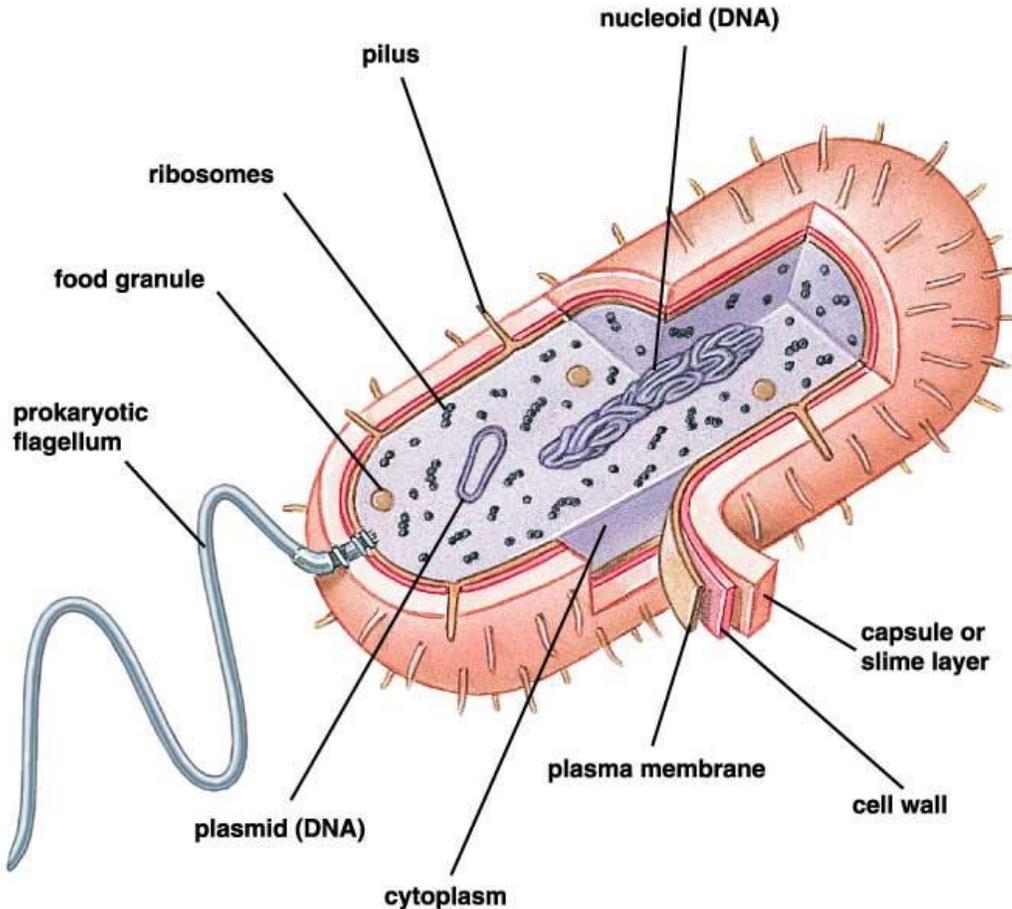
Eukaryotic = have a nucleus (protists, fungi, plants, and animals)

PROKARYOTIC CELLS

- very, very small
- very simple structure

Parts:

- A) Plasma (cell) membrane = encloses **cytoplasm** of cell
- B) Nucleoid Region = where DNA is at (not a nucleus)
- C) Ribosomes = assembles proteins with info from DNA
- D) Bacterial Cell Wall = a rigid outer layer that surrounds the cell membrane, protects the cell, maintains shape
- E) Capsule = a sticky outer layer over cell wall
- F) Pili and Fimbriae = numerous short projections that help with adherence
- G) Prokaryotic Flagella = longer projections that help with motility
- H) Plasmids = extra-chromosomal pieces of DNA



EUKARYOTIC CELLS

- have a nucleus
- very, very large
- complex internal organization
- compartmentalized
- membrane bound organelles

Organelle = "small organ", membrane enclosed structures found inside the cell, each for a specialized function. All chemical activities of the cell occur within organelles.

Benefits of Organelles:

- 1) Separate environments for chemical reactions
- 2) Increased membrane surface area

Eukaryotic Cells Broken Up into 3 Regions:

1. Cell Membrane
2. Cytoplasm (cytosol and organelles)
3. Nucleus

Organelles:

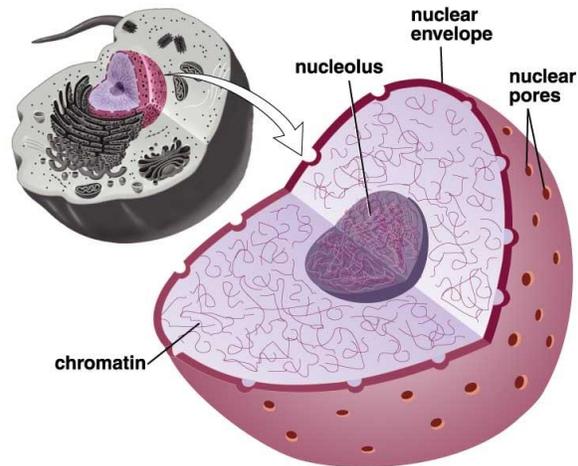
1. Nucleus *
2. Endoplasmic Reticulum (ER, smooth and rough)
3. Golgi Apparatus (or Body)
4. Vesicles (lysosomes and peroxisomes)
5. Mitochondria
6. Chloroplasts (*only in plants*)
7. Storage Vacuole (*mainly in plants*)
8. Centriolus (*only in animal cells*)

Other Structures:

1. Ribosomes
2. Cell Wall (*in plants*)*
3. Cell Membrane
4. Cytoskeleton
 - a. Microtubules
 - b. Microfilaments
 - c. Intermediate Filaments
5. Flagella and Cilia (*mainly in animals*)
6. Nucleolus

The Nucleus

- Cell's genetic control center
- Double membrane
- Nucleoplasm
- Nuclear envelope
- Nuclear pores
- Chromatin = DNA + associated proteins
- Nucleolus = internal structure of nucleus, site of ribosome assembly
- Chromatin vs. Chromosome

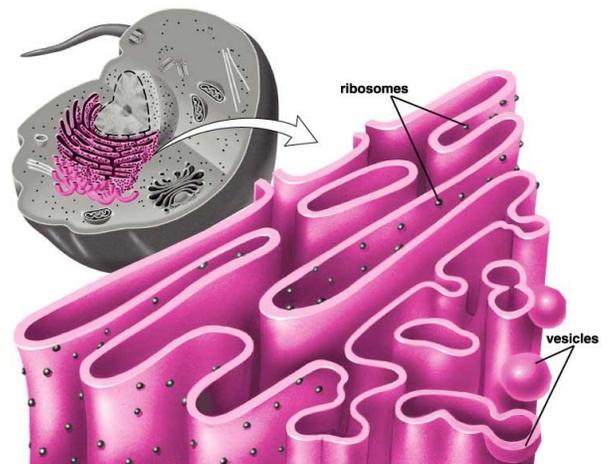


The Cytomembrane System

- Function: internal transport, importing and exporting of cell
- 3 parts:
 1. ER
 2. Golgi Apparatus
 3. Vesicles

Endoplasmic Reticulum

- Single, continuous membrane
- Pipes, tubes and tunnels in cell
- Continuous with nuclear envelope
- Superhighway of the cell



- 2 kinds: *Rough ER* + *Smooth ER*

Rough ER

- Flattened connected sacs
- Studded, or covered, with ribosomes
- Major site of protein synthesis
- Synthesis of new membrane

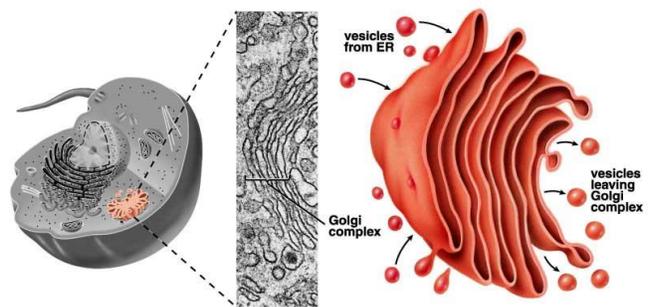
Smooth ER

- Lacks ribosomes
- Continuous with rough ER
- Functions:
 1. Transport
 2. Synthesis of lipids
 3. detoxification
 4. Storage of calcium ions

Golgi Apparatus

- Stack of flattened, pancake looking sacs located near cell membrane
- Handles export and import of material for cell
- Not continuous with ER, NOT physically connected
- Functions:

1. Storage, packaging, sorting and final touches and modification of proteins before exportation



2. The UPS of the cell

Vesicles

- General, short term transport, some storage, single membrane
- 3 special types:

Transport Vesicles

- 1) Used to transport material from ER to Golgi Apparatus
- 2) Transport of finished product from Golgi to Cell Membrane for export (process reversed for import)

Lysosomes

- 1) Contain digestive (hydrolytic) enzymes
- 2) Breakdown cell's food and wastes

Peroxisomes

- 1) Breakdown lipids
- 2) Detox alcohols and hydrogen peroxide

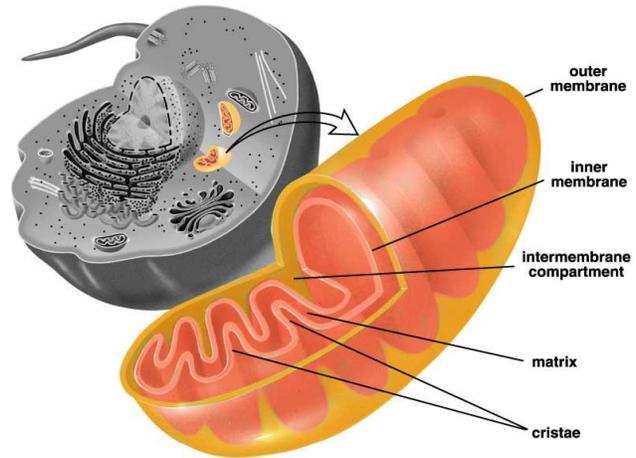
Vacuoles

- Very large, single membrane sacs
- Functions:
 1. Work with lysosomes for digestion
 2. Storage of food and water
 3. Stores wastes, excess water
 4. Turgor pressure in plants

Ex. Large Central Vacuole of plants

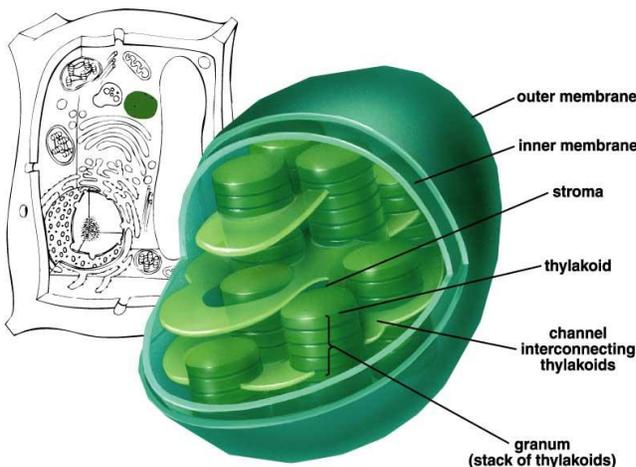
Mitochondria

- Found in all eukaryotic cells
- Carry out cellular respiration to produce energy for the cell
- Cell's "power house"
- Composed of 2 membranes
- **Cristae** = folds of inner membrane, site of energy production
- **Matrix** = fluid inside mitochondria



Chloroplasts

- Found only in *green* plant cells and algae
- Site of photosynthesis
- Contain the pigment *chlorophyll*
- Composed of 3 membranes
- **Grana** = stacks of discs of inner membrane, actual site of photosynthesis
- **Stroma** = fluid inside chloroplast



Centriolus

- Also referred to as basal bodies and MTOCs
- Composed of two centrioles in a membrane
- Used for anchoring, microtubule growth
- Centrioles also used in cell reproduction

Structures Based on Microtubules

The Cytoskeleton

- Framework of protein fibers inside cell
- Support and movement (dynamic)
- Composed of:
 1. Microfilaments = thinnest (actin)
 2. Intermediate filaments = (composition varies)
 3. Microtubules = thickest (tubulin)

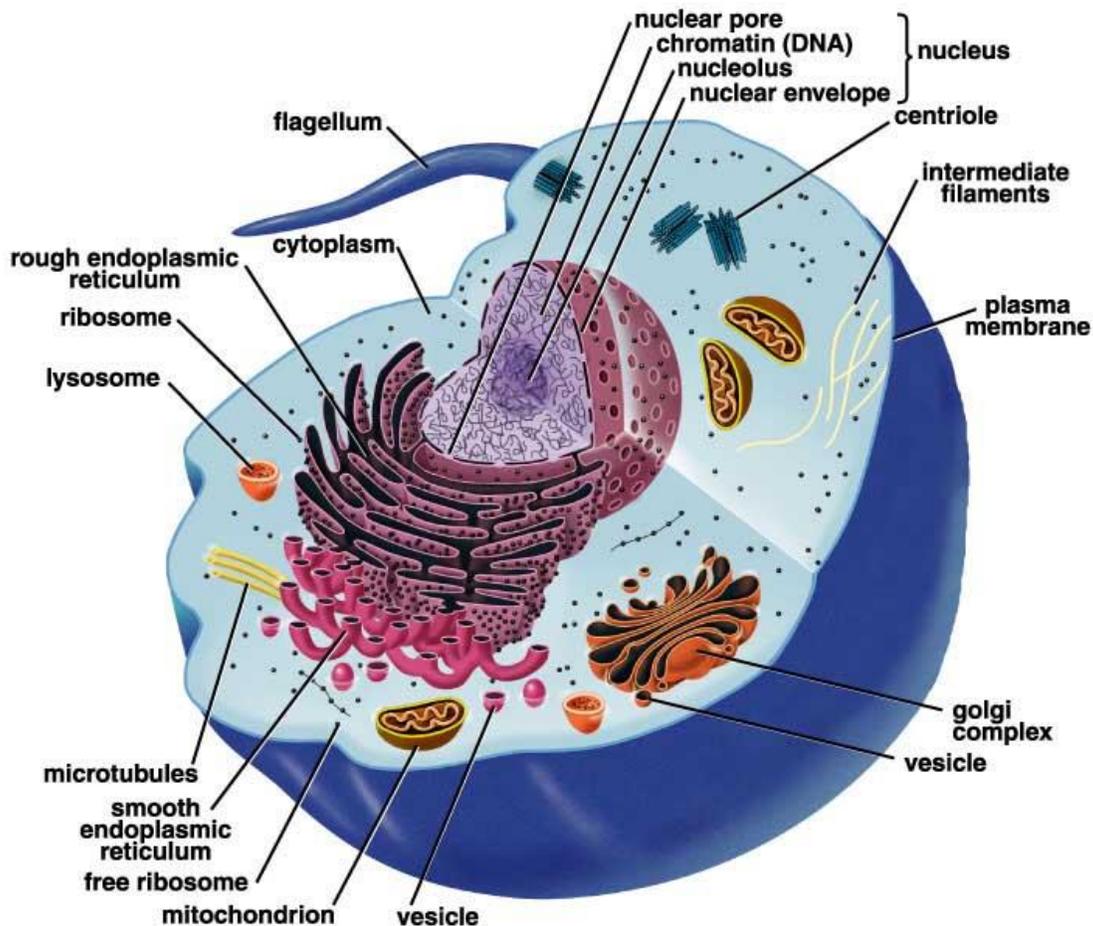
Cilia & Flagella

- Used in locomotion
 1. Cilia = numerous, very short
 2. Flagella = few, very long
- "9 + 2" arrangement of microtubules
 - 9 outer pairs
 - 2 single central

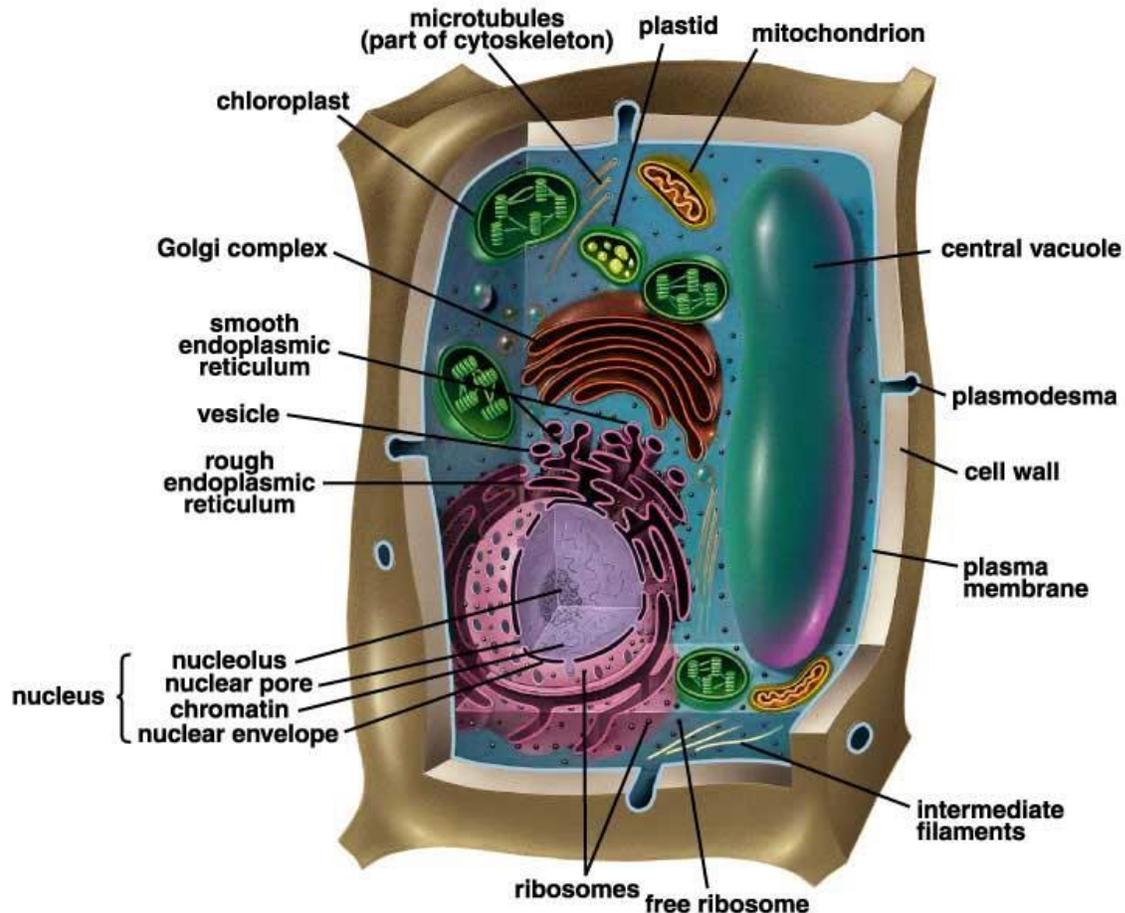
Plant Cell Wall

- Surrounds the cell external to cell membrane
- Very stiff, rigid structure
- Supports cell, gives it shape, protects it
- Composed of a complex sugar called *cellulose*
- Note: some protists and all fungi also have a cell wall

COMPOSITE ANIMAL CELL



COMPOSITE PLANT CELL



Some notes on microscopes:

Stereomicroscopes (dissecting)

Compound light microscopes

Scanning Electron Microscope (SEM)

Tunneling Electron Microscope (TEM)

Scanning-Tunneling Electron Microscope (STM)

Drawbacks on electron microscopes