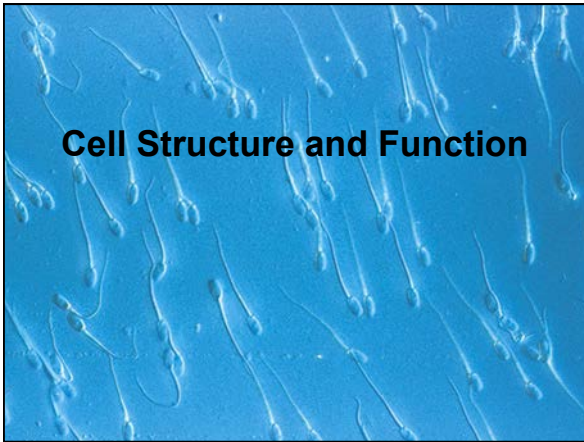




Cell Structure and function

Dr Badri Paudel
www.badripaudel.com



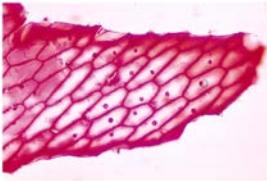
Cells

- Smallest living unit
- Most are microscopic

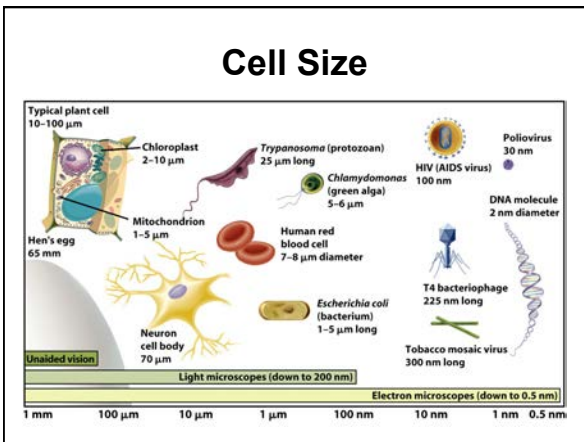
Discovery of Cells

- Robert Hooke (mid-1600s)
 - Observed sliver of cork
 - Saw “row of empty boxes”
 - Coined the term cell



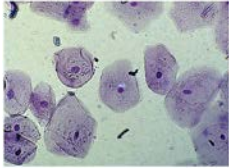
Principles of Cell Theory

- All living things are made of cells
- Smallest living unit of structure and function of all organisms is the cell
- All cells arise from preexisting cells (this principle discarded the idea of spontaneous generation)



Characteristics of All Cells

- A surrounding membrane
- Protoplasm – cell contents in thick fluid
- Organelles – structures for cell function
- Control center with DNA



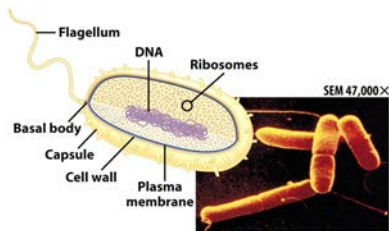
Cell Types

- Prokaryotic
- Eukaryotic



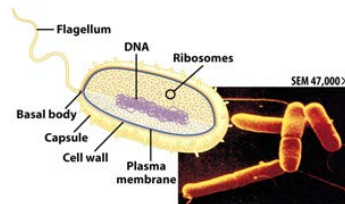
Prokaryotic Cells

- First cell type on earth
- Cell type of Bacteria and Archaea



Prokaryotic Cells

- No membrane bound nucleus
- Nucleoid = region of DNA concentration
- Organelles not bound by membranes



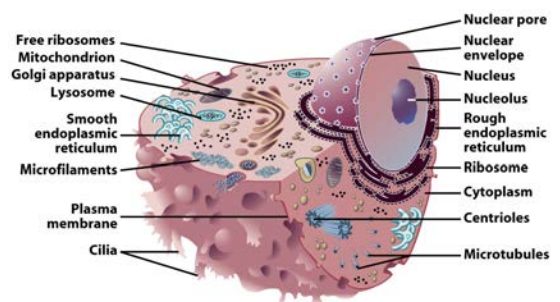
Eukaryotic Cells

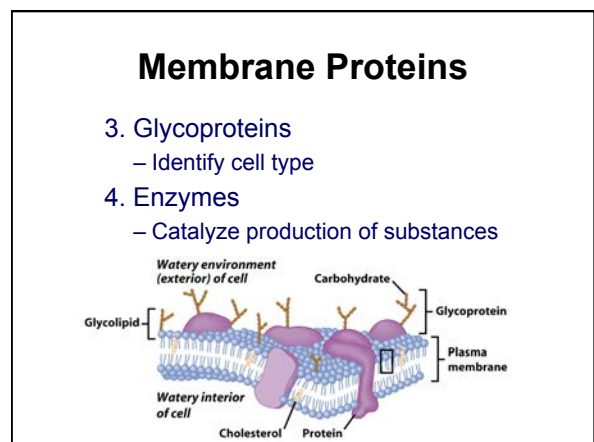
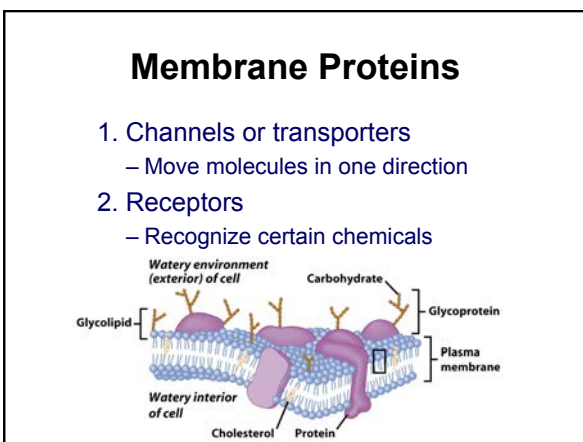
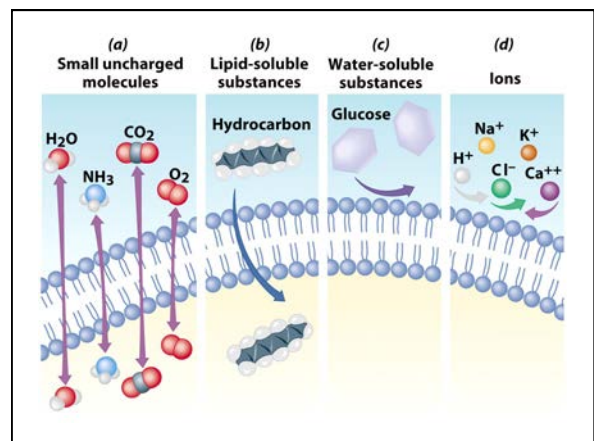
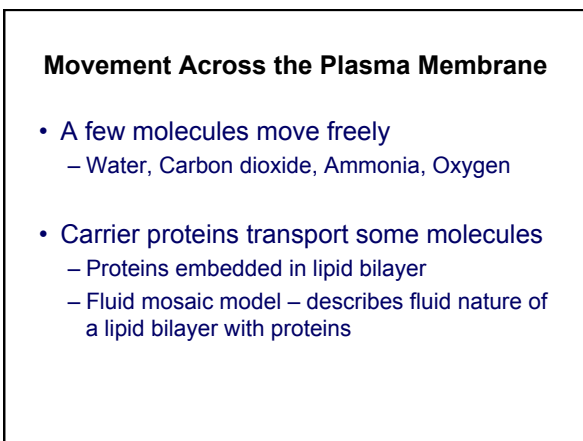
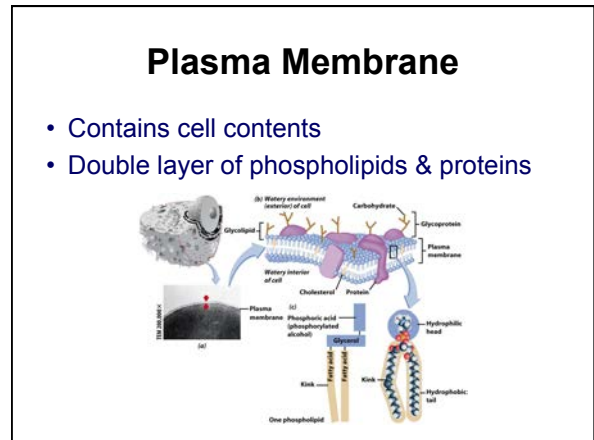
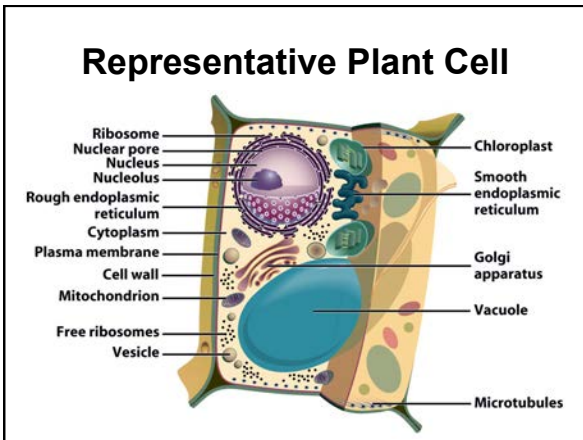
- Nucleus bound by membrane
- Include fungi, protists, plant, and animal cells
- Possess many organelles



Protozoan

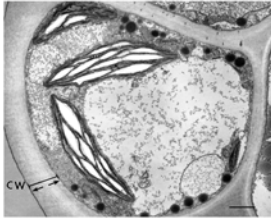
Representative Animal Cell





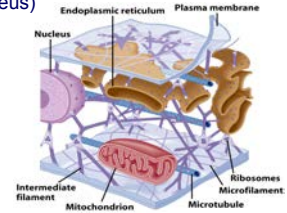
Cell Walls

- Found in plants, fungi, & many protists
- Surrounds plasma membrane



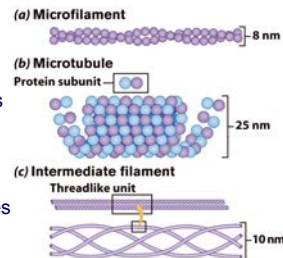
Cytoplasm

- Viscous fluid containing organelles
- components of cytoplasm
 - Interconnected filaments & fibers
 - Fluid = cytosol
 - Organelles (not nucleus)
 - storage substances



Cytoskeleton

- Filaments & fibers
- Made of 3 fiber types
 - Microfilaments
 - Microtubules
 - Intermediate filaments
- 3 functions:
 - mechanical support
 - anchor organelles
 - help move substances



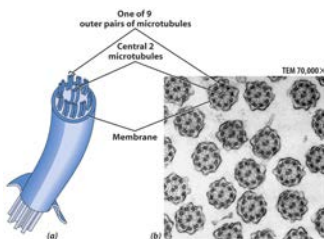
Cilia & Flagella

- Provide motility
- Cilia
 - Short
 - Used to move substances outside human cells
- Flagella
 - Whip-like extensions
 - Found on sperm cells
- Basal bodies like centrioles



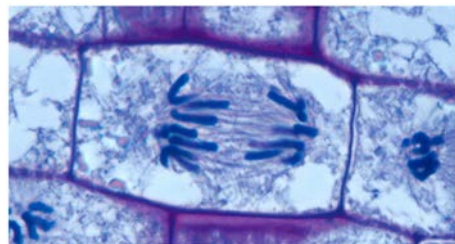
Cilia & Flagella Structure

- Bundles of microtubules
- With plasma membrane



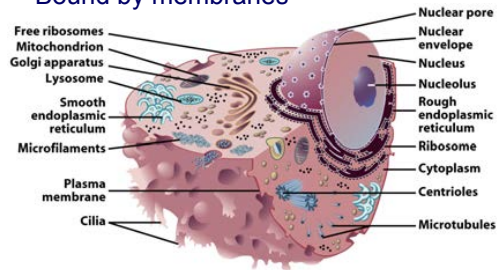
Centrioles

- Pairs of microtubular structures
- Play a role in cell division

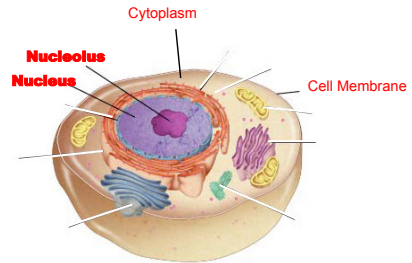


Membranous Organelles

- Functional components within cytoplasm
- Bound by membranes

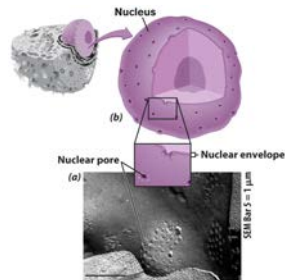


Animal Cell



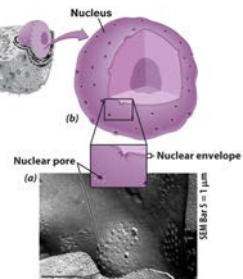
Nucleus

- Control center of cell
- Double membrane
- Contains
 - Chromosomes
 - Nucleolus



Nuclear Envelope

- Separates nucleus from rest of cell
- Double membrane
- Has pores



Eukaryotic Cell Organelles and Function

1. Nucleus

- Nickname: “The Control Center”
- Function: holds the DNA
- Parts:
 1. Nucleolus: dark spot in the middle of the nucleus that helps make ribosomes

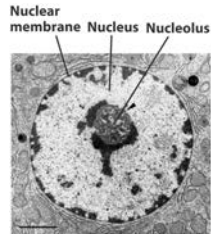
DNA

- Hereditary material
- Chromosomes
 - DNA
 - Proteins
 - Form for cell division
- Chromatin

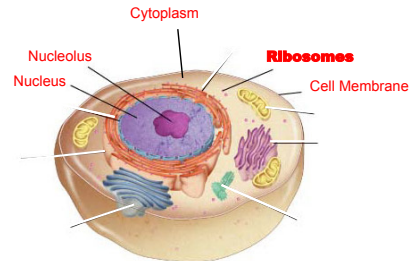


Nucleolus

- Most cells have 2 or more
- Directs synthesis of RNA
- Forms ribosomes



Animal Cell

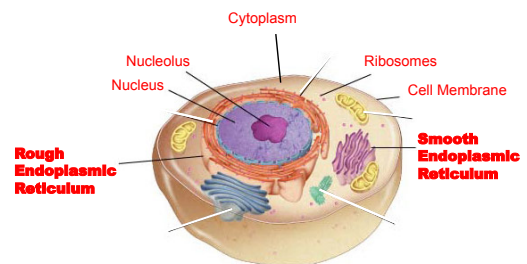


Eukaryotic Cell Organelles and Function

2. Ribosomes

- Function: makes proteins
- Found in all cells, prokaryotic and eukaryotic

Animal Cell



Eukaryotic Cell Organelles and Function

3. Endoplasmic Reticulum (ER)

- Nickname: "Roads"
- Function: The internal delivery system of the cell

Endoplasmic Reticulum

- Helps move substances within cells
- Network of interconnected membranes
- Two types
 - Rough endoplasmic reticulum
 - Smooth endoplasmic reticulum

Endoplasmic Reticulum

– 2 Types:

1. Rough ER:

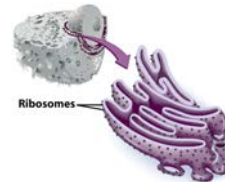
- Rough appearance because it has ribosomes
- Function: helps make proteins, that's why it has ribosomes

2. Smooth ER:

- NO ribosomes
- Function: makes fats or lipids

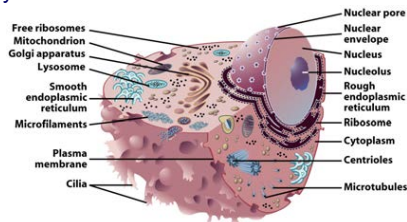
Rough Endoplasmic Reticulum

- Ribosomes attached to surface
 - Manufacture proteins
 - Not all ribosomes attached to rough ER
- May modify proteins from ribosomes

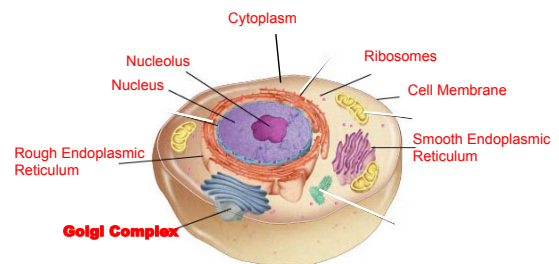


Smooth Endoplasmic Reticulum

- No attached ribosomes
- Has enzymes that help build molecules
 - Carbohydrates
 - Lipids



Animal Cell



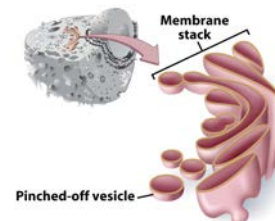
Eukaryotic Cell Organelles and Function

4. Golgi Complex

- Nickname: The shippers
- Function: packages, modifies, and transports materials to different location inside/outside of the cell
- Appearance: stack of pancakes

Golgi Apparatus

- Involved in synthesis of plant cell wall
- Packaging & shipping station of cell

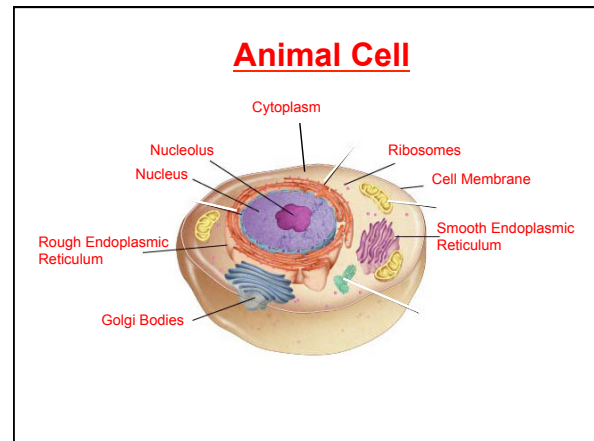
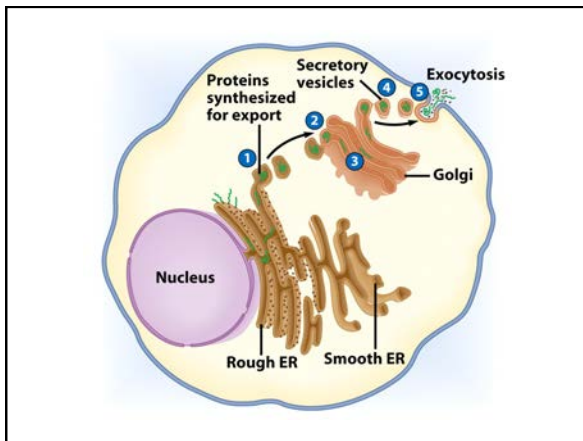


Golgi Apparatus Function

1. Molecules come in vesicles
2. Vesicles fuse with Golgi membrane
3. Molecules may be modified by Golgi

Golgi Apparatus Function (Continued)

4. Molecules pinched-off in separate vesicle
5. Vesicle leaves Golgi apparatus
6. Vesicles may combine with plasma membrane to secrete contents

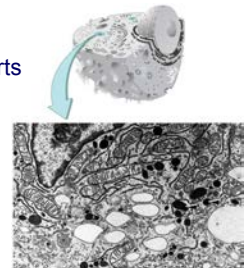


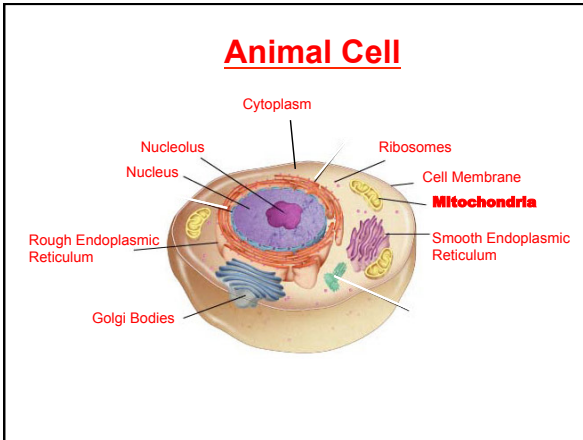
Eukaryotic Cell Organelles and Function

5. **Lysosomes**: circular, but bigger than ribosomes)
 - **Nickname**: "Clean-up Crews"
 - **Function**: to break down food into particles the rest of the cell can use and to destroy old cells

Lysosomes

- Contain digestive enzymes
- Functions
 - Aid in cell renewal
 - Break down old cell parts
 - Digests invaders

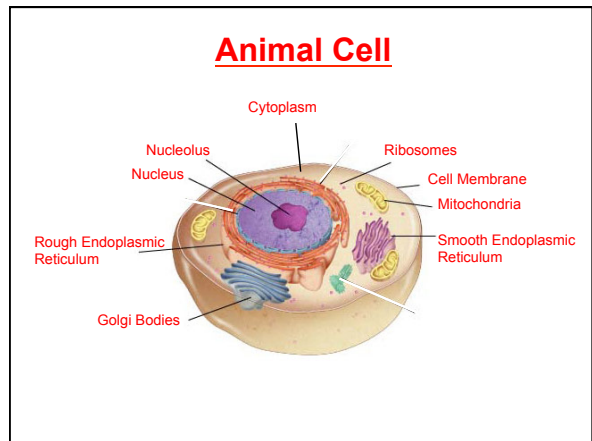
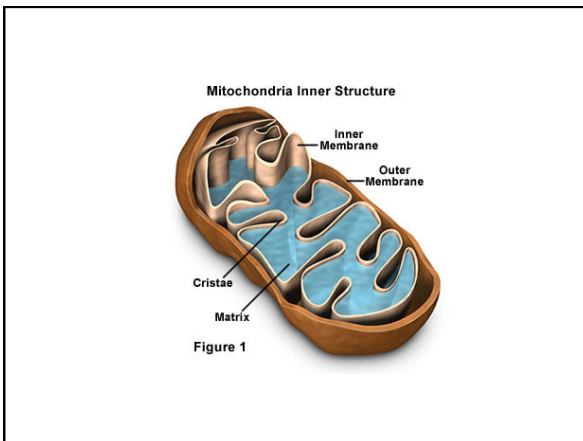




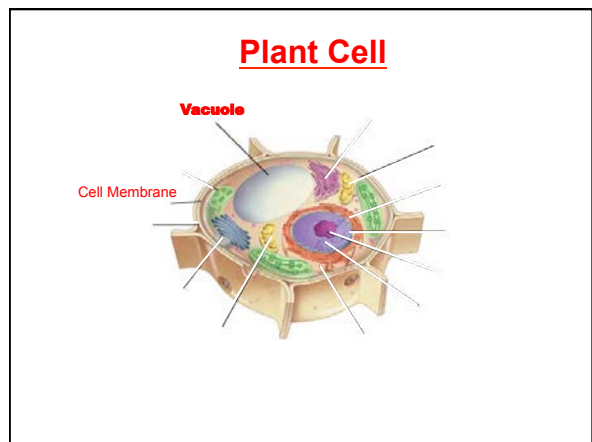
Eukaryotic Cell Organelles and Function

6. Mitochondria

- Nickname: “The Powerhouse”
- Function: Energy formation
 - Breaks down food to make ATP
 - ATP: is the major fuel for all cell activities that require energy



• Now let's talk about structures only found in PLANT Cells!!



Eukaryotic Cell Organelles and Function

7. Vacuoles

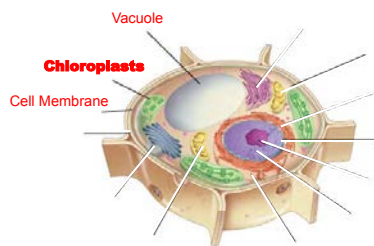
- Function: stores water
 - This is what makes lettuce crisp
 - When there is no water, the plant wilts

Vacuoles

- Membrane bound storage sacs
- More common in plants than animals
- Contents
 - Water
 - Food
 - wastes



Plant Cell

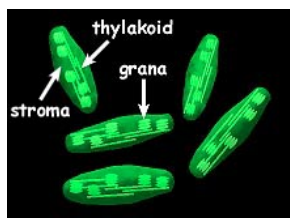


Eukaryotic Cell Organelles and Function

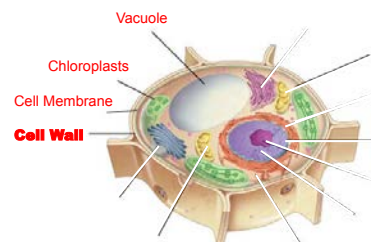
8. Chloroplasts

- Function: traps energy from the sun to produce food for the plant cell
- Green in color because of chlorophyll, which is a green pigment

Chloroplasts



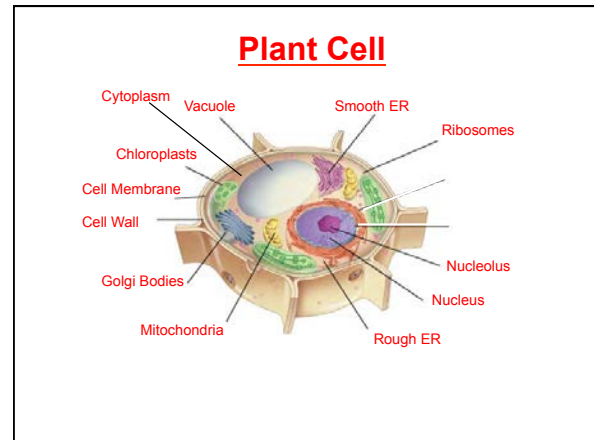
Plant Cell



Eukaryotic Cell Organelles and Function

9. Cell Wall

- **Function:** provides support and protection to the cell membrane
- Found outside the cell membrane in plant cells



Review of Eukaryotic Cells

Structure	Description	Function
Exterior Structures		
Cell wall	Outer layer of cellulose or chitin, or absent	Protection, support
Plasma membrane	Lipid bilayer in which proteins are embedded	Regulation of what passes in and out of cell, cell-to-cell recognition
Flagella (cilia)	Cellular extensions with 9 + 2 arrangement of pairs of microtubules	Motility or moving fluids over surfaces

Review of Eukaryotic Cells

Structure	Description	Function
Interior Structures and Organelles		
Endoplasmic reticulum (ER)	Network of internal membranes	Formation of compartments and vesicles; modification and transport of proteins; synthesis of carbohydrates and lipids
Ribosomes	Small, complex assemblies of protein and RNA, often bound to ER	Sites of protein synthesis
Nucleus	Spherical structure bounded by a double membrane, site of chromosomes	Control center of cell
Chromosomes	Long threads of DNA associated with protein	Sites of hereditary information
Nucleolus	Site within nucleus of rRNA synthesis	Synthesis and assembly of ribosomes
Golgi apparatus	Stacks of flattened vesicles	Packaging of proteins for export from cell
Lysosomes	Membranous sacs containing digestive enzymes found in animal cells	Digestion of various molecules
Cytoskeleton	Network of protein filaments, fibers, and tubules	Structural support, cell movement
Mitochondria	Bacteria-like elements with inner membrane highly folded	"Power plant" of the cell
Chloroplasts	Bacteria-like elements with inner membrane forming sacs containing chlorophyll, found in plant cells and algae	Site of photosynthesis

Comparing Plant and Animal Cells

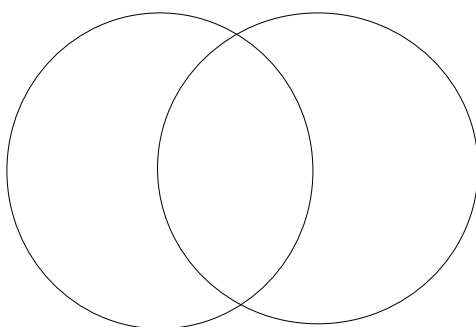


TABLE 5.2 A Comparison of Bacterial, Animal, and Plant Cells

	Bacterium	Animal	Plant
Exterior Structures			
Cell wall	Present (protein polysaccharide)	Absent	Present (cellulose)
Plasma membrane	Present	Present	Present
Flagella (cilia)	Sometimes present	Sometimes present	Sperm of a few species possess flagella
Interior Structures and Organelles			
Endoplasmic reticulum	Absent	Usually present	Usually present
Microtubules	Absent	Present	Present
Centrioles	Absent	Present	Absent
Golgi apparatus	Absent	Present	Present
Nucleus	Absent	Present	Present
Mitochondria	Absent	Present	Present
Chloroplasts	Absent	Absent	Present
Chromosomes	A single circle of naked DNA	Multiple units, DNA associated with protein	Multiple units, DNA associated with protein
Ribosomes	Present	Present	Present
Lysosomes	Absent	Present	Present
Vacuoles	Absent	Absent or small	Usually a large single vacuole in mature cell

Molecule Movement & Cells

- Passive Transport
- Active Transport
- Endocytosis
(phagocytosis & pinocytosis)
- Exocytosis

Passive Transport

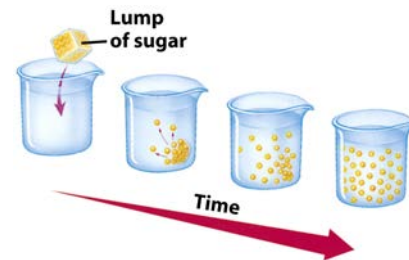
- No energy required
- Move due to gradient
 - differences in concentration, pressure, charge
- Move to equalize gradient
 - High moves toward low

Types of Passive Transport

1. Diffusion
2. Osmosis
3. Facilitated diffusion

Diffusion

- Molecules move to equalize concentration

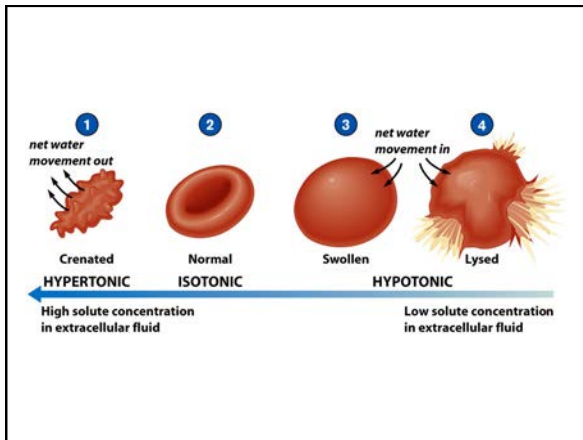


Osmosis

- Special form of diffusion
- Fluid flows from lower solute concentration
- Often involves movement of water
 - Into cell
 - Out of cell

Solution Differences & Cells

- solvent + solute = solution
- Hypotonic
 - Solutes in cell more than outside
 - Outside solvent will flow into cell
- Isotonic
 - Solutes equal inside & out of cell
- Hypertonic
 - Solutes greater outside cell
 - Fluid will flow out of cell

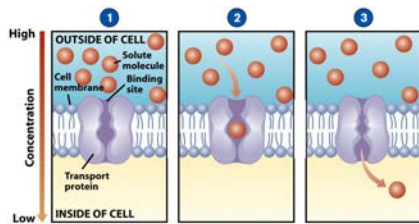


Facilitated Diffusion

- Differentially permeable membrane
- Channels (are specific) help molecule or ions enter or leave the cell
- Channels usually are transport proteins (aquaporins facilitate the movement of water)
- No energy is used

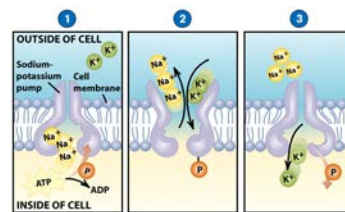
Process of Facilitated Transport

- Protein binds with molecule
- Shape of protein changes
- Molecule moves across membrane



Active Transport

- Molecular movement
- Requires energy (against gradient)
- Example is sodium-potassium pump

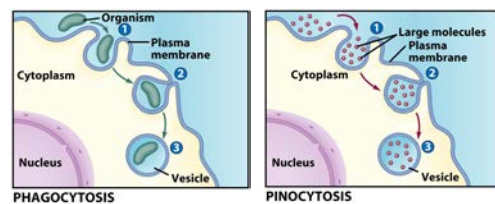


Endocytosis

- Movement of large material
 - Particles
 - Organisms
 - Large molecules
- Movement is into cells
- Types of endocytosis
 - bulk-phase (nonspecific)
 - receptor-mediated (specific)

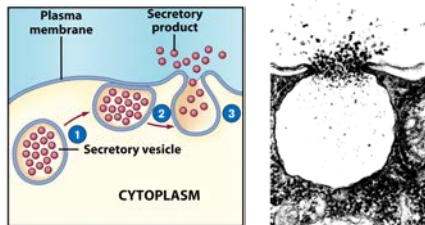
Forms of Endocytosis

- Phagocytosis – cell eating
- Pinocytosis – cell drinking



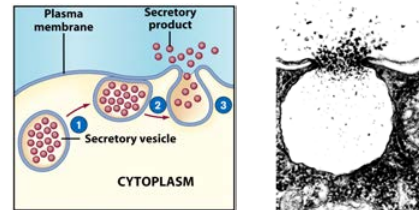
Exocytosis

- Reverse of endocytosis
- Cell discharges material



Exocytosis

- Vesicle moves to cell surface
- Membrane of vesicle fuses
- Materials expelled



Describe cells and their structure

- **Protoplasm:** A colorless, jellylike substance in which food elements such as protein, fats, carbohydrates, mineral salts, and water are present. All cells are composed of protoplasm. Visualize as the white of a raw egg.
- **Nucleus:** The dense, active protoplasm found in the center of the cell. The nucleus plays an important part in cell reproduction and metabolism. Visualize as the yolk of a raw egg

- **Cytoplasm:** All the protoplasm of a cell except for the nucleus. A watery fluid that contains food material necessary for growth, reproduction, and self-repair of the cell.
- **Cell membrane:** Encloses the protoplasm and permits soluble substances to enter and leave the cell.

Describe cell reproduction

- Cells reproduce, providing new cells for growth and replacement.
- **Mitosis:** The reproduction of cells by dividing into two identical cells called daughter cells.
- To reproduce, cells need food, oxygen, water, suitable temperatures, and the ability to eliminate waste products.
- Cells become impaired or destroyed in unfavorable conditions, including toxins (poisons) and disease.

Describe cell metabolism

- Metabolism:** A chemical process whereby cells are nourished and carry out their activities.
- Two phases of metabolism: Anabolism and catabolism. Phases are carried out simultaneously and continually within cells.

- **Anabolism:** The process of building up larger molecules from smaller ones. The body stores water, food, and oxygen for use when needed for cell growth and repair.
- **Catabolism:** The breaking down of complex compounds within the cells to smaller ones. Catabolism releases energy that is stored by special molecules to be used in muscle contractions, body secretions, or heat production.

Define tissue

- Tissue is a collection of similar cells that perform a particular function.
- Each tissue has a specific function and can be recognized by its characteristic appearance.
- Body tissues are composed of 60 to 90 percent water.

Describe the five types of tissue found in the body and their functions

- **Connective tissue:** Supports, protects, and binds together other tissues of the body. Examples include bone, cartilage, ligaments, tendons, fascia (separates muscles), and fat or adipose tissue.
- **Epithelial tissue:** A protective covering on body surfaces. Examples include skin, mucous membranes, heart lining, digestive and respiratory organs, and glands.
- **Liquid tissue:** Carries food, waste products, and hormones throughout the body. Examples include blood and lymph.

- **Muscular tissue:** Contracts and moves the various parts of the body.
- **Nerve tissue:** Carries messages to and from the brain and controls and coordinates all bodily functions. Nerve tissue is composed of special cells known as neurons, which make up the nerves, brain, and spinal cord.

Define organ

- Organs are groups of tissues designed to perform a specific function.

List the major organs of the body and describe their key function

- Brain: Controls the body.
- Eyes: Controls vision.
- Heart: Circulates blood.
- Kidneys: Excrete water and waste products.
- Lungs: Supply oxygen to the blood.
- Liver: Removes toxic products of digestion.
- Skin: Forms external protective covering of the body.
- Stomach and intestines: Digest food.