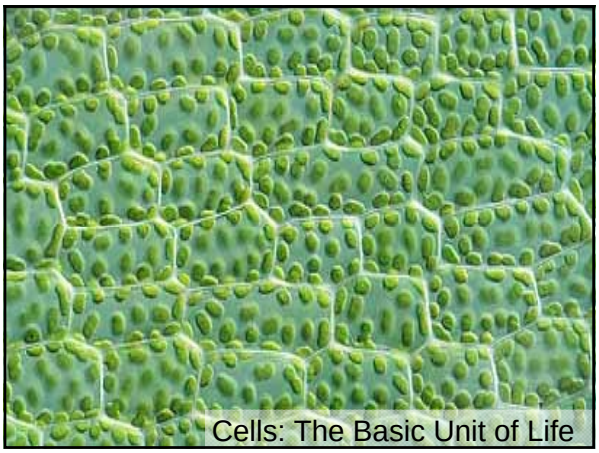


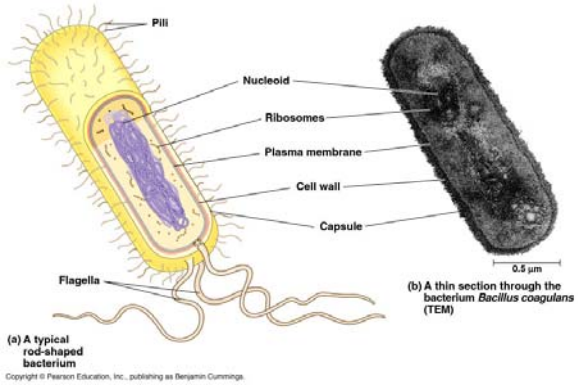
Cell Theory

- **All living things are composed of one or more cells**
- **Cells are the basic unit of structure and function of living things**
- **All cells are produced from other cells**

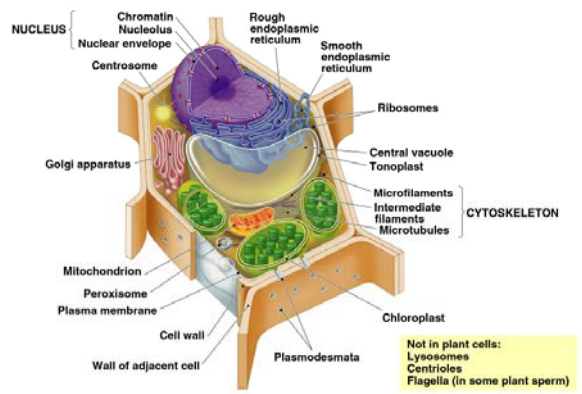
Two Types of Cells

- **Prokaryotic: Do not have a membrane enclosed nucleus**
  - **Example: bacteria and archae**
- **Eukaryotic: Have a membrane enclosed nucleus to protect their DNA**
  - **Example: Plants, Animals, Fungi, Protists**

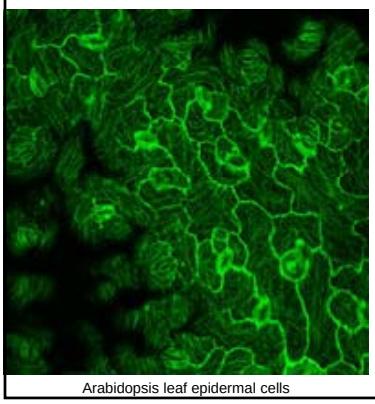
A prokaryotic cell



Overview of a plant cell



What we can see



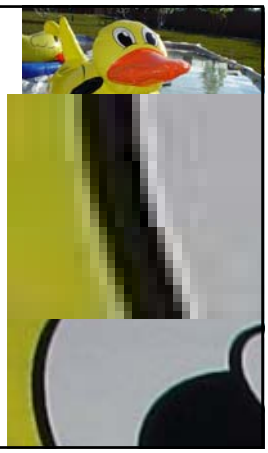
Arabidopsis leaf epidermal cells

- Plant and animal cells can be easily seen using the compound light microscopes we have at school.

- Not all organelles are readily apparent using the light microscope.

Microscopes

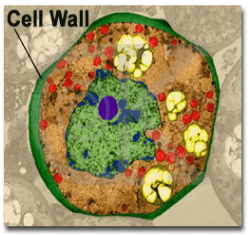
- The main function of a microscope is to magnify small objects.
- However, the clarity of what you see is just as important…the resolving power of a microscope is its ability to distinguish 2 closely positioned objects as being separate.



Electron Microscopes

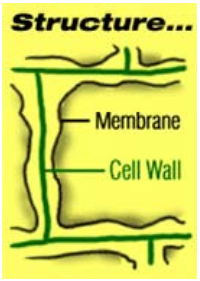
- It wasn't until the use of Ems that biologist were able to study the insides of cells.
- Today we know that cells are made up of smaller parts called organelles

Cell Anatomy



- Cell Wall→
  - rigid layer of nonliving material
  - Provide protection & support
  - Found in plant, some bacteria, some protists and some, fungi

Cell Anatomy

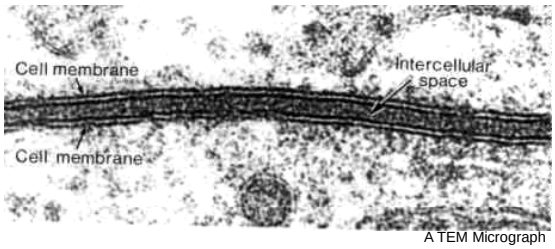


- Cell membrane
  - The outer layer of animal cells, found inside cell walls (if wall is present)
  - Controls what enters and leaves the cell
  - Most important organelle in terms of maintaining homeostasis

What is Homeostasis?

Homeostasis – Maintaining a Balance

- Cells must keep the proper concentration of nutrients and water and eliminate wastes.
- The plasma membrane is selectively permeable – it will allow some things to pass through, while blocking other things.

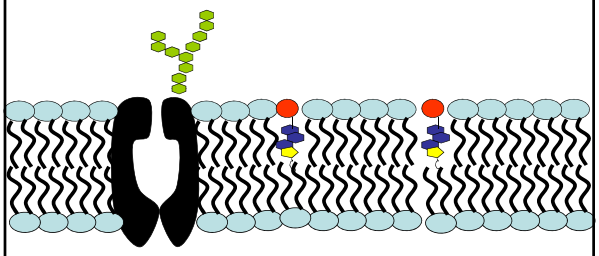


A TEM Micrograph

The cell membrane is made up of two layers of molecules called phospholipids

The job of the cell membrane is to regulate the movement of materials into and out of the cell.

The Plasma Membrane is described using the fluid mosaic model



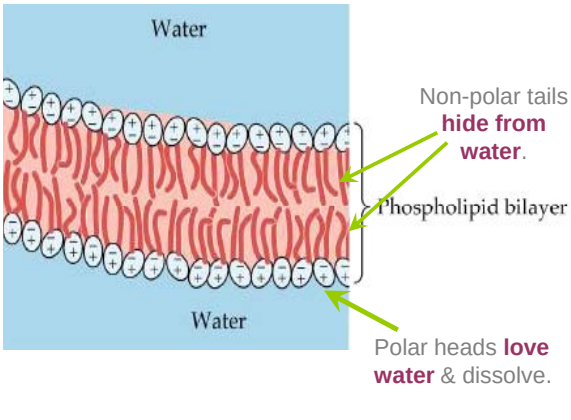
Structure of the Plasma Membrane

- Lipid bilayer – two sheets of lipids (phospholipids).
  - –Found around the cell, the nucleus, vacuoles, mitochondria, and chloroplasts.
  - –Embedded with proteins and strengthened with cholesterol molecules.

What is a Phospholipid?

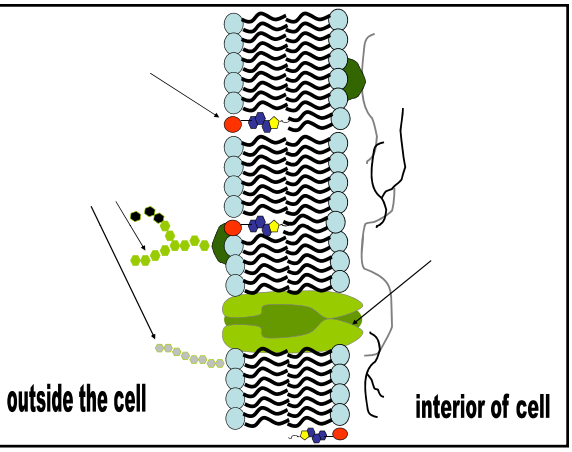
What's a Phospholipid?

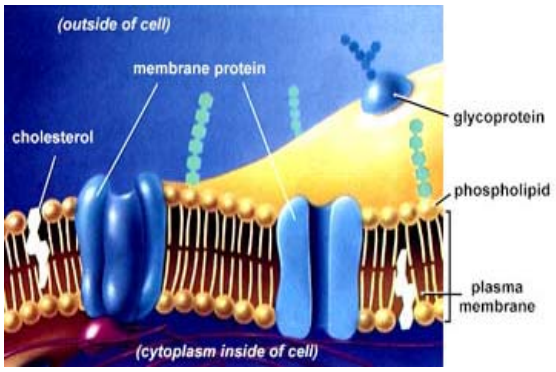
- It's a pair of fatty acid chains and a phosphate group attached to a glycerol backbone.
  - –Polar (water-soluble) heads face out and the nonpolar fatty acids hang inside.



Membrane Proteins

- 1. Determine what particles can pass through the membrane.
- 2. Serve as enzymes (may speed reactions).
- 3. Act as markers that are recognized by chemicals and molecules from the inside and the outside of the cell (the immune system).





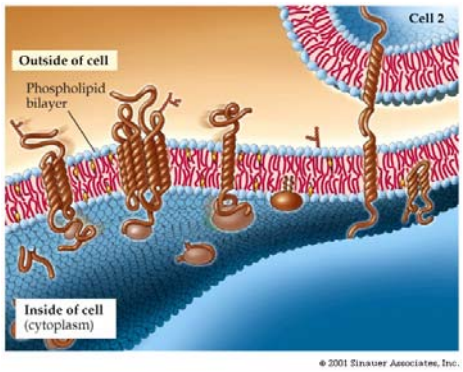
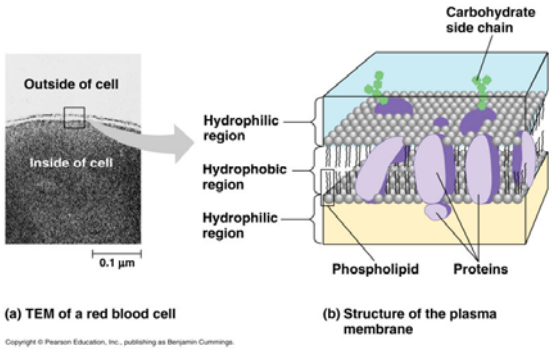


Figure 7.6 The plasma membrane



Cellular Transport

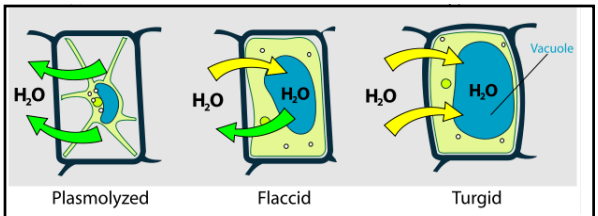
- Diffusion – movement of particles from an area of high concentration to an area of low concentration caused by kinetic energy.
  - Kinetic Energy (movement of particles because of the movement of their atoms).
  - Continues until an equilibrium is reached (no gradient).
  - Dynamic equilibrium – particles move freely and are evenly distributed.

Osmosis

- Diffusion of water across a selectively permeable membrane.
- Occurs until water is balanced on both sides of the membrane.

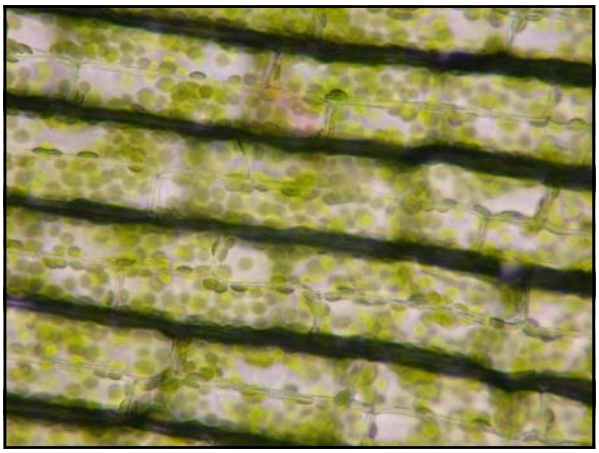
Cell Concentrations

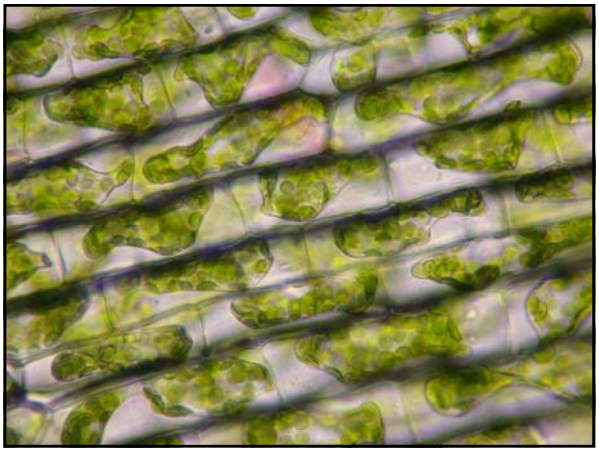
- Hypertonic solutions – when one solution has more dissolved solute.
- Hypotonic solutions – the solution with a lower concentration of dissolved solute.
- Isotonic solutions – the same concentration of dissolved solute.



When plant cells are placed in a Hypertonic solution – the cells will have more solvent than the environment (the cell's internal fluid is hypotonic to the environment). The water inside the cell will then move outwards to reach equilibrium. This will cause the cell to swell as it gains water.

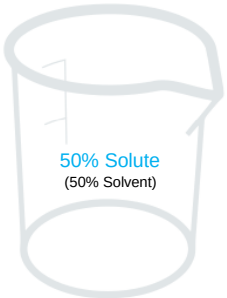
Luckily the cell wall will then prevent the membrane from growing so large that it bursts. Instead it will build up turgor pressure.





If a red blood cell is placed within a solution containing 50% solute what will be the effect of diffusion on the cell if the cell membrane is impermeable to the solute?

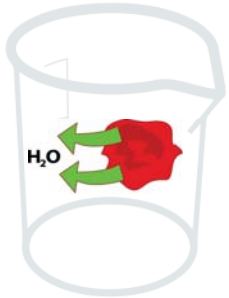
5% Solute
(95% Solvent)



50% Solute
(50% Solvent)

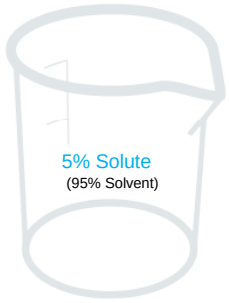
If a red blood cell is placed within a solution containing 50% solute what will be the effect of diffusion on the cell if the cell membrane is impermeable to the solute?

Since the Solute cannot exit the cell (the membrane is impermeable to solute) the red blood cell will loose water to the beaker as the solvent flows out to reach equilibrium.



If a red blood cell is placed within a solution containing 5% solute what will the effect of diffusion be on the cell if the cell membrane is impermeable to the solute?

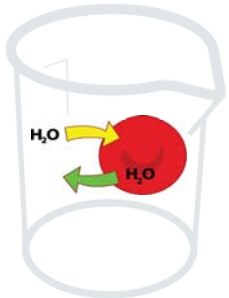
5% Solute
(95% Solvent)



5% Solute
(95% Solvent)

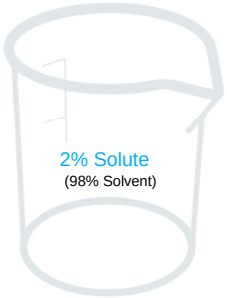
If a red blood cell is placed within a solution containing 5% solute what will the effect of diffusion be on the cell if the cell membrane is impermeable to the solute?

Since the amount of solvent is equal both inside and outside the red blood cell the amount of solvent entering will be equal to the amount of solvent exiting



If a red blood cell is placed within a solution containing 2% solute what will the effect of diffusion on the cell if the cell membrane is impermeable to the solute?

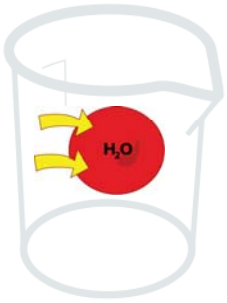
5% Solute
(95% Solvent)



2% Solute
(98% Solvent)

If a red blood cell is placed within a solution containing 2% solute what will the effect of diffusion on the cell if the cell membrane is impermeable to the solute?

Since the Solute cannot exit the cell (the membrane is impermeable to solute) the red blood cell will gain water to the beaker as the solvent flows into the cell as it tries to reach equilibrium.



Elodeagif.swf

Cell Concentrations

- Hypertonic solutions – when one solution has greater concentration of impermeable solutes.
- Hypotonic solutions – the solution with a lower concentration of impermeable solutes.
- Isotonic solutions – the same concentration of impermeable solute.

Overcoming Osmosis

- Contractile vacuoles – expel excess water from bacterial cells that live in water.
- Turgor pressure – water pressure in a plant cell. Loss of turgor pressure causes wilting (plasmolysis).

Cellular Transport

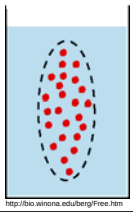
- Passive transport – no energy is needed to move particles.
  1. Diffusion
  2. Facilitated diffusion
  3. Osmosis

Diffusion is a type of Passive Transport

1. **Diffusion**: <u>random</u> movement of particles **from an area of high concentration to an area of low concentration**.

   (***High to Low***)

- Diffusion continues until all molecules are evenly spaced (**equilibrium** is reached)-
- ***<u>Note:</u>*** molecules will still move around but stay spread out.



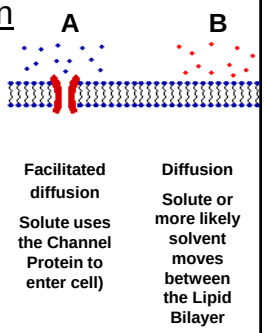
http://bio.winona.edu/berg/Free.htm

Passive Transport: <u>Facilitated Diffusion</u>

2. Facilitated diffusion: diffusion of specific particles **through transport proteins** found in the membrane

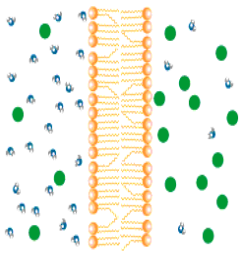
a. Transport Proteins are <u>specific</u> – they "select" only certain molecules to cross the membrane

b. Transports larger or charged molecules



Passive Transport: **Osmosis**

- **Osmosis**: diffusion of *water* through a selectively permeable membrane
- Water moves from high to low concentrations



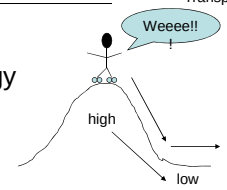
•Water moves freely through pores.

•Solute (green) is too large to diffuse across.

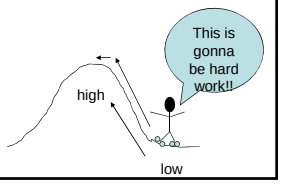
Types of Cellular Transport

•Animations of Active Transport & Passive Transport

- **Passive Transport**
  cell doesn't use energy
  1. Diffusion
  2. Facilitated Diffusion
  3. Osmosis



- **Active Transport**
  cell does use energy
  1. Protein Pumps
  2. Endocytosis
  3. Exocytosis



Cellular Transport

- Active transport – energy is needed to move particles.
  - Carrier proteins – embedded proteins change shape to open and close passages across the membrane.
  - Endocytosis – taking something into the cell.
  - Exocytosis – expelling something from the cell.

Types of Endocytosis

- **Phagocytosis- "Cell eating"** when the membrane is used to surround a large food particle (that is so big it can't fit into a transport protein)
- **Pinocytosis- "Cell Drinking"** when the membrane is used to surround a liquidy food particle (that is so big it can't fit into a transport protein)

transport1.swf

Cytoplasm

- contains the organelles
- allows for the transport of substances within the cell;
- provides an environment in which chemical reactions can occur;
- helps to support the cell.

Colloid

A substance in between a solution and a suspension

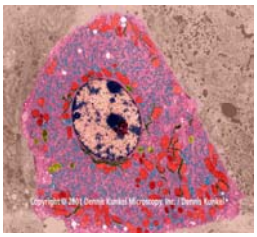
Fog

Jell-O

Cytoplasm

- **Cytoplasm** is all of the liquidy stuff inside a cell except for the nucleus.
- Cytoplasm is separated from nucleus by the nuclear envelope and from the external environment by the plasma membrane.
- The cytoplasm contains the organelles and a colloidal like aqueous fluid called the cytosol. Dissolved in the cytosol are salts, minerals and organic molecules.

Nucleus



- Nucleus→
  - Stores the recipes for making proteins
  - Contains DNA found on **chromatin** strands
  - Materials pass in and out through nuclear pores in the double layered nuclear membrane

Nucleus

The nucleus controls and regulates the cell's activities by transmitting genetic information during cell division; and by providing instructions for protein synthesis.

It is made up of the following components

•A double membrane-enclosed sac containing:
•Chromatin fibers (which comprise DNA and proteins)
•Nucleoplasm (a gel-like fluid)
•and the nucleolus.

The nucleolus (a dense sphere made of RNA and proteins) makes ribosomal RNA.

Why is the Nucleus more like a library then a brain?

Libraries store information just like the nucleus stores DNA. DNA on it's own does not actually do anything. The information stored within the molecule is what is important.

Brains on the other hand are used to make decisions and actively participate in the running of the organisim.

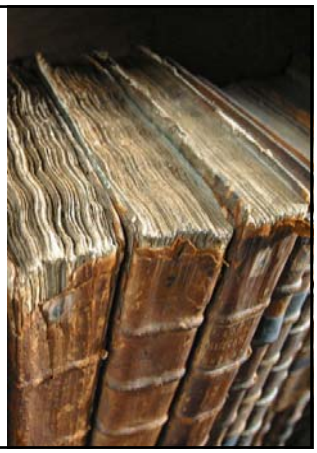


Figure 7.9 The nucleus and its envelope

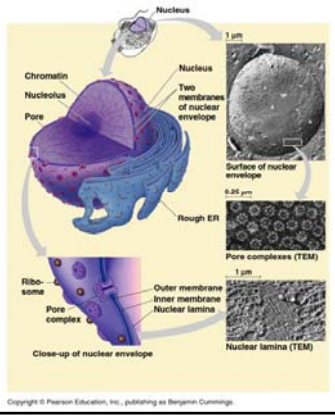
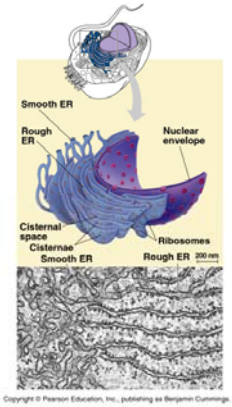
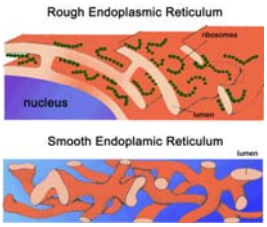


Figure 7.11 Endoplasmic reticulum (ER)



Cell Anatomy



- Endoplasmic Reticulum→ (ER)
  - Carry proteins and other materials through the cell

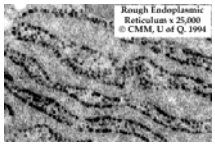
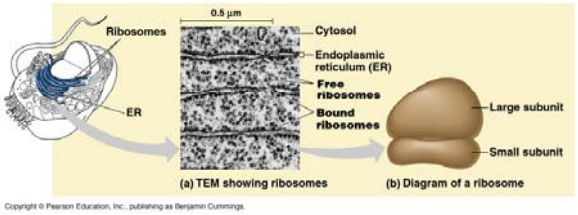
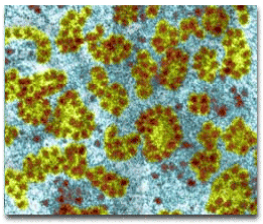


Figure 7.10 Ribosomes

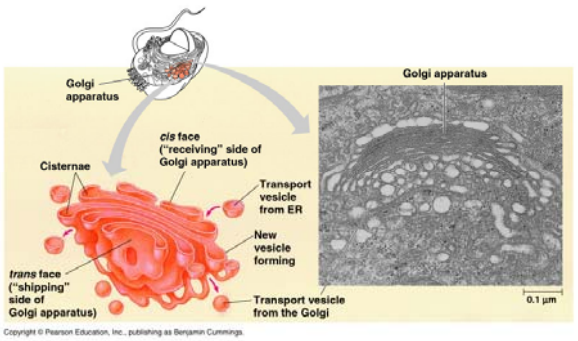


Cell Anatomy

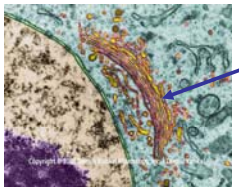


- Ribosome→
  - Found on ER or in the cytoplasm
  - Produce protein for the cell

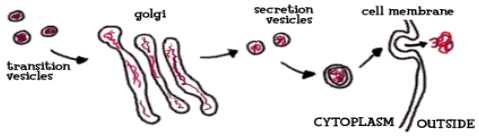
Figure 7.12 The Golgi apparatus



Cell Anatomy

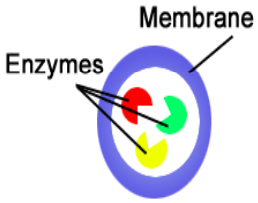


- Golgi Body→
  - Flattened sacs
  - Receive proteins and other material, package them and ship them out

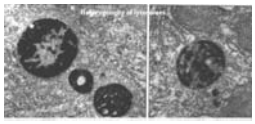


The Golgi apparatus is the FedEx of the cell because it packages proteins and ships vesicles throughout the cell

Cell Anatomy



- Lysosome→
  - Contain enzymes that function in digestion of food and dead cell parts
  - Surrounded by a membrane



Cell Anatomy

MORE NUMEROUS IN ANIMALS

- Lysosome→
  - Contain enzymes that function in digestion of food and dead cell parts
  - Surrounded by a membrane

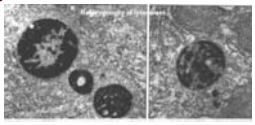


Figure 7.14 The formation and functions of lysosomes (Layer 1)

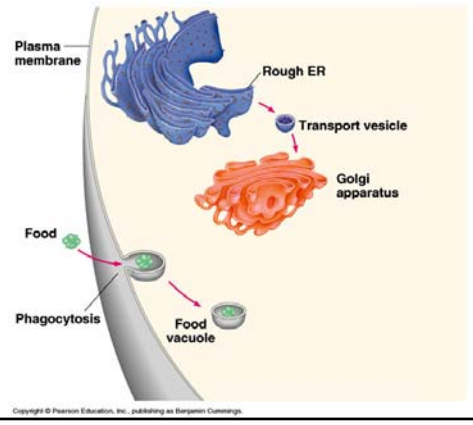


Figure 7.14 The formation and functions of lysosomes (Layer 2)

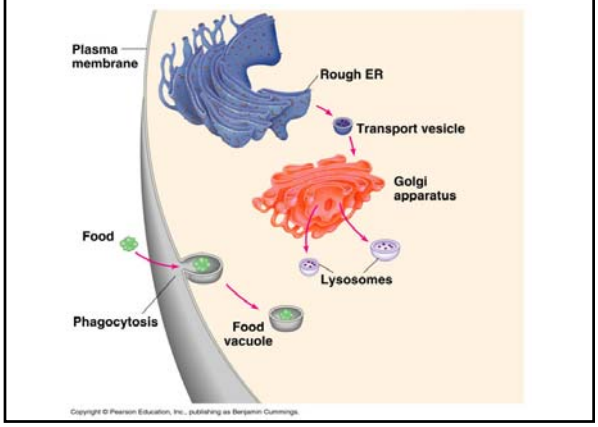


Figure 7.14 The formation and functions of lysosomes (Layer 3)

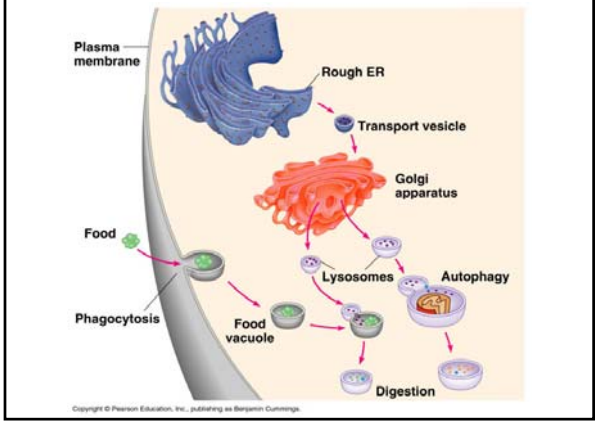


Figure 7.16 Review: relationships among organelles of the endomembrane system

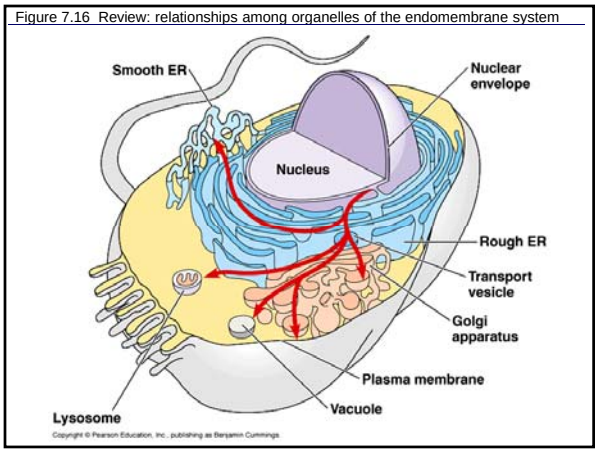
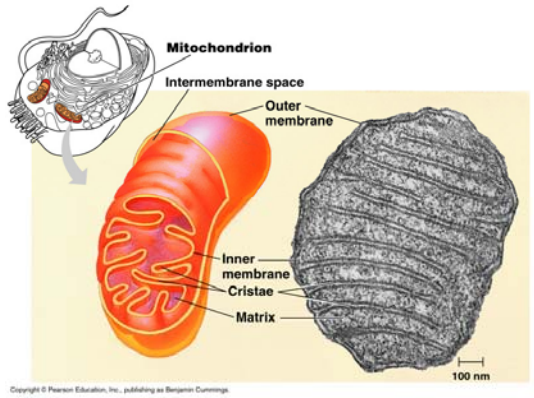


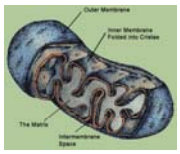
Figure 7.17 The mitochondrion, site of cellular respiration

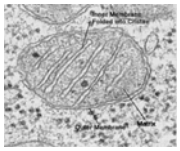


Why is the inside of the Mitochondria highly folded?

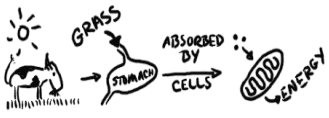
The cristae is the highly folded inner membrane of the mitochondria. It is folded to allow for greater surface area thus creating more room for making ATP

Cell Anatomy

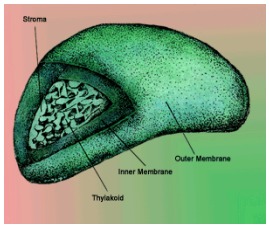




- Mitochondria→
  - Rod-shaped
  - Create energy for the cell from food
  - Why is the inside of the mitochondria folded?

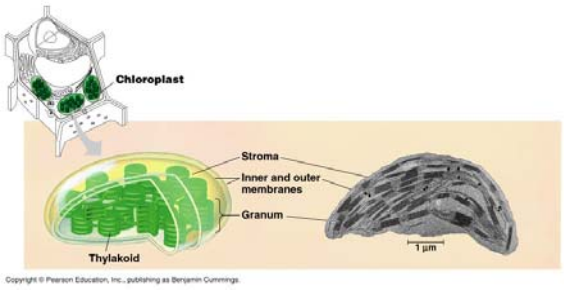


Cell Anatomy

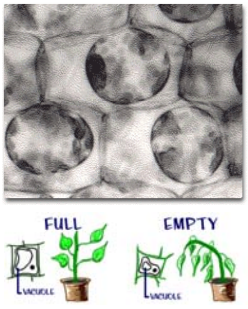


- Chloroplast→
  - Turn the Sun's energy into food through photosynthesis
    - They do not make energy, they convert it

Figure 7.18 The chloroplast, site of photosynthesis



Cell Anatomy



- Vacuole→
  - Store food water and other materials
  - Small in animal cell
  - Large in plants
    - Store H_2O
    - Help keep the plant upright

Figure 7.15 The plant cell vacuole

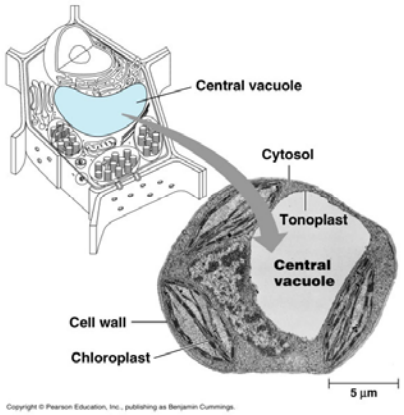


Table 7.2 The structure and function of the cytoskeleton

Table 7.2 The Structure and Function of the Cytoskeleton

Property	Microtubules	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, consisting of α-tubulin and β-tubulin	Actin	One of several different proteins of the keratin family, depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina
	10 µm	10 µm	5 µm
	Tubulin dimer, 25 nm	Actin subunit, 7 nm	Protein subunits, Fibrous subunits, 10 nm

SOURCE: Adapted from W. M. Becker, L. J. Kleinsmith, and J. Hardin, *The World of the Cell*, 4th ed. (San Francisco, CA: Benjamin Cummings, 2000), p. 753.

Figure 7.20 The cytoskeleton

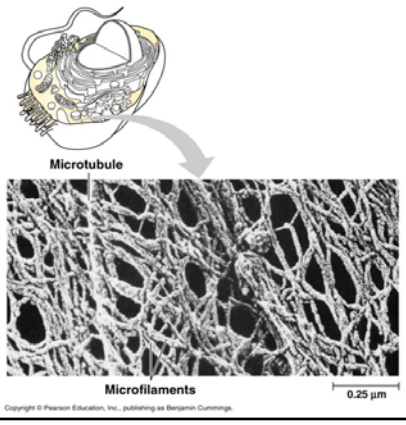


Figure 7.23 A comparison of the beating of flagella and cilia

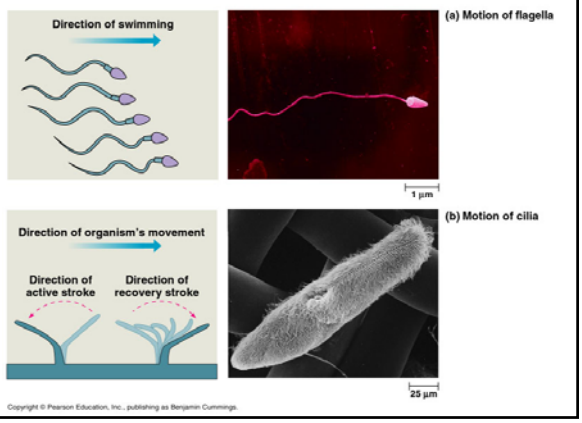
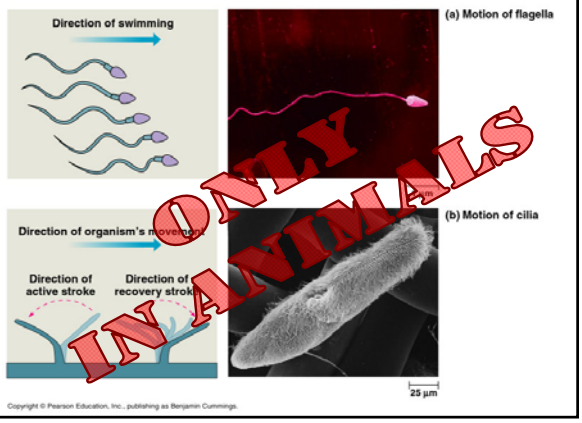
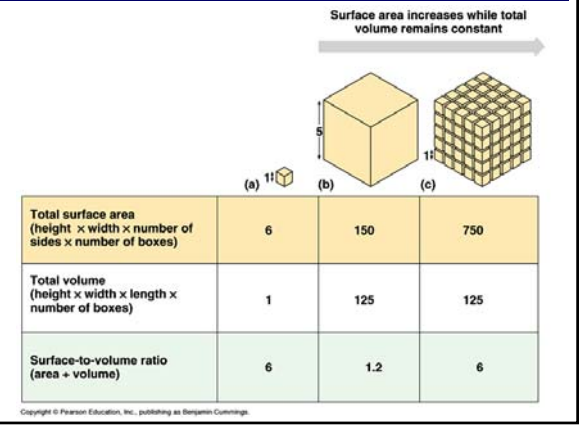


Figure 7.23 A comparison of the beating of flagella and cilia



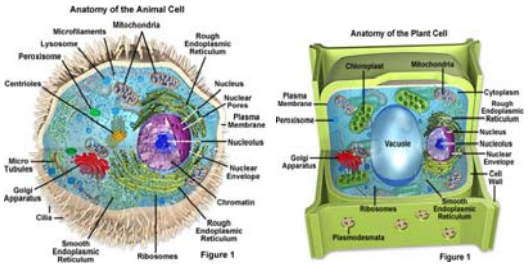
ONLY IN ANIMALS

Figure 7.5 Geometric relationships explain why most cells are microscopic



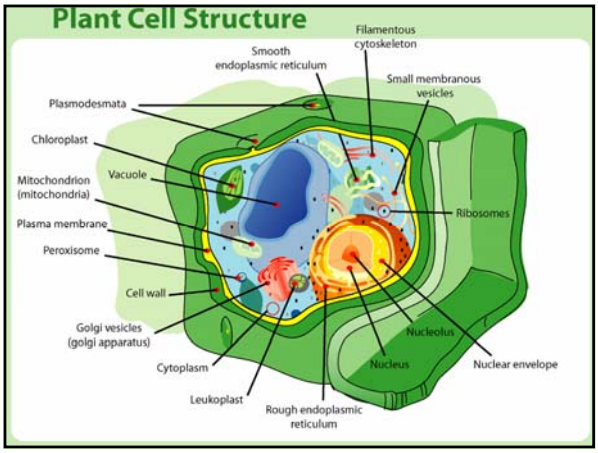
	(a)	(b)	(c)
Total surface area (height × width × number of sides × number of boxes)	6	150	750
Total volume (height × width × length × number of boxes)	1	125	125
Surface-to-volume ratio (area ÷ volume)	6	1.2	6

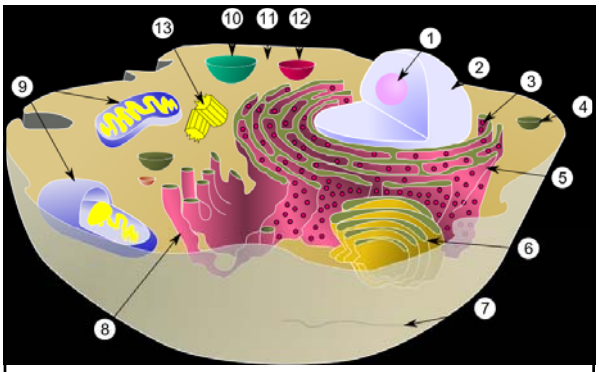
Animal vs. Plant



Animal vs. Plant

1. Plant cells have chloroplasts
2. Plant cells have a cell wall
3. Plant cells have a large central vacuole
4. Animal cells have more lysosomes





1. Nucleolus
2. Nucleus
3. Ribosome
4. Vesicle
5. Rough endoplasmic reticulum
6. Golgi apparatus (or "Golgi body")
7. Cytoskeleton
8. Smooth endoplasmic reticulum
9. Mitochondrion
10. Vacuole
11. Cytoplasm
12. Lysosome 13. Centriole