Chapter 3

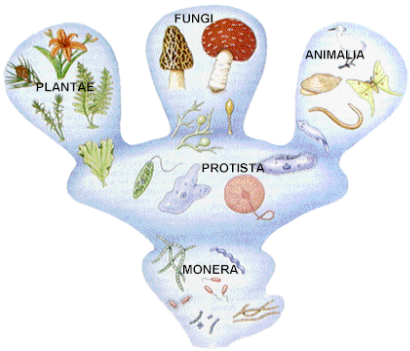
Prokaryotes and Eukaryotes

Prokaryote vs. eukaryote

✓Prokaryotic cells
- ✒Lack a membrane-bound nucleus
- ✒Lack a membrane-bound organelles.
  - ☞Bacteria and cyanobacteria

✓Eukaryotic cells
- ✒Much more complex
- ✒Containing a membrane-bound nucleus
- ✒Membrane-bound organelles.
  - ☞Animals, plants, protists, fungi

Five-Kingdom classification



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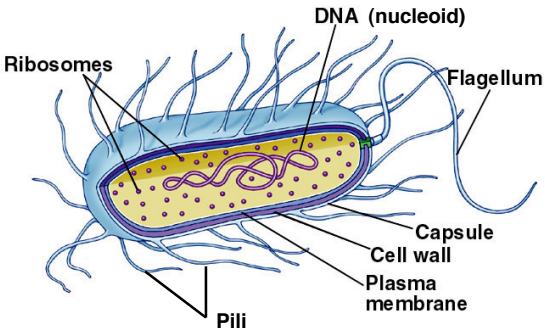
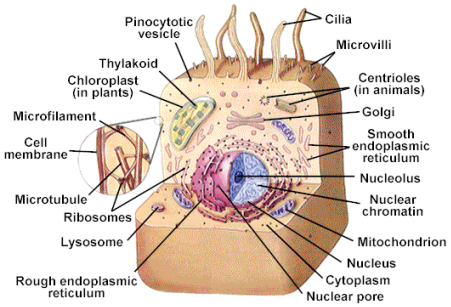
Bacterial Cell Structure



Eukaryotic cell



Cell shapes

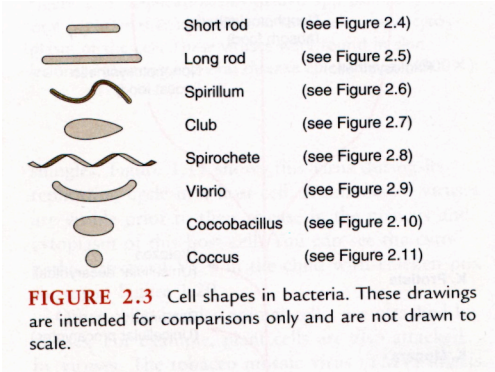
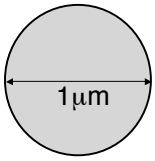


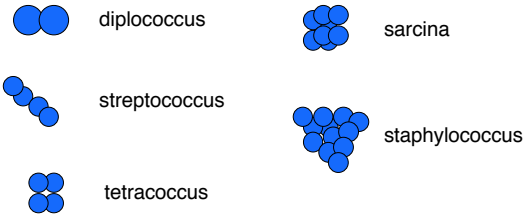
FIGURE 2.3 Cell shapes in bacteria. These drawings are intended for comparisons only and are not drawn to scale.

Cocci

One coccus, many cocci.

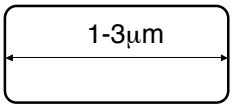


Arrangements of cocci

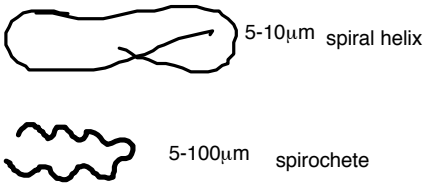


Bacilli

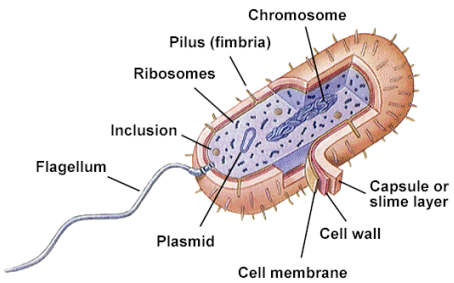
One bacillus, many bacilli.



Spirals



Prokaryotic cell

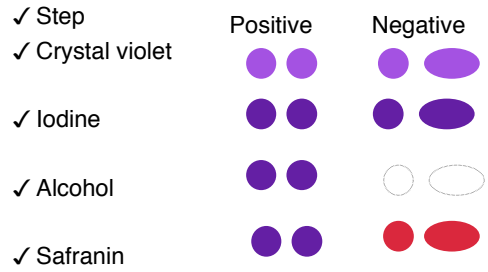


Key structural differences exist between Gram positive and Gram negative bacteria.

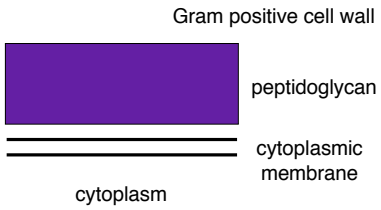
Gram stain

✓1. Crystal violet
✓2. Iodine
✓3. Alcohol rinse
✓4. Safranin

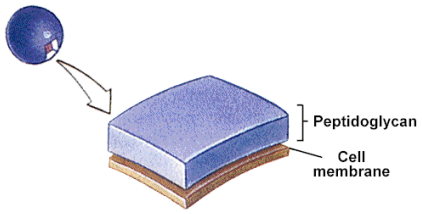
Gram reaction



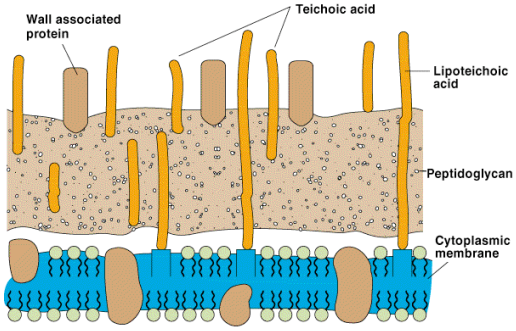
Gram positive



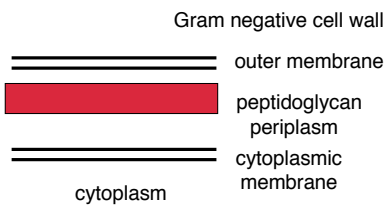
Gram (+)



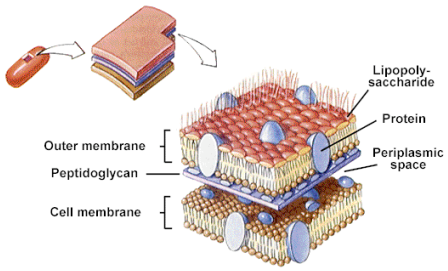
Gram (+) cell wall



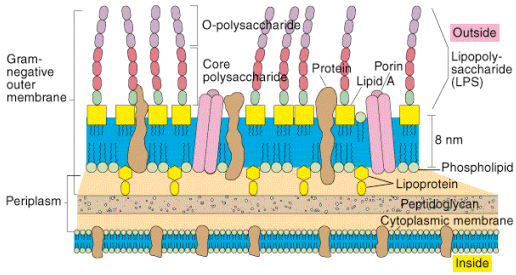
Gram negative



Gram (-)



Gram (-) cell wall

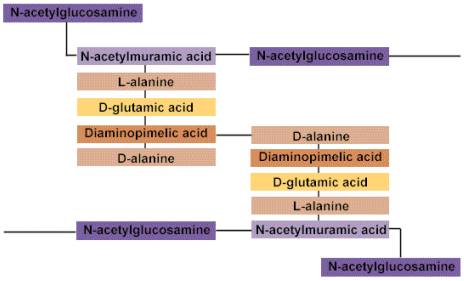


Peptidoglycan

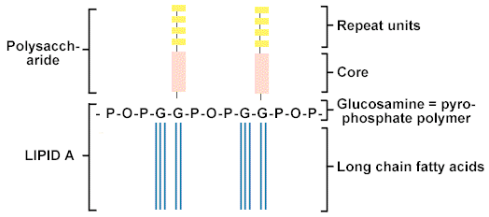
peptidoglycan contains cross-linked modified sugar subunits:

N-acetylglucosamine (NAG)
N-acetylmuramic acid (NAM)

Gram (-) peptidoglycan

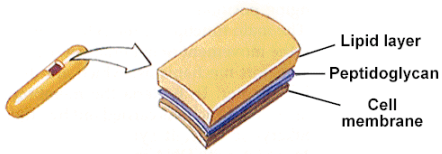


Lipopolysaccharide (endotoxin)



Acid fast bacteria

Carbolfuchsin gets into the cytoplasm and resists decoloration by the acid alcohol



Controlling bacteria

✓Damaging the cell wall
- ✒Penicillin
  - ☞Blocks the synthesis of peptidoglycan
- ✒Lysozyme
  - ☞Digests peptidoglycan

Membranes

✓Phospholipid bilayer.

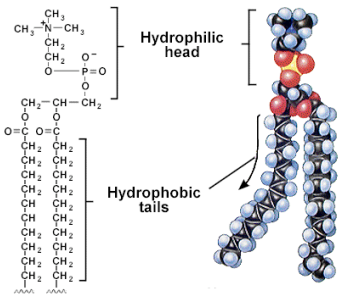
✓Contains proteins, glycoproteins, glycolipids.

✓"Fluid mosaic" structure.
- ☞Both protein and lipids move freely within the plane of the membrane

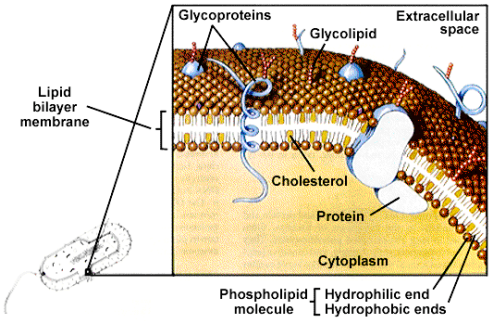
✓Serve as a hydrophobic barrier. Hydrophilic molecules are contained either outside or inside of the cell.

✓Membranes are selectively permeable.
- ☞Water will transport (diffuse) across the membrane
- ☞Membrane proteins help transport specific molecules across the membrane

Phospholipids



Fluid-mosaic model



Bacterial internal structures

✓Cytoplasm

✓Ribosomes
- ✒Polyribosomes

✓Nucleoid (nuclear region)

✓Chromatophores (photosynthetic bacteria)

✓Vacuoles (photosynthetic bacteria)

✓Endospores

External structures

✓Flagella
- ✒Polar -- on the end
  - ☞Monotrichous -- one on the end
  - ☞Amphitrichous -- one on each end
  - ☞Lophotrichous -- more than one on one or both ends
- ✒Peritrichous -- all over the surface of the cell
- ✒Atrichous -- no flagella

Monotrichous

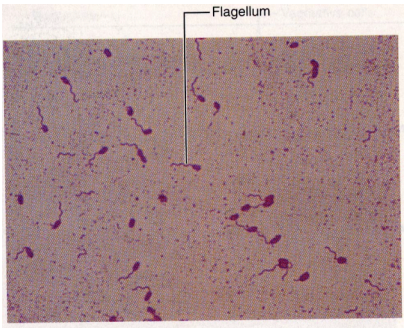


FIGURE 3.33 Monotrichous flagellation in *Pseudomonas aeruginosa* (3600×).

Amphitrichous

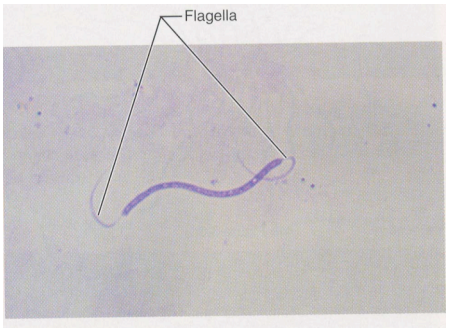


FIGURE 3.34 Amphitrichous flagella of *Spirillum volutans* (3600×).

Lophotrichous

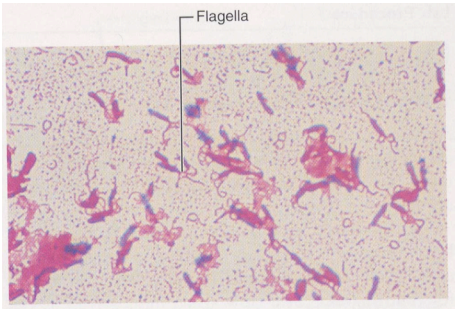


FIGURE 3.35 Lophotrichous flagella of *Pseudomonas marginalis* (3600×).

Peritrichous

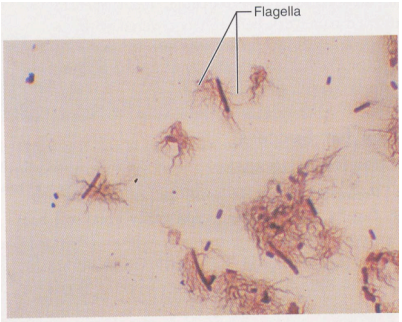
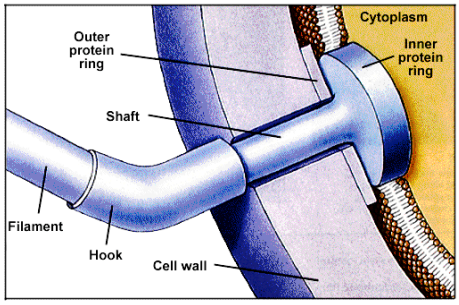
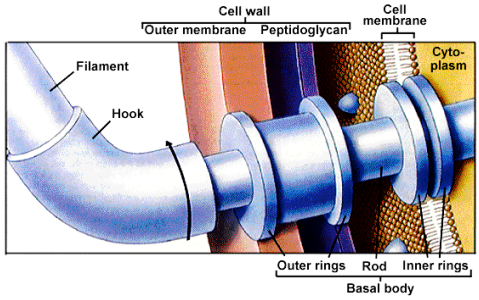


FIGURE 3.36 Peritrichous flagella of *Proteus vulgaris* (3600×).

Flagellum in Gram (+)



Flagellum in Gram (-)



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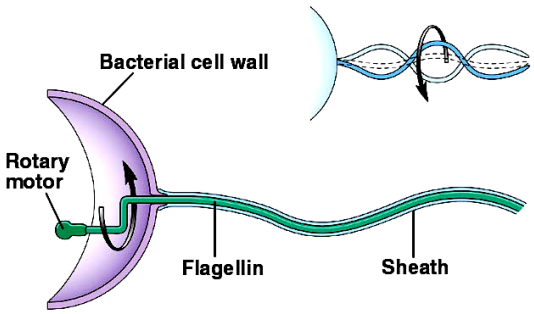
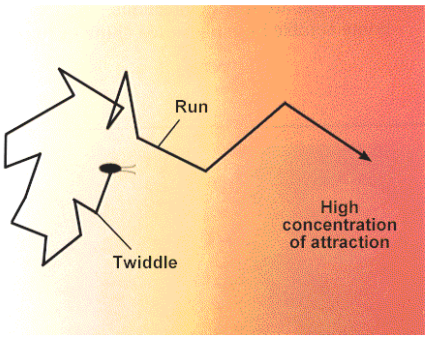
Bacterial Movement — Rotating Flagellum



Chemotaxis



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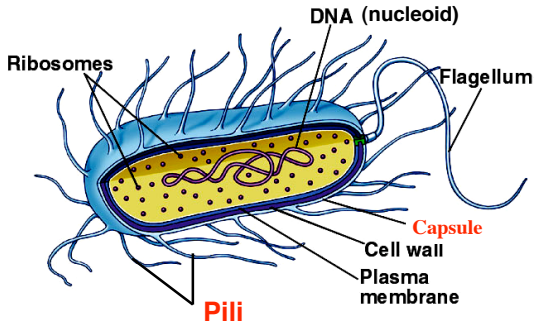
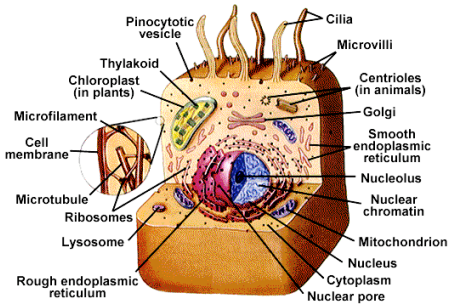
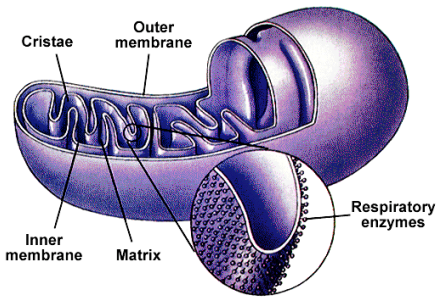
Bacterial Cell Structure



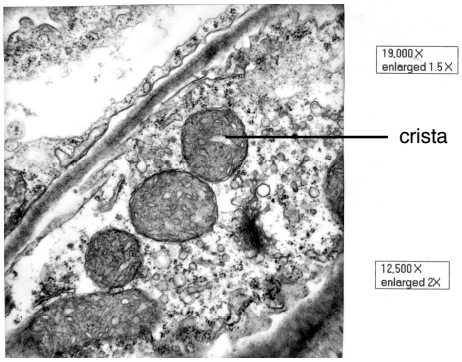
Eukaryotic cell



Mitochondria



Mitochondria

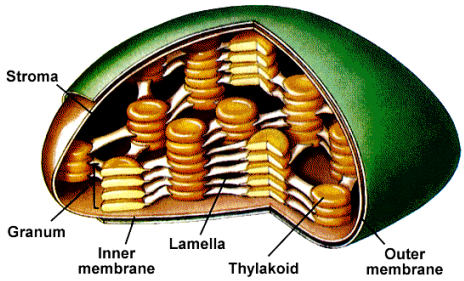


Function of the mitochondria

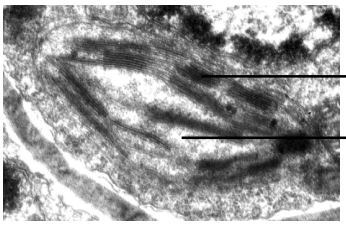
✓Cellular respiration

- ✒Site of Kreb's cycle.
- ✒Phosphorylating ATP using a proton motive force.

Chloroplast



Chloroplast

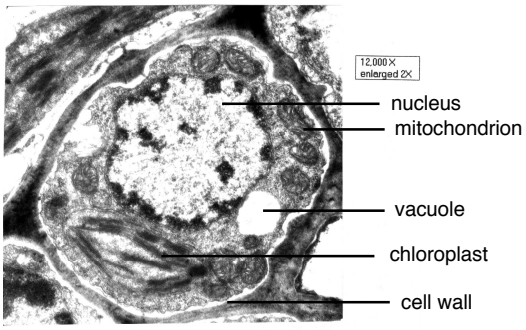


Function of the chloroplast

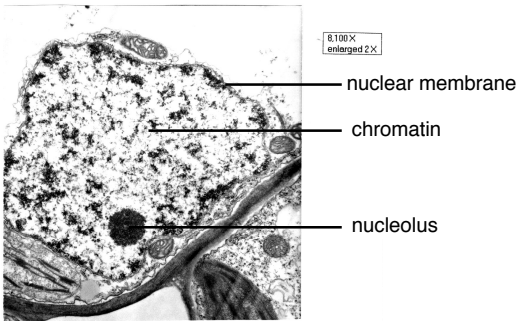
✓Site of photosynthesis.

- ✒Light capture in the thylakoid membranes of the grana.
- ✒Carbon fixation (forming carbohydrates) occurs in the stroma.

Plant Cell



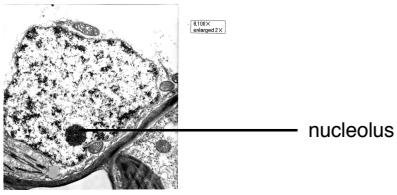
Nucleus



Nucleolus

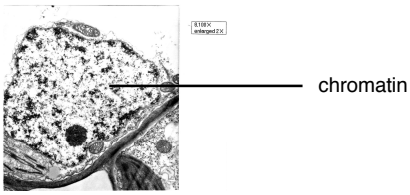
✓Structure found within nucleus.

✓Involved in the synthesis of ribosomes.



Chromatin

✓A complex of DNA and protein.

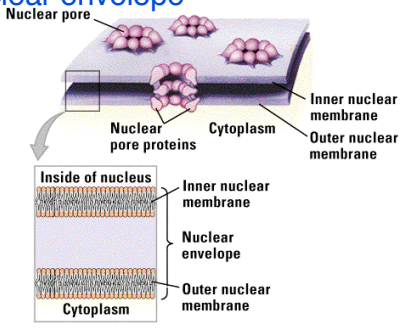


Plasma membrane

✓Regulation of movement of materials in and out of the cell

✓Receives and translates chemical and environmental signals from outside of the cell

Nuclear envelope



Intracellular Traffic

✓Endoplasmic reticulum

- Rough
  - ribosomes -- synthesis of proteins
- Smooth
  - synthesis and metabolism of lipids
  - detoxification alcohol

✓Golgi complex

- packaging center and traffic director

✓Lysosomes

- Enzymes -- breakdown macromolecules

Endoplasmic reticulum

Rough ER

Large, flattened, membrane sacs

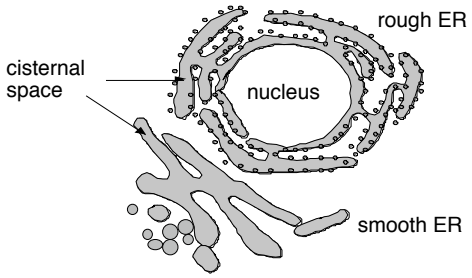
Predominates in cells actively synthesizing protein for export

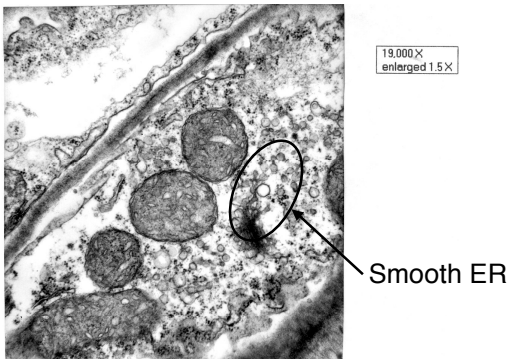
Smooth ER

Interconnected membrane tubules

Predominates in cells involved in metabolism of lipids, drugs, toxins

Endoplasmic reticulum

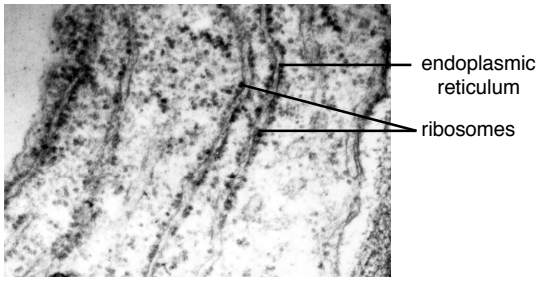




Functions of the smooth ER

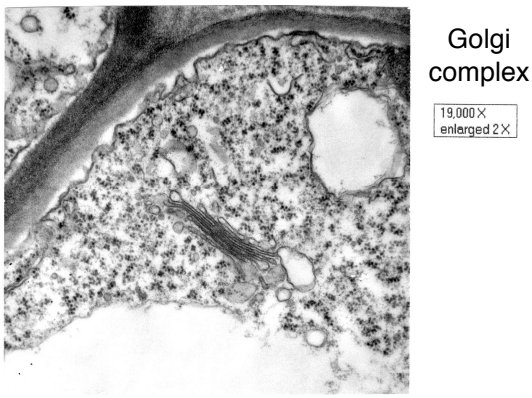
- ✓A receptacle of metabolic enzymes.
- ✓Synthesis of triacylglycerols and steroids.
- ✓Synthesis of phospholipids.
- ✓Detoxification of drugs, pesticides, toxins, and pollutants.

Rough ER



Functions of the rough ER

- ✓Protein targeting
- ✓Modification of proteins



Lysosomes

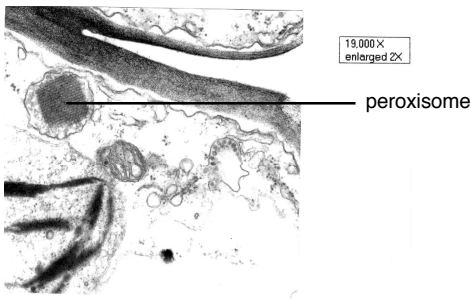
✓ Membrane-bounds vesicles that contain degradative enzymes.
- ✒ acid phosphatase
- ✒ other acid hydrolases such as proteases, nucleases, lipases, glycosidases

Lysosomes

Primary lysosome contains only degradative enzymes.

Secondary lysosomes have fused with another vesicle and in which degradative processing is occurring.

Peroxisomes



Function of peroxisomes

✓ Contain degradative enzymes that use oxygen.

✓ Contain the protective enzyme, catalase.

Vacuole

✓ Provide turgor pressure in plant cells.

✓ Contain water and waste materials.

✓ Store sugars and amino acids, pigments and other substances that may be harmful in the cytoplasm.

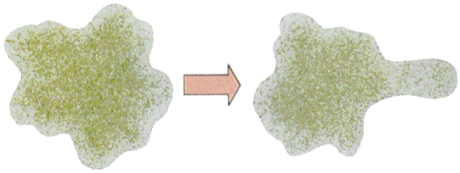
Cytoskeleton

✓ Comprised of 3 types of protein filaments.
- ✒ Microtubules
- ✒ Actin filaments (microfilaments)
- ✒ Intermediate filaments

Function of the cytoskeleton

- ✓ movements of cells -- within and outside the cell
- ✓ transport of materials
- ✓ Scaffolding (shape of cell)
- ✓ supports, organizes, guides interactions between organelles

Amoeboid movement

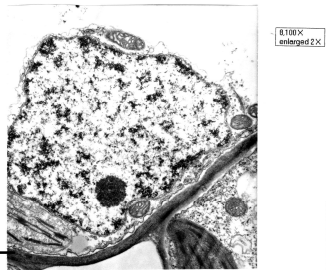


Resting amoeba with cytoplasm distributed evenly

Newly formed pseudopodium with less dense cytoplasm

Cell Wall

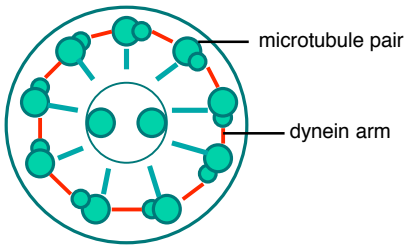
- ✓ Containment
- ✓ Protection
- ✓ Support



Flagellum/Cilium

- ✓ Plurals: flagella and cilia
- ✓ Flagella are whip-like; cilia are hair-like.
- ✓ Move cell through its environment or its environment past the cell!
- ✓ Have "9+2" arrangement of fused microtubules.

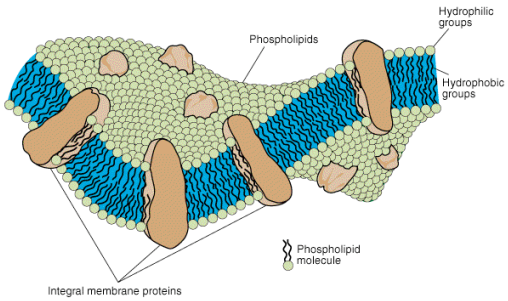
"9+2" arrangement



Movement of molecules through the membrane

- ✓ Passive Transport
  - ✒ Simple diffusion
  - ✒ Facilitated diffusion
- ✓ Active Transport

Bilayer lipid membrane



Factors influencing movement of molecules across the membrane

- ✓ Lipid solubility (hydrophobicity)
- ✓ Size of molecule.
- ✓ Electrical charge of molecule.
- ✓ Presence of membrane proteins that facilitate movement of large and electrically-charged molecules.

Simple diffusion

- ✓ Diffusion is the random movement of molecules, ions, or atoms from an area of high concentration to an area of low concentration.
- ✓ The space between the two areas is called a concentration gradient.
- ✓ Eventually equilibrium is established.

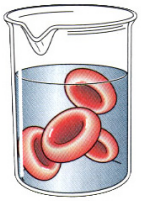
Simple diffusion through membranes.

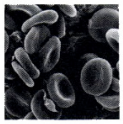
- ✓ For most lipid-soluble molecules, diffusion occurs through the plasma membrane without help of proteins.
- ✓ For large or electrically-charged molecules or ions, diffusion can be channel-mediated.

Osmosis

- ✓ Movement of water across a selectively permeable membrane in response to a concentration gradient.
- ✓ Movement of water is towards the zone of high concentration.
- ✓ The pressure associated with the movement of water is called osmotic pressure.

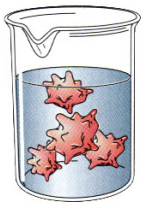
Isotonic

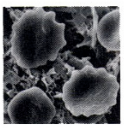




- ✓ Solute concentration is the same on both sides of the plasma membrane.
- ✓ Movement of water is equal in both directions.

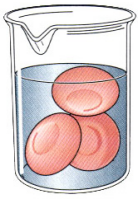
Hypertonic

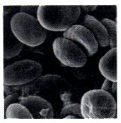




- ✓ Solute concentration is greater on the outside of cell.
- ✓ Movement of water is towards the greater solute concentration.
- ✓ Water moves OUT of the cell.

Hypotonic



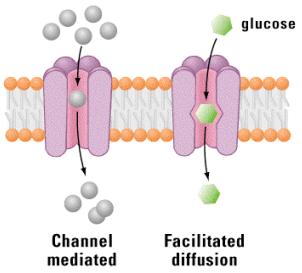


- ✓ Solute concentration is greater on the inside of cell.
- ✓ Movement of water is towards the greater solute concentration.
- ✓ Water moves INTO the cell.

Facilitated diffusion

- ✓ Increases the rate of passive transport.
- ✓ Specific proteins within the membrane facilitate the movement of molecules into and out of the cell.
- ✓ Movement is down a concentration gradient.

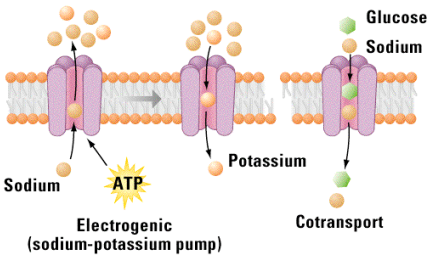
Channel-mediated vs. facilitated diffusion



Active Transport

- ✓ A pump mechanism that moves molecules and ions through the membrane.

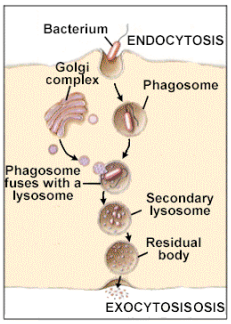
Sodium-Potassium Pump



Other mechanisms

✓ Membrane fusion
- ✒ Endocytosis
- ✒ Pinocytosis
- ✒ Exocytosis

Endocytosis and exocytosis



Plasmodesmata

✓ Intercellular channels that allow molecules to pass directly from one plant cell to another.

Cell connections

✓ Gap junctions - Intercellular connections between animal cells.

✓ Adhering junctions resist mechanical stress without affecting intercellular communication.

✓ Desmosomes connect cells together

✓ Tight junctions fuse membranes
- ✒ Prevent leaking around cells