Introduction to the Cell

Overview of Organelles and Their Properties

Cell Theory

- Living things are made of cells
- Cells are the smallest unit of life
- Cells come from pre-existing cells

- Evidense?

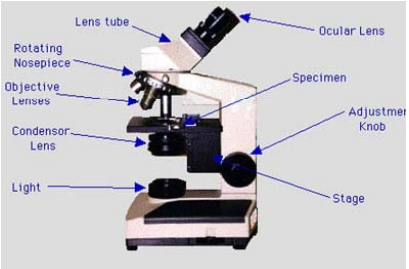
Visualizing Cells

- Microscopes
  - Magnification
    - Eyepiece times Objective
    - Resolving power vs magnification
    - Limits
    - Selection of proper scope to use

Types of Microscopes

- Light microscopes.
- Scanning electron microscope.
  - Coated with metal and scanned with electrons.
- Transmission electron microscope.
  - Sliced thin and stained. Bombarded with electrons.

Light Microscope

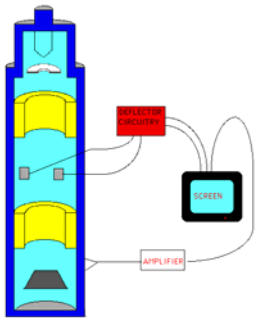


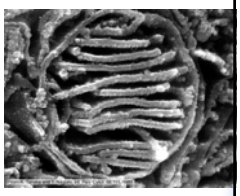
Light Microscopy

Table 7.1 Different Types of Llight Microscopy: A Comparison

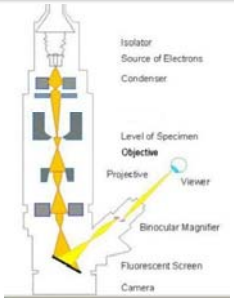
Type of Microscopy	Light Micrographs of Human Cheek Epithelial Cells		Type of Microscopy
Brightfield (unstained specimen). Passes light directly through specimen; unless cell is naturally pigmented or artificially stained, image has little contrast.			**Phase-contrast.** Enhances contrast in unstained cells by amplifying variations in density within specimen; especially useful for examining living, unpigmented cells.
Brightfield (stained specimen). Staining with various dyes enhances contrast, but most staining procedures require that cells be fixed (preserved).			**Differential-interference-contrast (Nomarski).** Like phase-contrast microscopy, it uses optical modifications to exaggerate differences in density.
Fluorescence. Shows the locations of specific molecules in the cell. Fluorescent substances absorb short-wavelength, ultraviolet radiation and emit longer-wavelength, visible light. The fluorescing molecules may occur naturally in the specimen but more often are made by tagging the molecules of interest with fluorescent molecules.			**Confocal.** Uses lasers and special optics for "optical sectioning." Only those regions within a narrow depth of focus are imaged. Regions above and below the selected plane of view appear black rather than blurry. This microscope is typically used with fluorescently stained specimens, as in the example here.

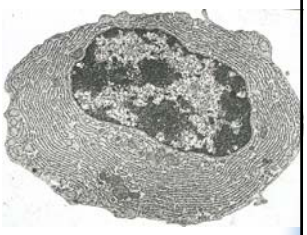
SEM





TEM





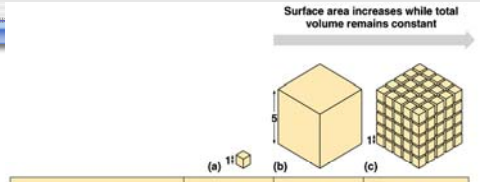
Cell Size

- What limits cell size?
  - SA/V
  - Function of nucleus

Cell Size

- Relative Size:
  - Molecule: 1 nm
  - Membrane: 10 nm
  - Virus: 100 nm
  - Bacteria 1 um
  - Organelle: up to 10 um
  - Cell: up to 100um

SA/V

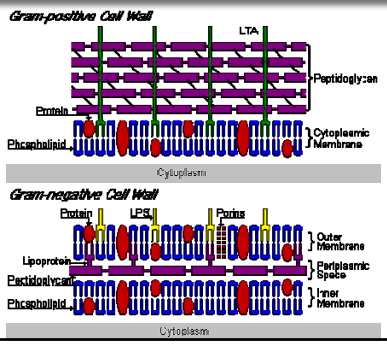


Total surface area (height × width × number of sides × number of boxes)	6	150	750
Total volume (height × width × length × number of boxes)	1	125	125
Surface-to-volume ratio (area ÷ volume)	6	1.2	6

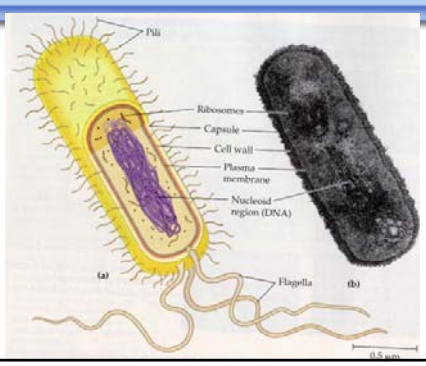
Prokaryotic Cells

- Bacteria and Arachaea
- Size
  - 2-8 um
- No Nucleus
- Nucleoid
- Ribosomes (70s)
- Plasma membrane
- Cell Wall
- Capsule
- Pili
- Flagella

Bacterial Cell Wall



Prokaryote Structure



Eukaryotic Cells

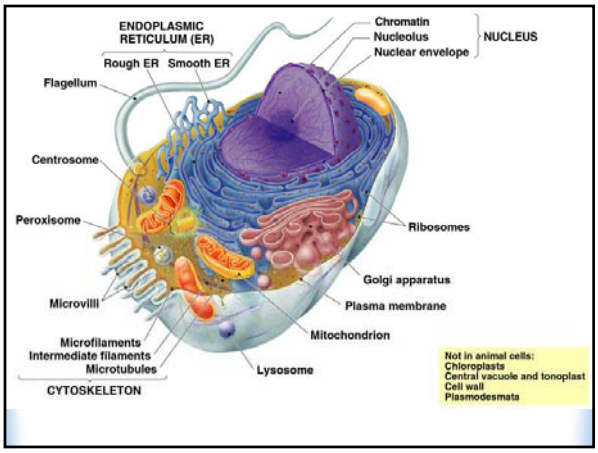
- Larger
  - 10-100 um
- Internal membranes
- Non membrane organelles
- Membranous organelles
  - Nucleus
  - Endoplasmic Reticulum
  - Golgi
  - Mitochondria / Plastids
  - Lysosomes
  - Peroxisomes

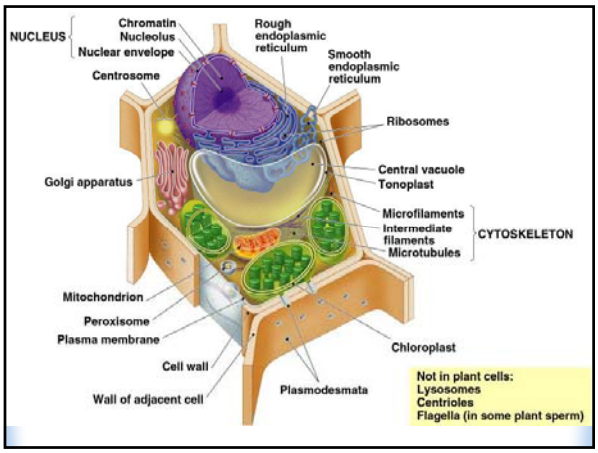
Eukaryotic Cells

- Non-membranous Organelles
  - Ribosomes
  - Microtubules
  - Centrioles
  - Flagella
  - Cytoskeleton
- Animal Cells are bounded by a plasma membrane with no cell wall
- Plant cells have a plasma membrane and cell wall. They also have a large central vacuole

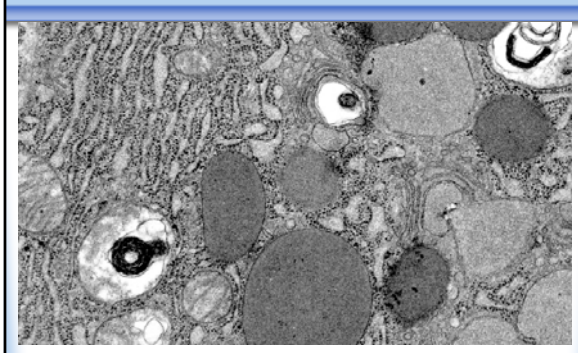
Prokaryote vs Eukaryote

- Prokaryote
  - Naked DNA
  - DNA in Cytoplasm
  - No Mitochondria
  - 70s Ribosomes
  - No internal membranes
- Eukaryote
  - DNA with Associated Proteins (Histones)
  - DNA in Nucleus
  - Mitochondria
  - 80 s Ribosomes
  - Membrane bound organelles

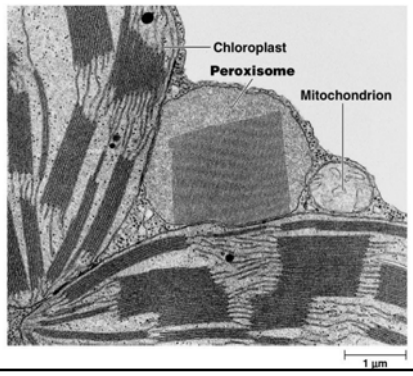




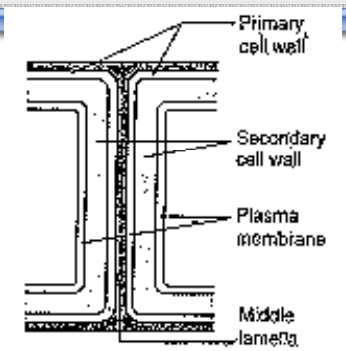
Liver Acinar Cell TEM



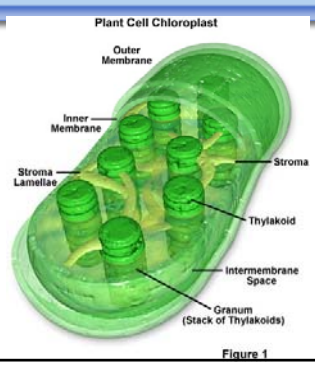
Plant or Animal?



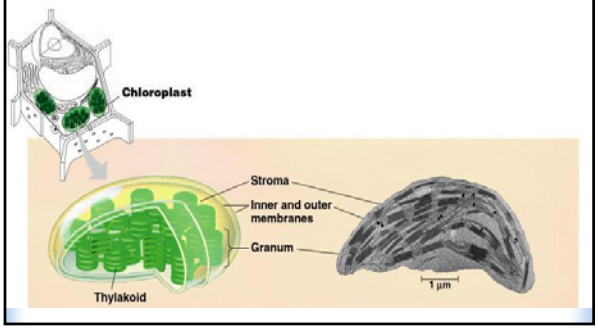
Plant Cell Wall



Chloroplast

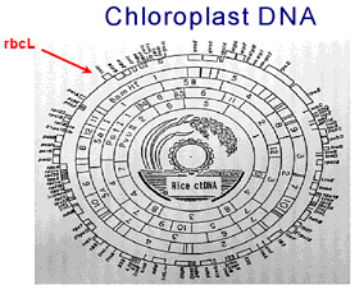


Chloroplast



Chloroplast DNA

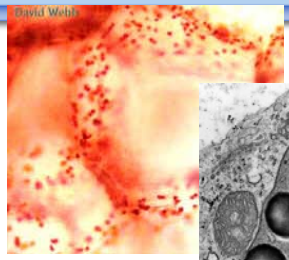
Chloroplast DNA

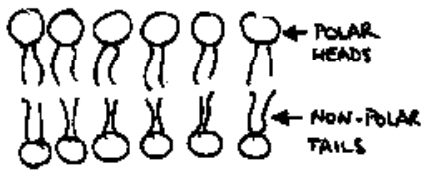


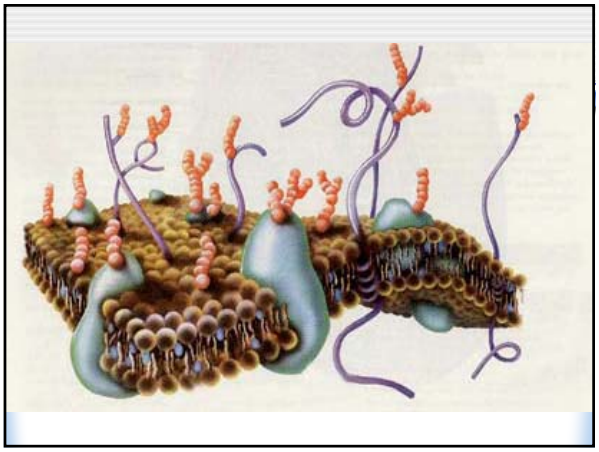
Eukaryotic Cells

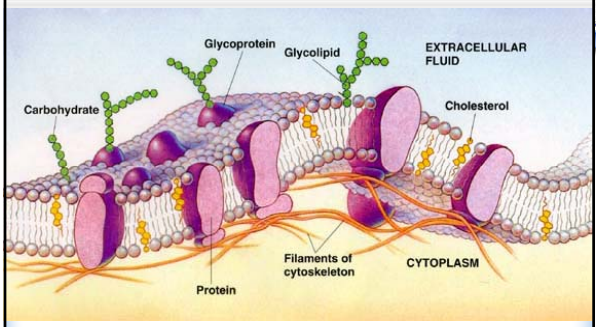
- Plants
  - Lack centrioles
  - Usually Lack lysosomes and flagella
  - Have Plastids
    - Chromo
    - Chloro
    - Leuko

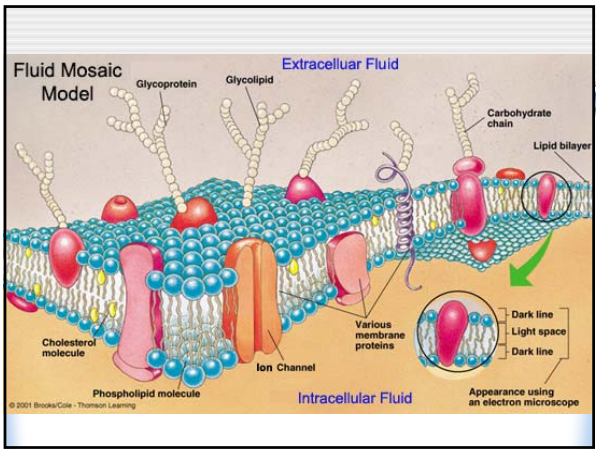
Plastids

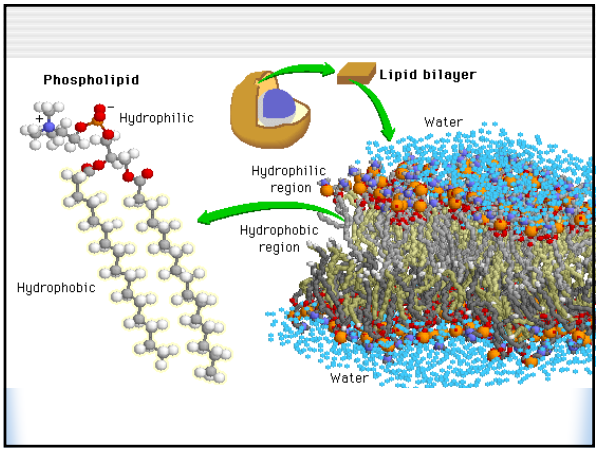


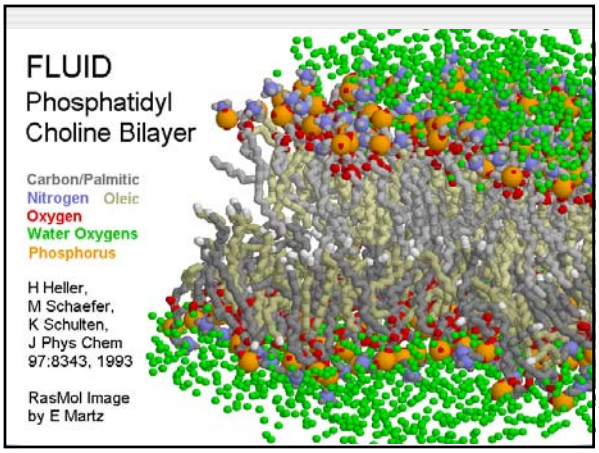

POLAR HEADS
NON-POLAR TAILS

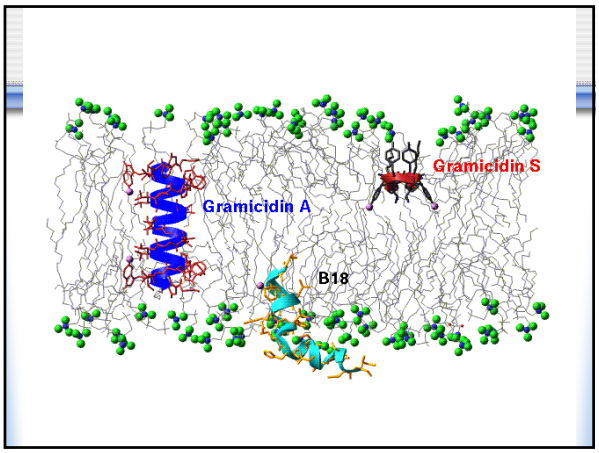



Glycoprotein
Glycolipid
EXTRACELLULAR FLUID
Carbohydrate
Cholesterol
Filaments of cytoskeleton
CYTOPLASM
Protein

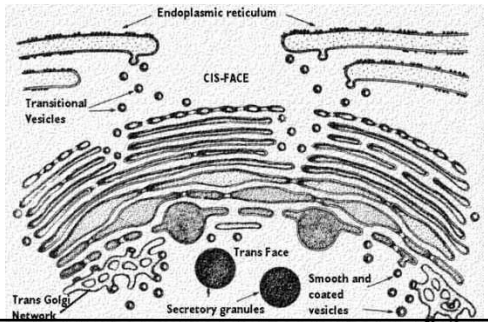

Fluid Mosaic Model
Extracelluar Fluid
Glycoprotein
Glycolipid
Carbohydrate chain
Lipid bilayer
Cholesterol molecule
Various membrane proteins
Dark line
Light space
Dark line
Ion Channel
Phospholipid molecule
Intracellular Fluid
Appearance using an electron microscope
© 2001 Brooks/Cole - Thomson Learning


Phospholipid
Hydrophilic
Lipid bilayer
Water
Hydrophilic region
Hydrophobic region
Hydrophobic
Water

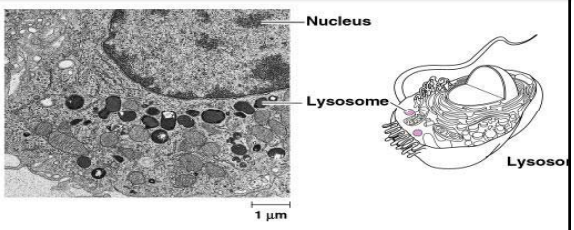

FLUID
Phosphatidyl Choline Bilayer
Carbon/Palmitic
Nitrogen Oleic
Oxygen
Water Oxygens
Phosphorus
H Heller, M Schaefer, K Schulten, J Phys Chem 97:8343, 1993
RasMol Image by E Martz



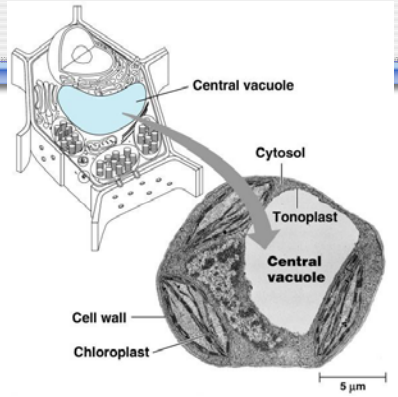
ER/Golgi Mission

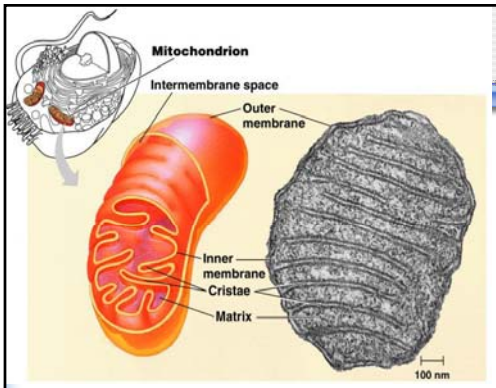


Lysosome



(a) Lysosomes in a white blood cell



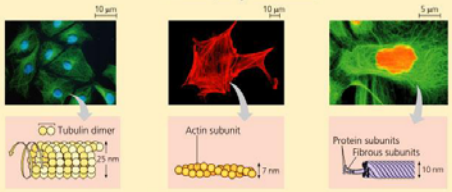


Cytoskeleton

- Microtubules, Microfilaments, and Intermediate fibers
- Microtubules- made of tubulin aide in movement in the cell and the whole cell
- Microfilaments- solid rods for cell movement and contraction
- Intermediate fibers- ropelike strands of fibrous proteins for anchors

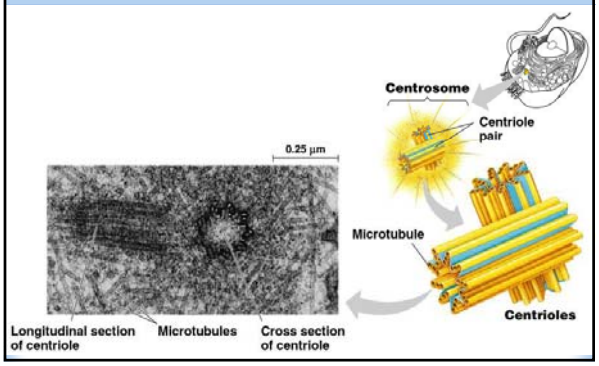
Table 7.2 The Structure and Function of the Cytoskeleton

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

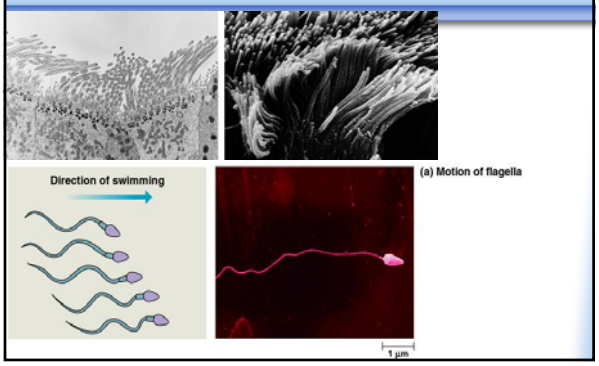


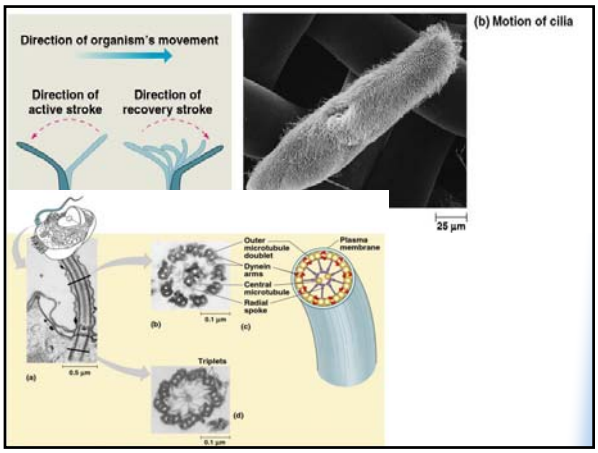
SOURCE: Adapted from W. M. Becker, L. J. Kleinsmith, and J. Hardin, *The World of the Cell*, 4th ed. (San Francisco, CA: Benjamin Cummings, 2000), p. 733.

Centriole vs Centrosome

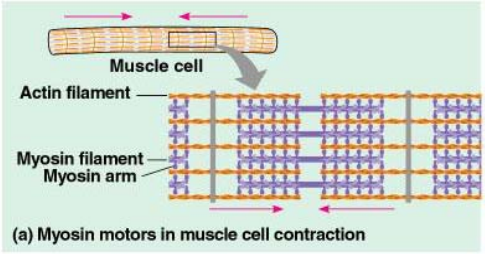


Cilia and Flagella



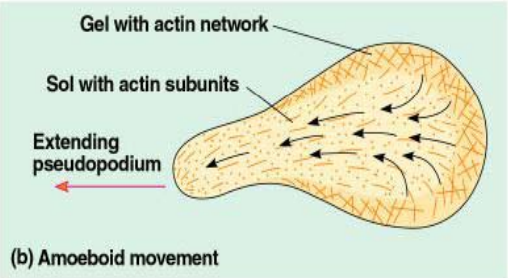


Movement



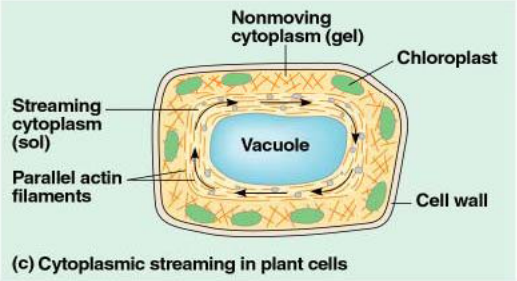
(a) Myosin motors in muscle cell contraction

Movement



(b) Amoeboid movement

Movement

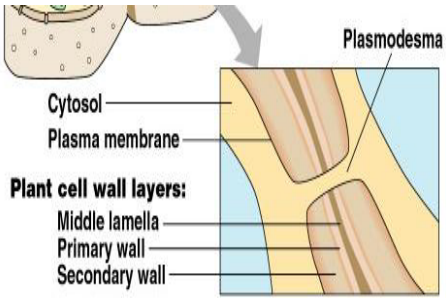


(c) Cytoplasmic streaming in plant cells

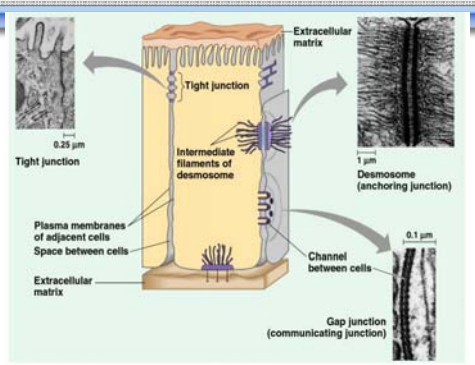
Eukaryotic Cell Junctions

- Plants
  - Plasmodesmata
- Animals
  - Tight Junctions
  - Gap Junctions
  - Desmosomes

Plasmodesmata and Gap Junctions



Plasmodesmata and Gap Junctions



Major Functions of Organelles

- Manufacture
- Breakdown
- Energy Processing
- Support and Movement