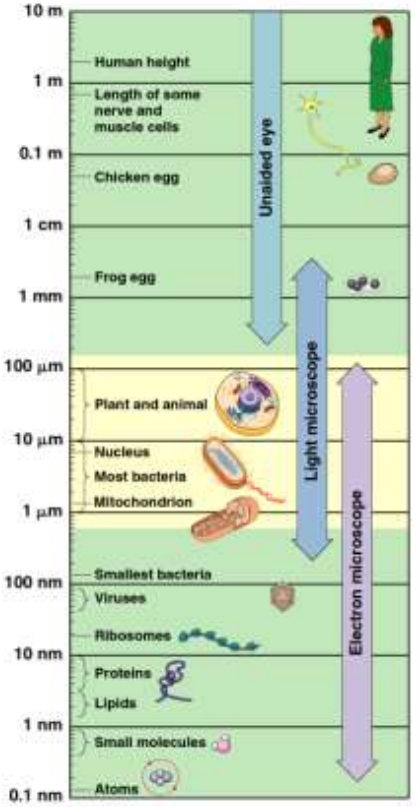
- **Chapter 7:** ***A Tour of the Cell***

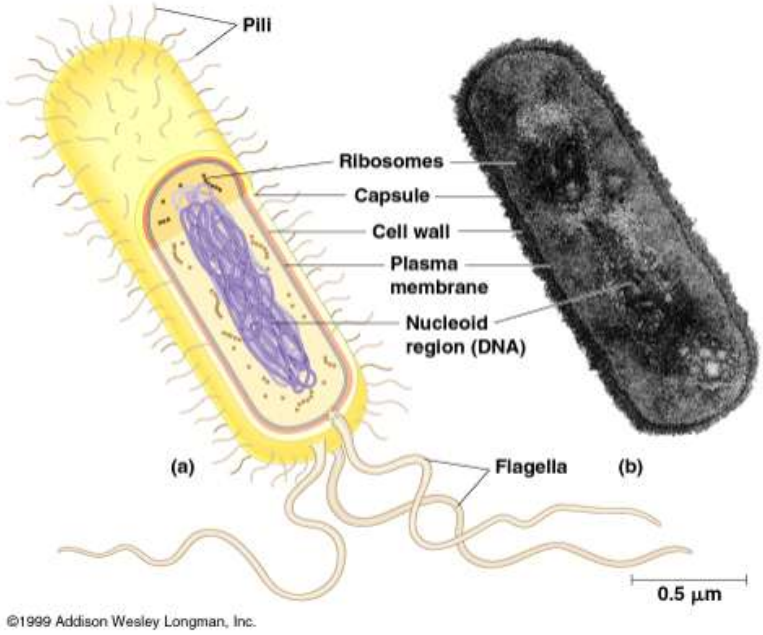
Cytology

- Light microscopy
  - resolving power
- Electron microscopy
  - TEM
  - SEM
- Cell fractionation
- Ultracentrifuges

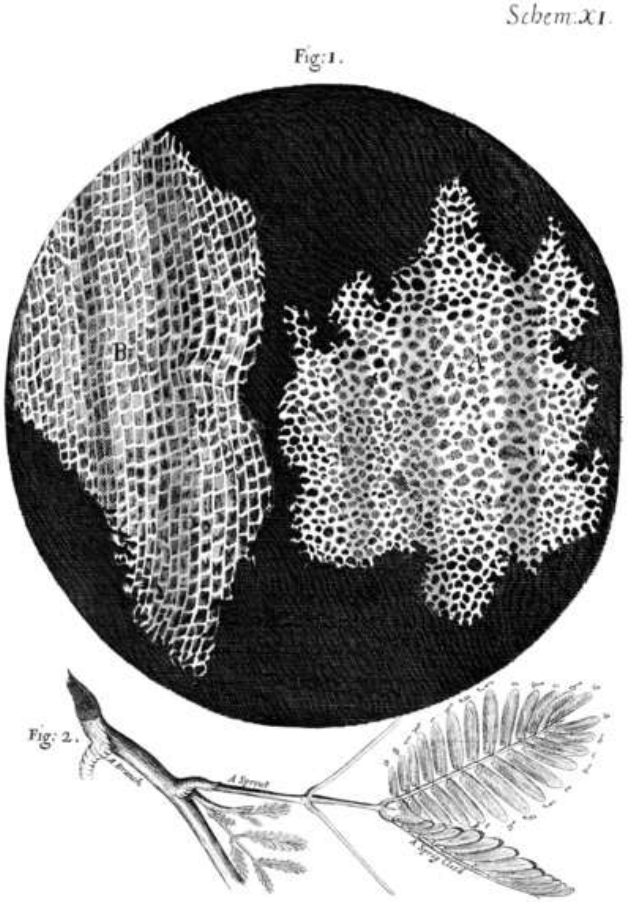


Prokaryotic cells

- Nucleoid
- No organelles with membranes
- Ribosomes
- Plasma membrane
- Cytoplasm/cytosol



Cell Theory

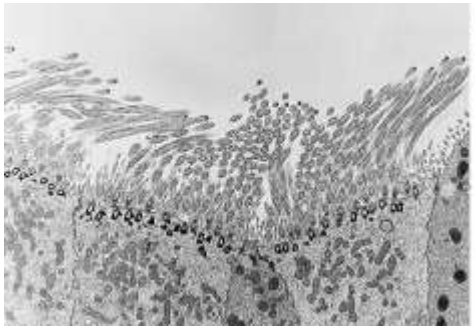


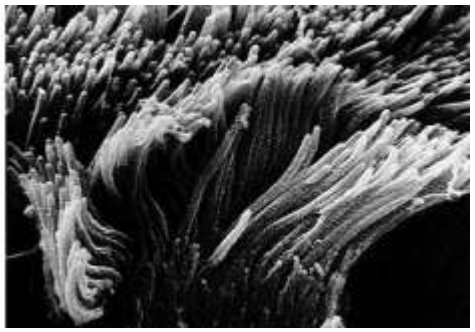
- Hooke, Leeuwenhoek, Schleiden, Schwann, Virchow
- All living things or organisms are made of cells and their products.
- New cells are created by old cells dividing into two.
- Cells are the basic building units of life.

Cytology: science/study of cells

- Light microscopy
  - resolving power~ measure of clarity
- Electron microscopy
  - TEM~ electron beam to study cell ultrastructure
  - SEM~ electron beam to study cell surfaces

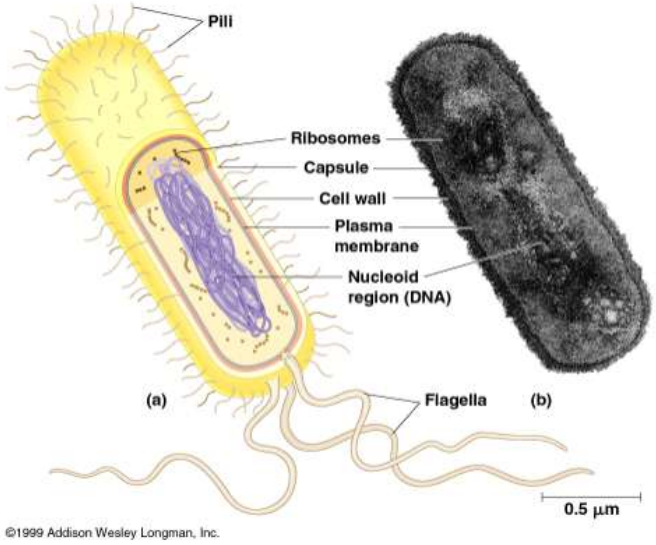
- Cell fractionation~ cell separation; organelle study
- Ultracentrifuges~ cell fractionation; 130,000 rpm





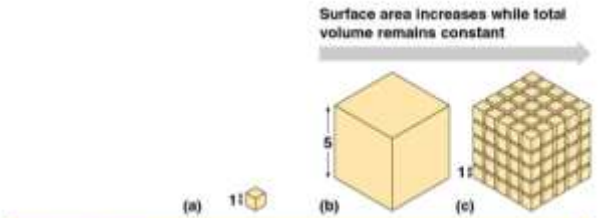
Cell Types: *Prokaryotic*

- Nucleoid Region: DNA concentration
- No organelles with membranes
- Ribosomes: protein synthesis
- Plasma membrane: semi-permeable
- Cytoplasm/cytosol (all cells)
- Archea (no peptidoglycan
- Eubacteria (with peptidoglycan)



Cell size

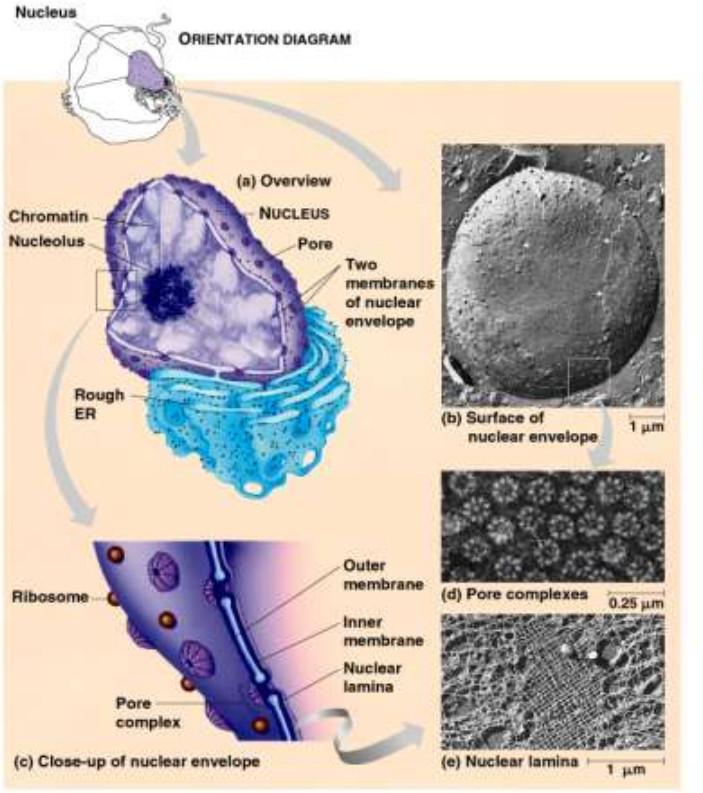
- As cell size increases, the surface area to volume ratio decreases
- Rates of chemical exchange may then be inadequate for cell size
- Cell size, therefore, remains small



	(a) 1	(b) 5	(c) 1
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-area-to-volume ratio (area ÷ volume)	6	1.2	6

Nucleus

- Genetic material...
    - chromatin
    - chromosomes
    - *nucleolus*: rRNA; ribosome synthesis
- Double membrane envelope wi pores
- Protein synthesis (mRNA)



Organelle Chart

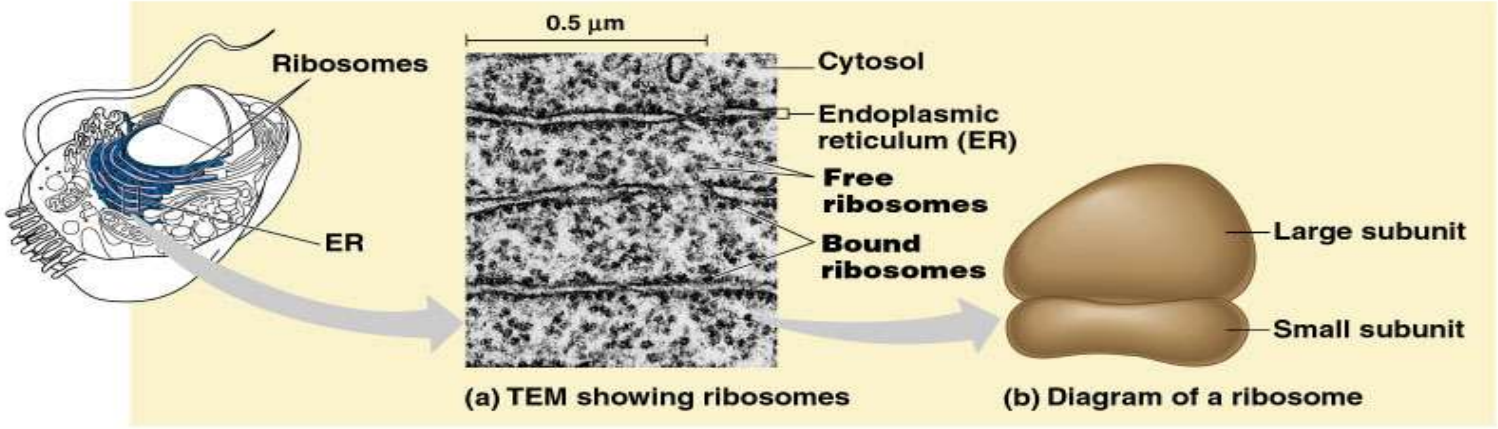
1. Ribosomes
2. Endoplasmic reticulum
3. Golgi apparatus
4. Vacuoles
5. Cytoskeleton
6. Flagella
7. Cilia
8. Mitochondria
9. Chloroplast
10. Lysosome

Place each organelle in chart with the following information:

structure
function
drawing

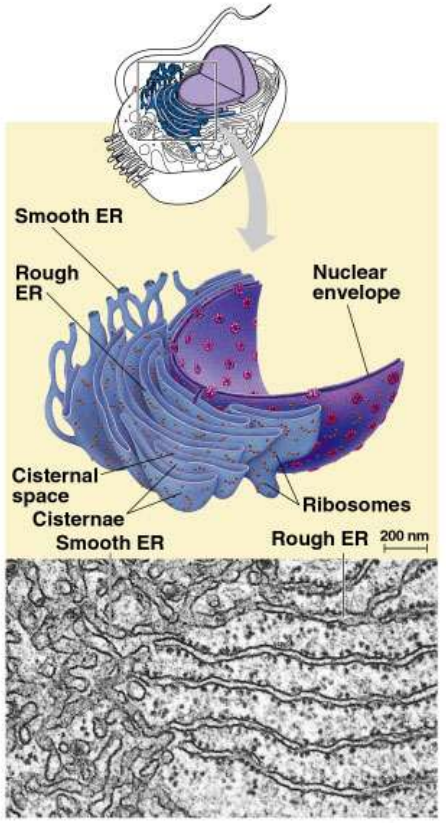
Ribosomes

- Protein manufacture
- *Free* •cytosol; •protein function *in* cell
- *Bound* •endoplasmic reticulum; •membranes, organelles, and *export*



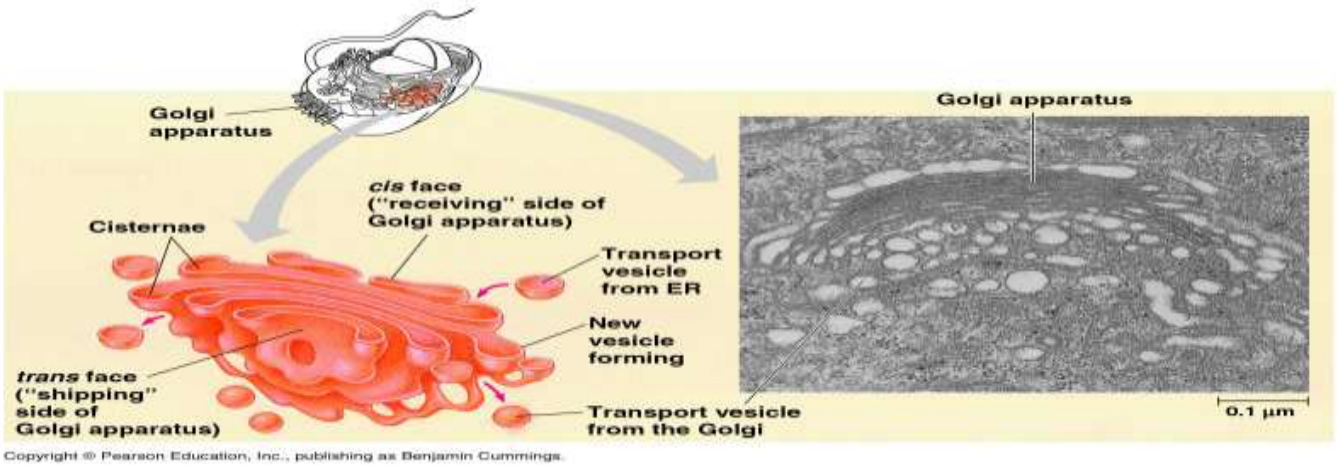
Endomembrane system, I

- <u>Endoplasmic reticulum (ER)</u>
- Continuous with nuclear envelope
- Smooth ER •no ribosomes; •synthesis of lipids, •metabolism of carbohydrates; •detoxification of drugs and poisons
- Rough ER •with ribosomes; •synthesis of secretory proteins (glycoproteins), membrane production



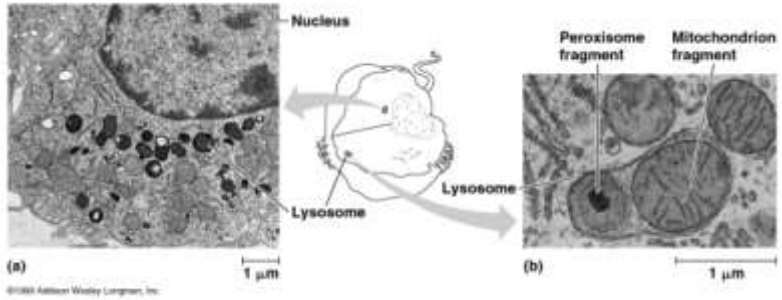
Endomembrane system, II

- <u>Golgi apparatus</u> then shipped
- ER products are modified, stored, and
- Cisternae: flattened membranous sacs
- *trans* face (shipping) & *cis* face (receiving)
- Transport vesicles



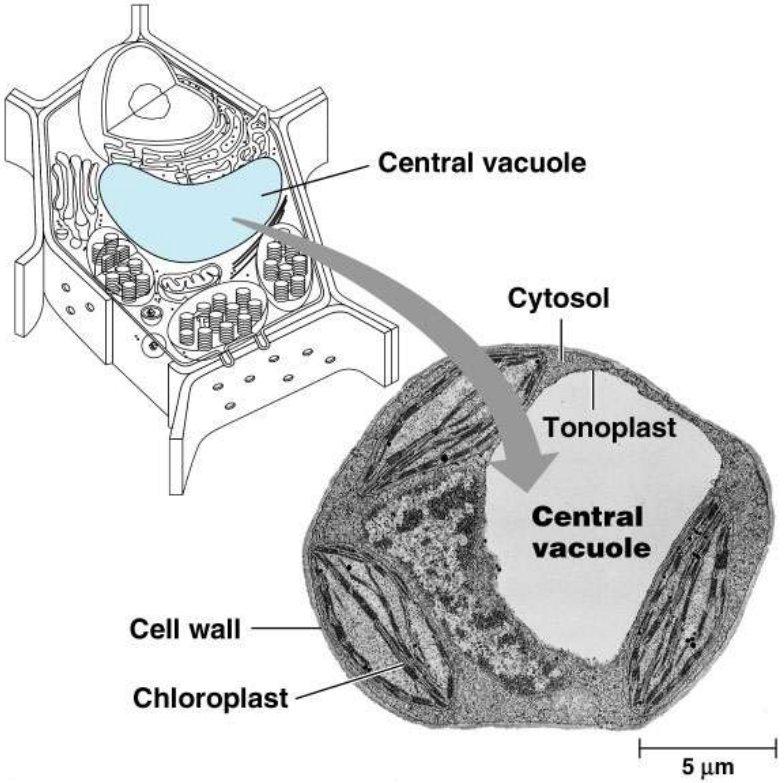
Endomembrane system, III

- Lysosomes
  - sac of hydrolytic enzymes; digestion of macromolecules
  - Phagocytosis
  - Autophagy: recycle cell's own organic material
  - Tay-Sachs disease - lipid-digestion disorder



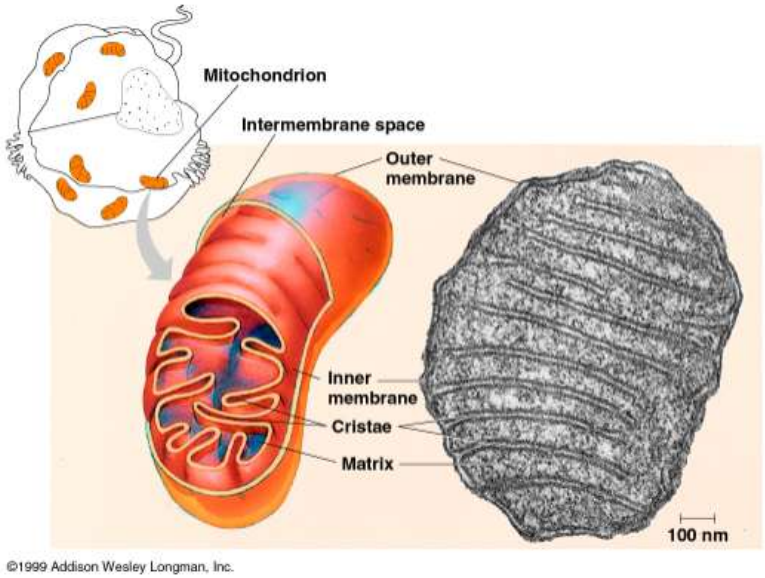
Endomembrane system, IV

- Vacuoles
  - membrane-bound sacs (larger than vesicles)
- Food (phagocytosis)
- Contractile (pump excess water)
- Central (storage in plants)
  - tonoplast membrane



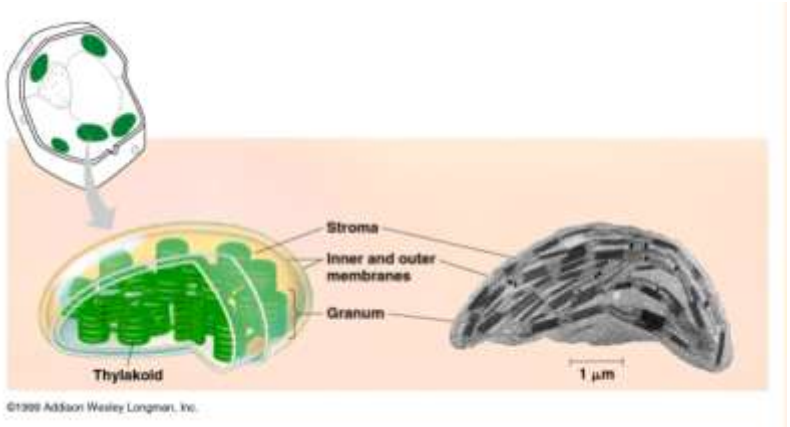
Other membranous organelles, I

- <u>Mitochondria</u>
- cellular respiration;
- double membranous;
- cristae/matrix;
- contain DNA



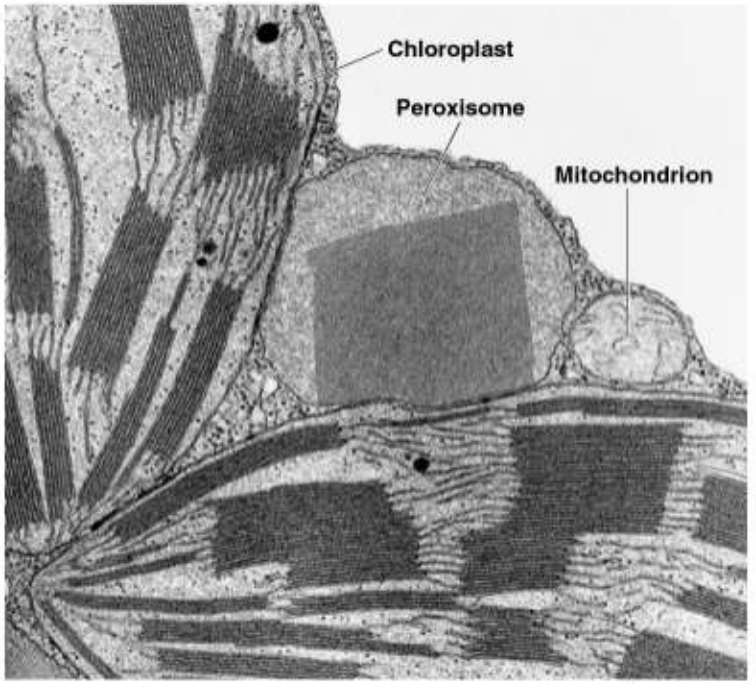
Other membranous organelles, II

- Chloroplast
  - plastid;
  - double membranous;
  - thylakoids;
  - grana;
  - stroma;
  - own DNA



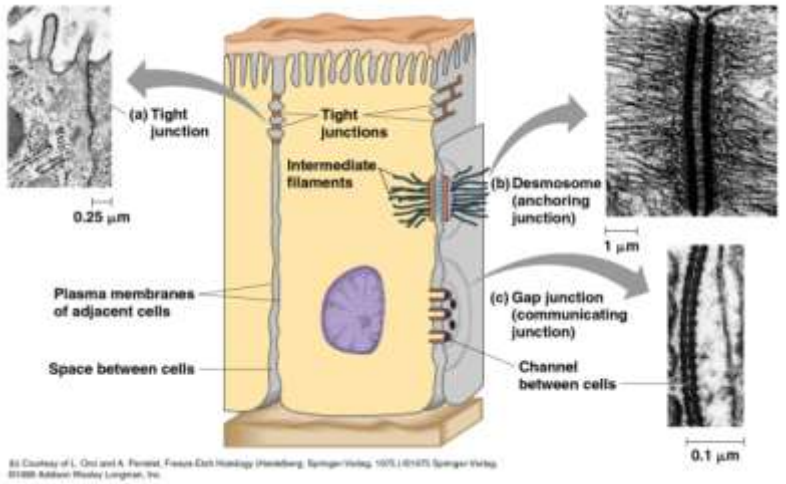
Peroxisomes

- Single membrane
- Produce hydrogen peroxide in cells
- Metabolism of fatty acids; detoxification of alcohol
- Hydrogen peroxide then converted to water



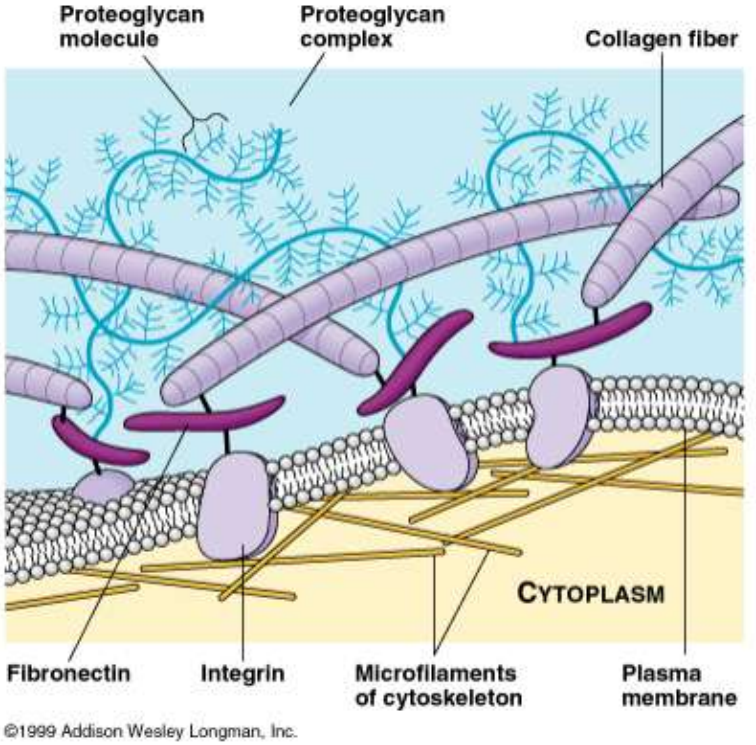
Intracellular junctions

- Plasmodesmata: cell wall perforations
- Tight junctions~ animal cells; prevents leakage between cells
- Desmosomes~ anchoring junction
- Gap junctions~ animal cells; allows passage of material or current between cells



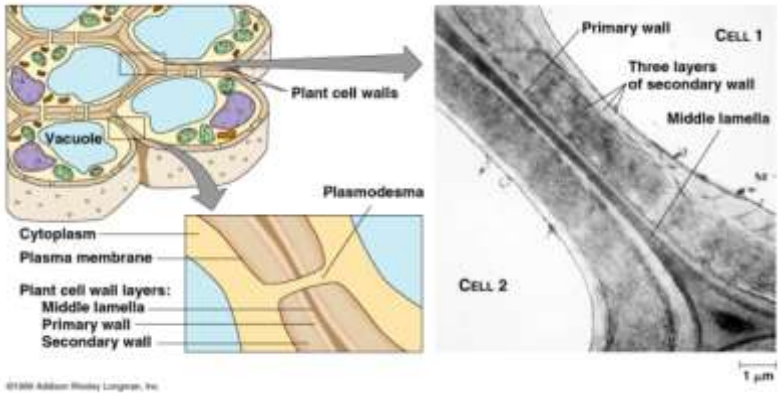
Extracellular matrix (ECM)

- **Glycoproteins:**
  - **proteins covalently bonded to carbohydrate**
- **Collagen (50% of protein in human body)**
  - **embedded in proteoglycan (another glycoprotein- 95% carb)**
- **Fibronectins**
  - **bind to receptor proteins in plasma membrane called integrins (cell communication?)**



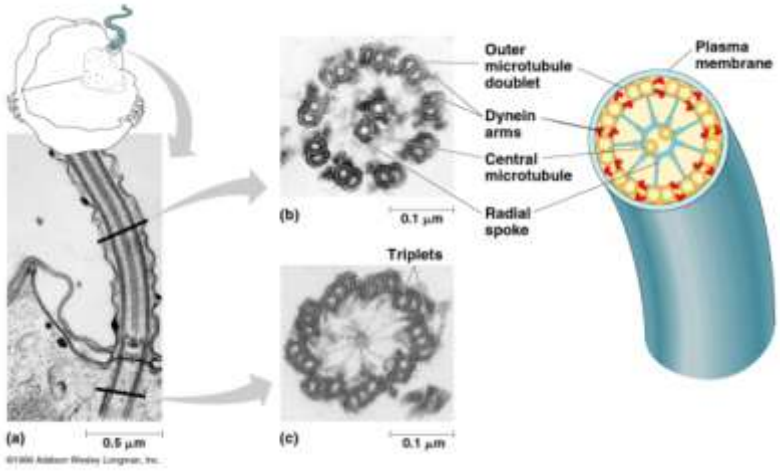
Cell surfaces & junctions

- **Cell wall: •not in animal cells •protection, shape, regulation**
- **Plant cell: •primary cell wall produced first •middle lamella pectin; holds cells together •secondary cell wall strong durable matrix; wood**



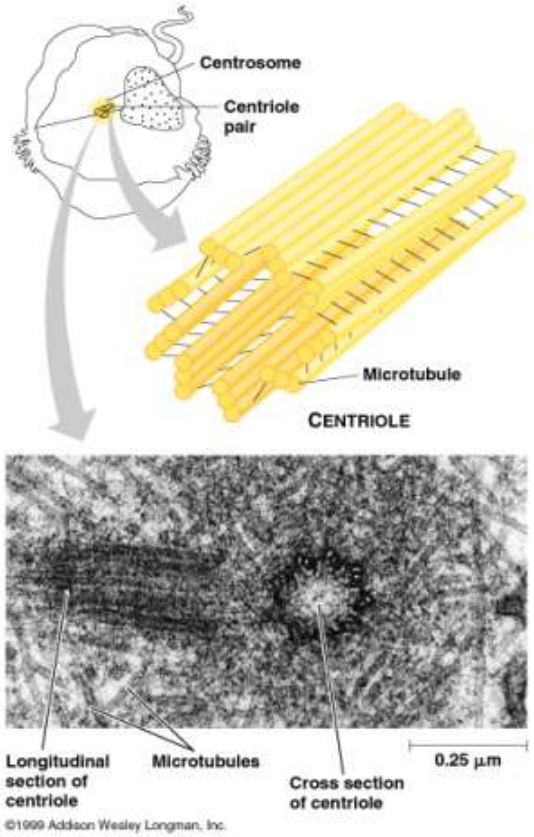
Cilia/flagella

- **Locomotive appendages**
- **“9+2” pattern**
  - **9 doublets of mictotubules in a ring;**
  - **2 single microtubules in center**
  - **connected by radial spokes**
  - **anchored by basal body**
  - **dynein protein**



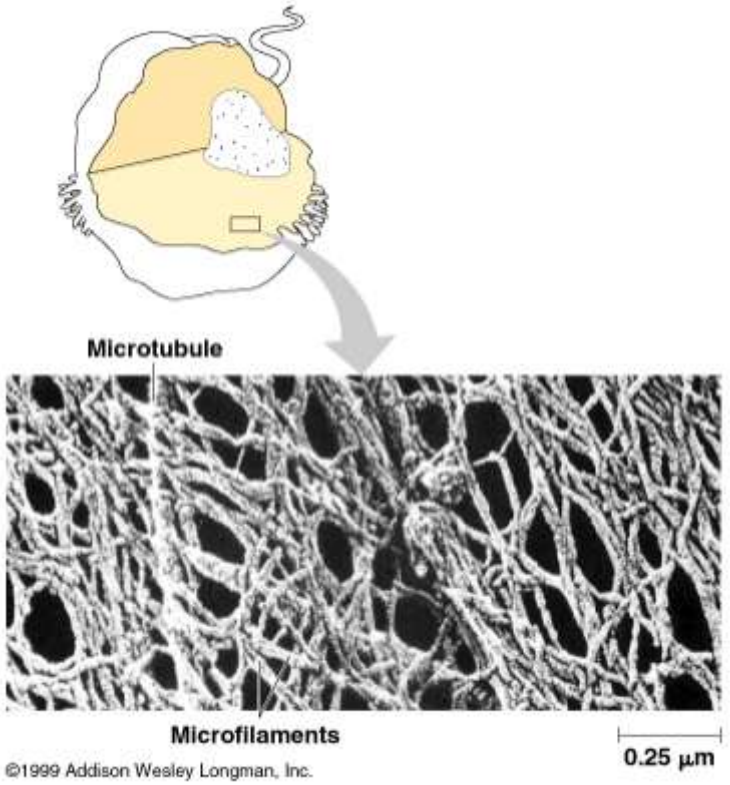
Centrosomes/centrioles

- <u>Centrosome:</u>
  - region near nucleus
- <u>Centrioles:</u>
  - 9 sets of triplet microtubules in a ring
  - used in cell replication
  - only in animal cells



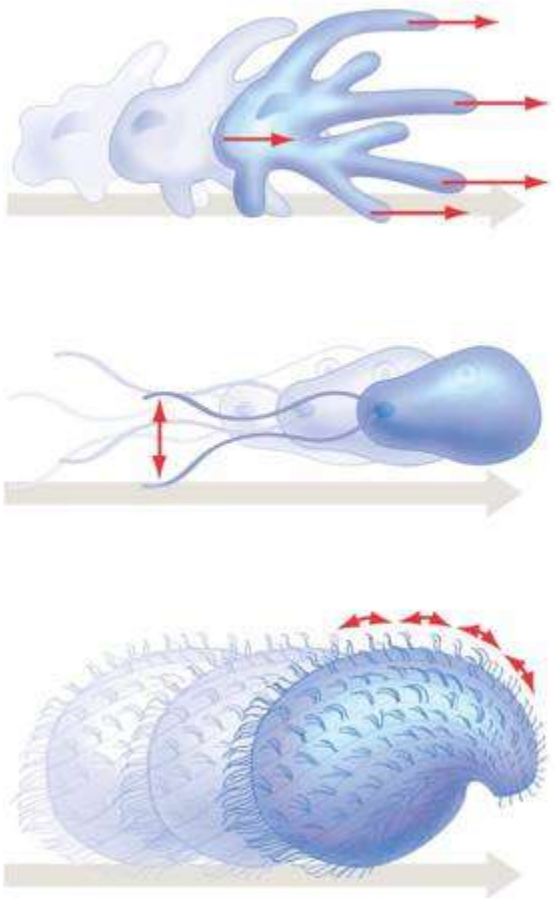
The Cytoskeleton

- Fibrous network in cytoplasm
- Support, cell motility, biochemical regulation
- Microtubules:
  thickest;
  tubulin protein;
  transport;
  chromosome separation
- Microfilaments:
  thinnest;
  actin filaments
- Intermediate filaments:
  middle diameter



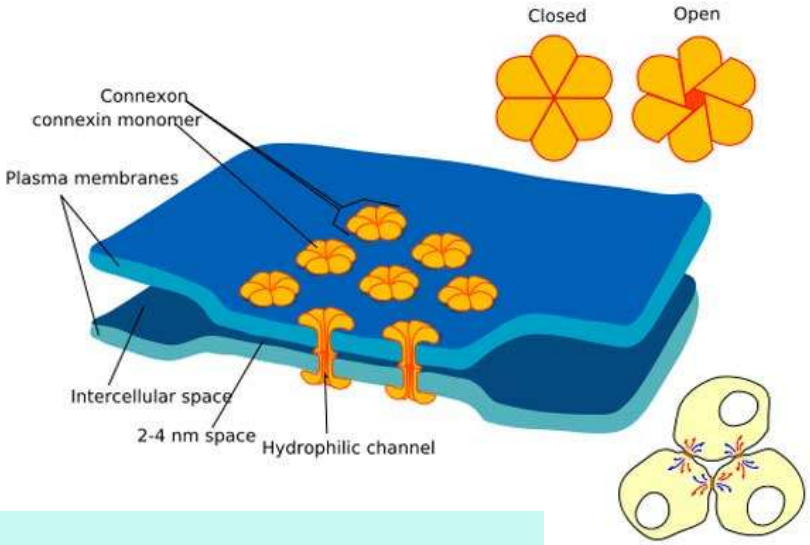
Cell Movement

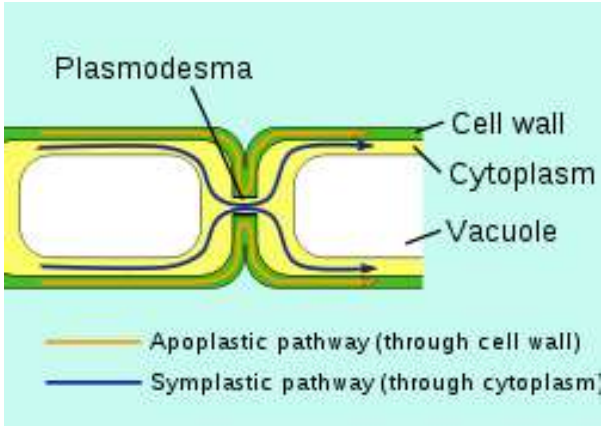
- Internal via cytoskeleton
- Flagella
  - Prokaryotic
  - Eukaryotic
    - 9 + 2 structure
- Cilia



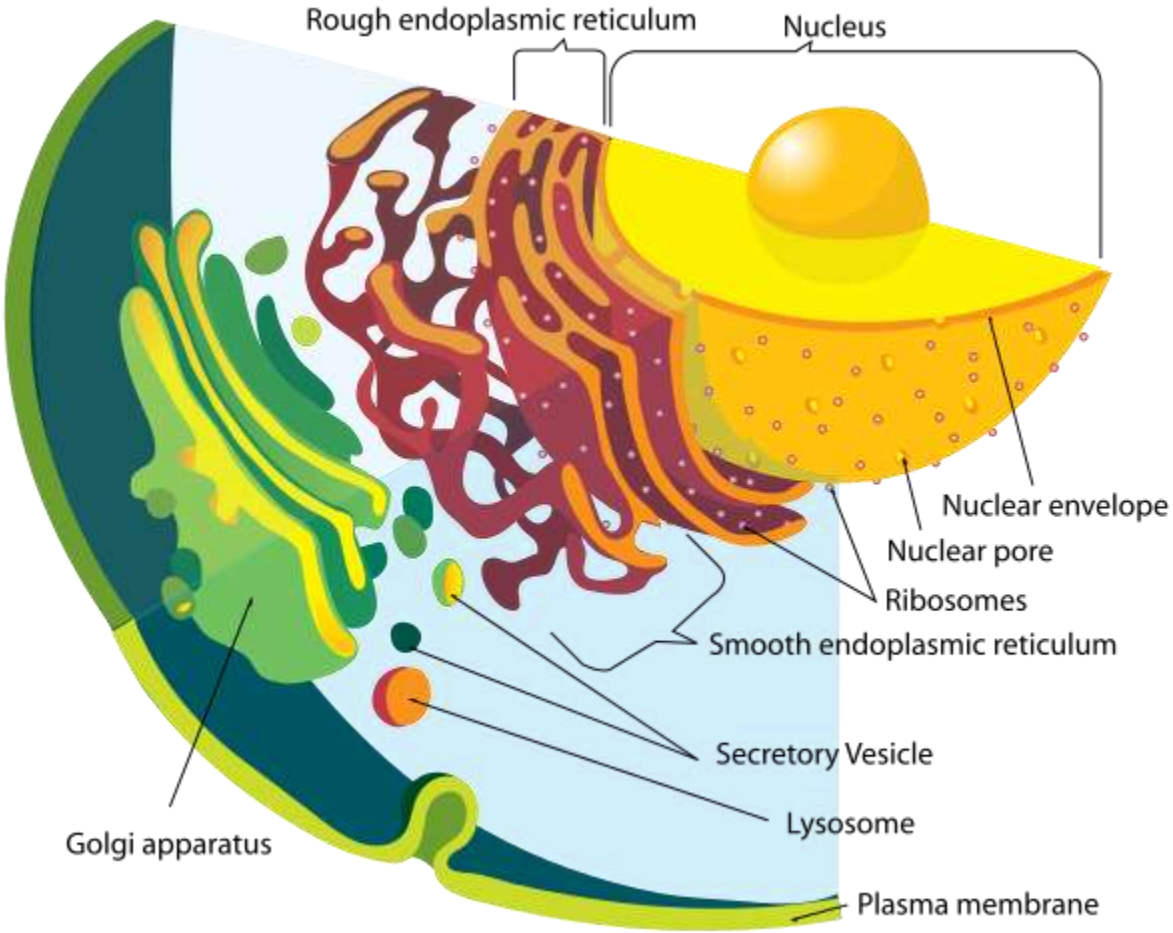
Cell to Cell Interactions

- Cell surface markers
- Cell junctions
  - Tight junctions
  - Anchoring junctions
  - Gap junctions (animals)
  - Plasmodesmota (plants)



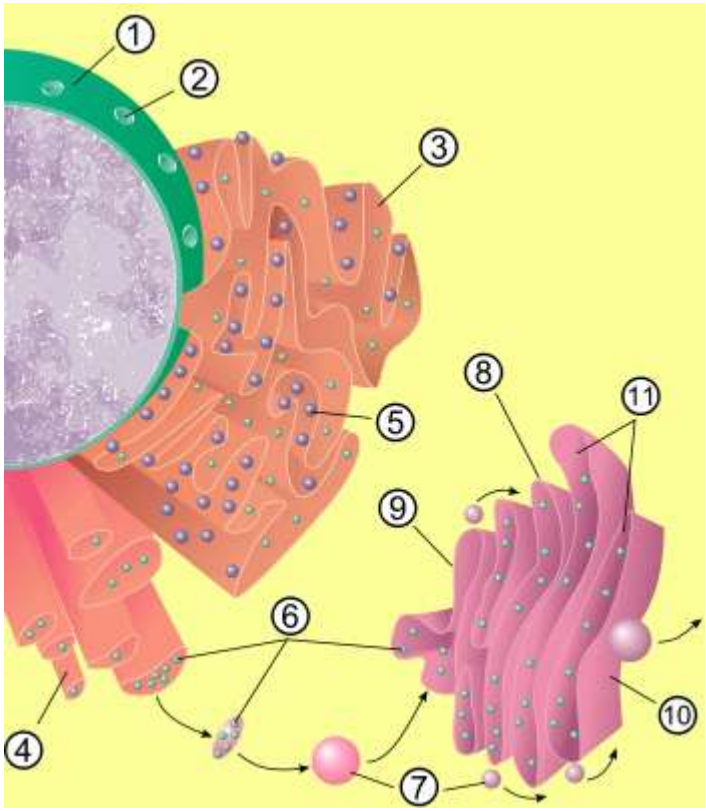


Endomembrane System

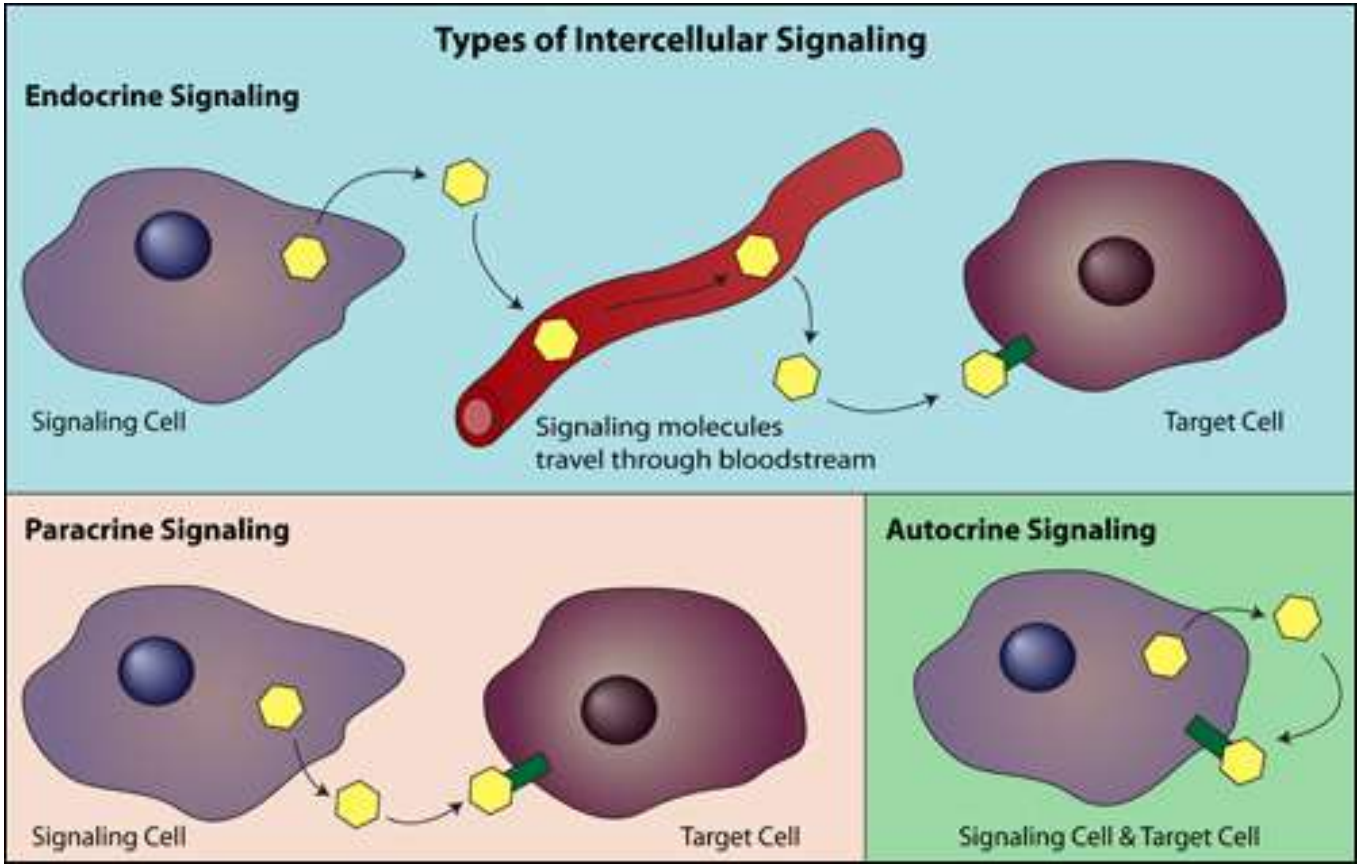


Flow through the Endomembrane system

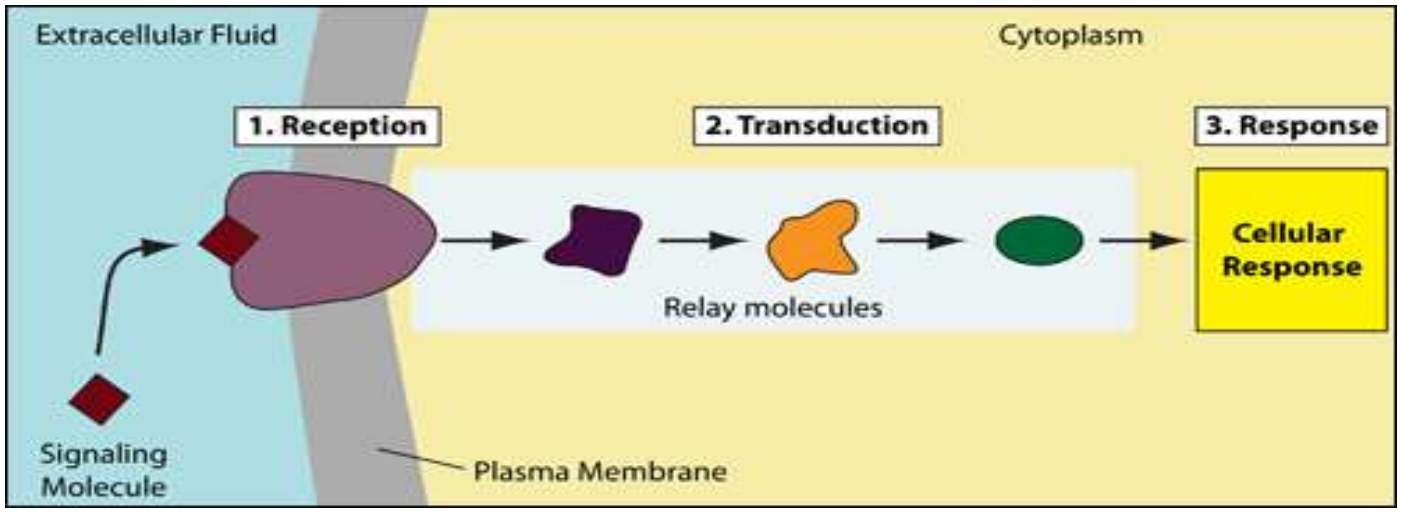
- **1** Nucleus
- **2** Nuclear Pore
- **3** Rough endoplasmic reticulum (RER)
- **4** Smooth endoplasmic reticulum (SER)
- **5** Ribosome on the rough ER
- **6** Proteins that are transported
- **7** Transport Vesicle
- **8** Golgi apparatus
- **9** Cis face of the Golgi apparatus
- **10** Trans face of the Golgi apparatus
- **11** Cisternae of the Golgi apparatus



Cell Signaling

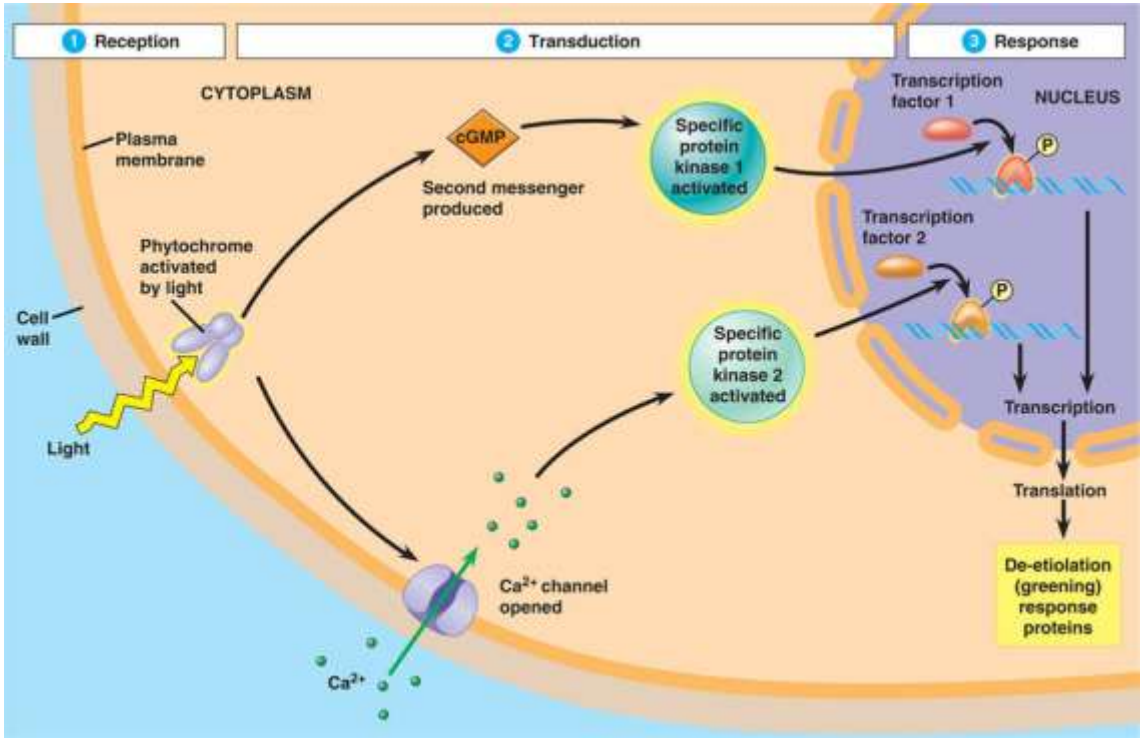


The steps of signaling

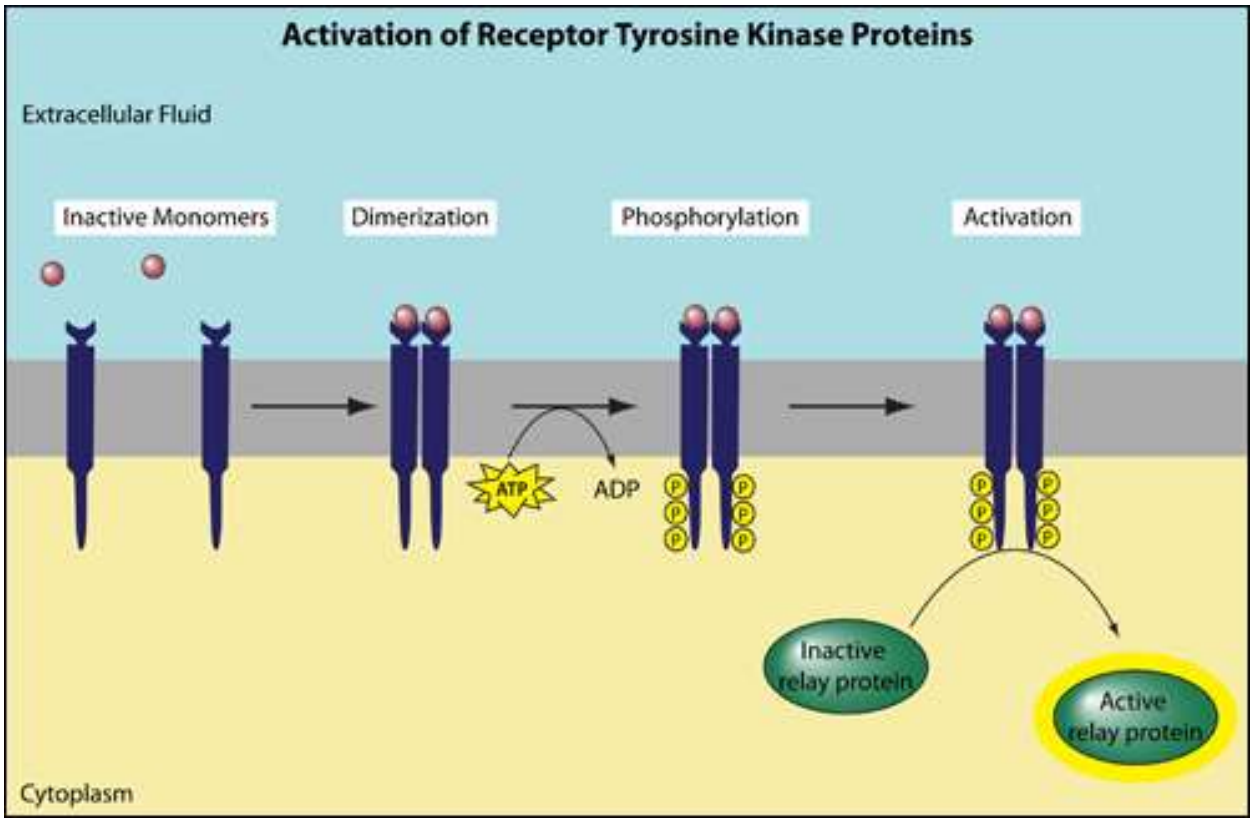


Signal Transduction Pathways

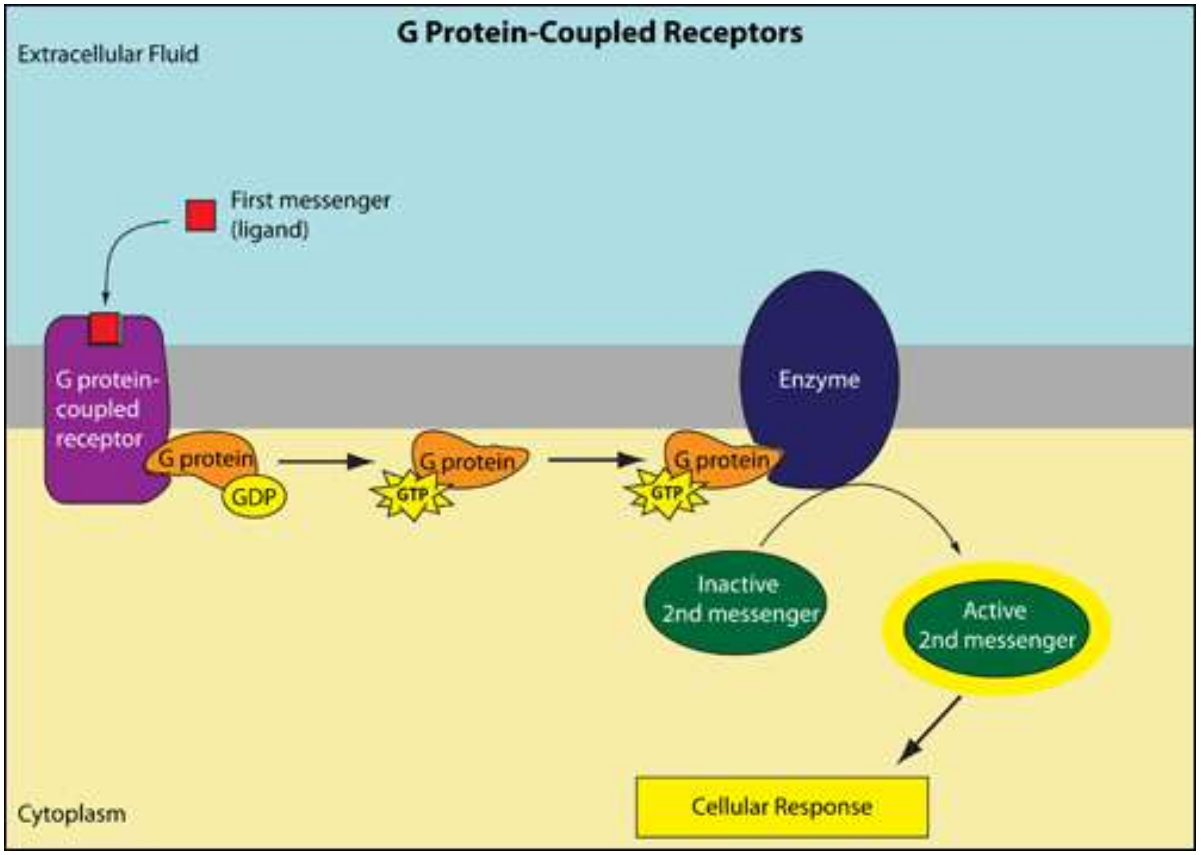
- A specific example in plant etoilation



Tyrosine Kinase

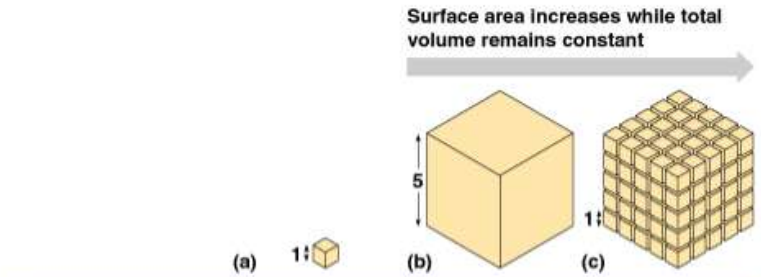


G protein coupled receptor



Cell size

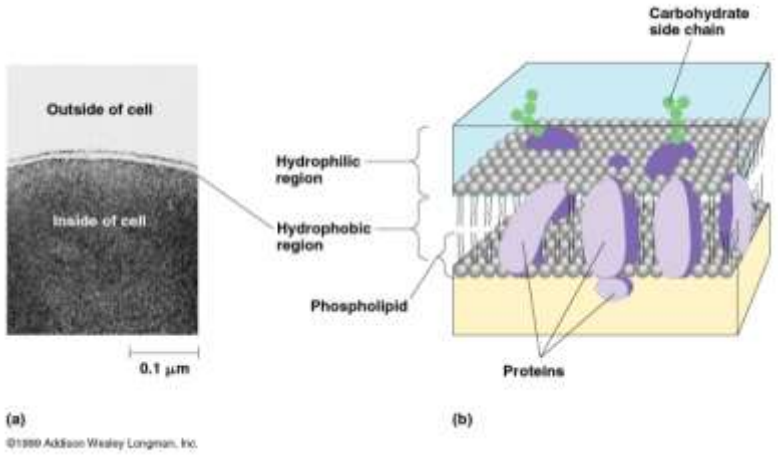
- As cell size increases, the surface area to volume ratio decreases
- Rates of chemical exchange may then be inadequate for cell size
- Cell size, therefore, remains small



	(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-area-to-volume ratio (area ÷ volume)	6	1.2	6

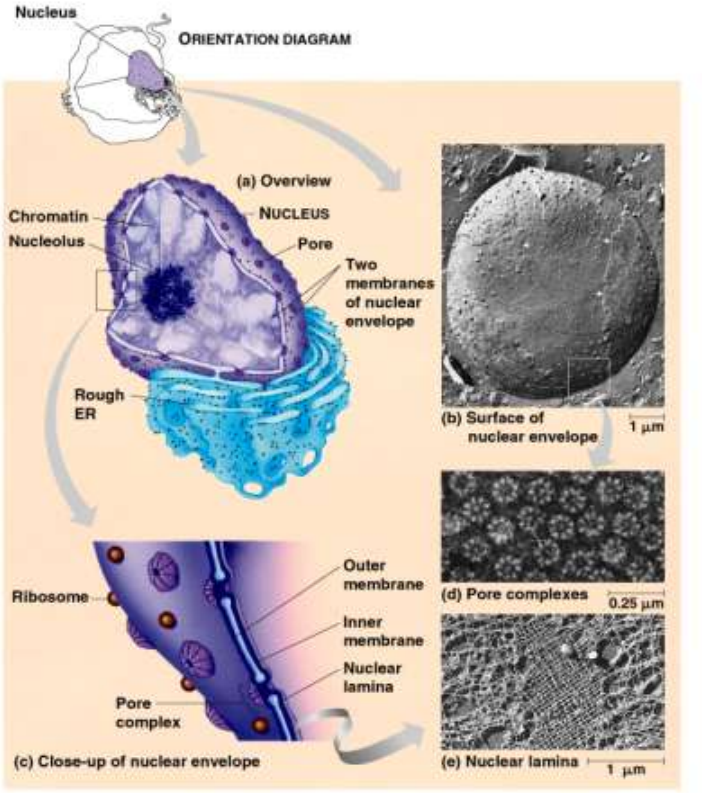
Plasma membrane

- Semi-permeable
- Phosopholipid bilayer
    - hydrophobic
    - hydrophilic
- Embedded proteins
- Carbohydrate receptors



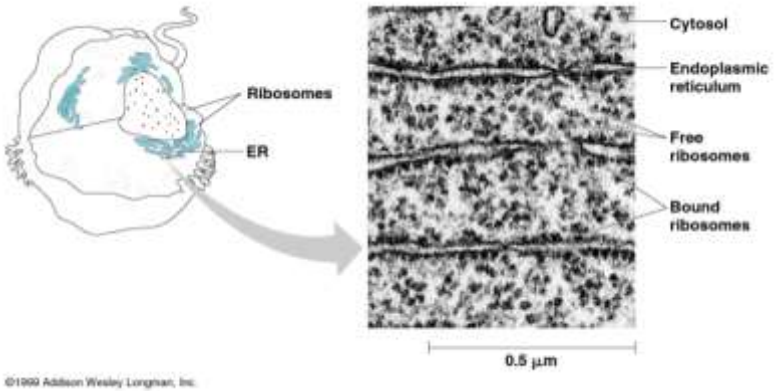
Nucleus

- Genetic material
  - chromatin
  - chromosomes
  - nucleolus (ribosomes)
- Double membrane envelope with pores
- Nuclear lamina (shape)
- Protein synthesis (mRNA)



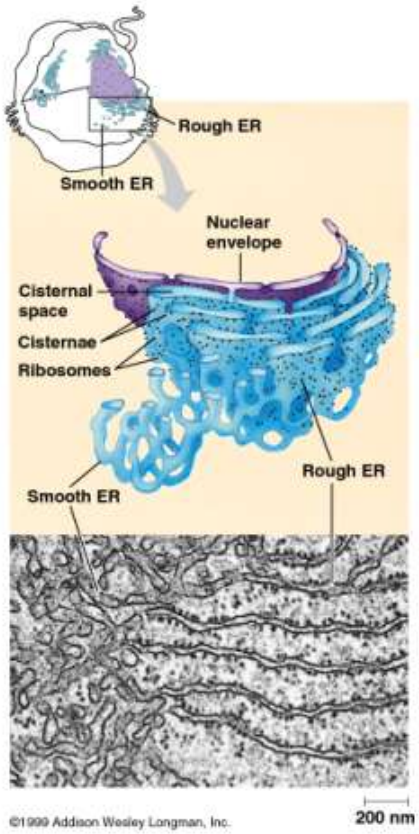
Ribosomes

- Protein manufacture
- Free
  - cytosol; function in cell
- Bound
  - endoplasmic reticulum; membranes, organelles, export



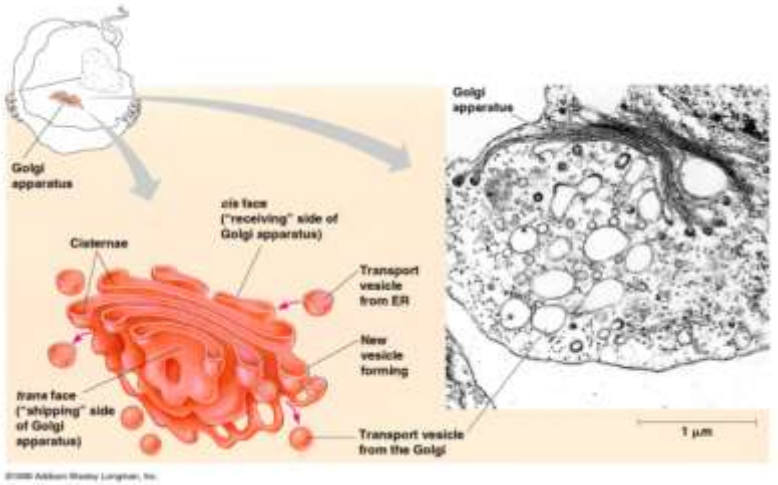
Endomembrane system, I

- **<u>Endoplasmic reticulum (ER)</u>**
- **Continuous with nuclear envelope**
- **Smooth ER •no ribosomes; •synthesis of lipids, •metabolism of carbs; •detoxification of drugs and poisons**
- **Rough ER •with ribosomes; •synthesis of secretory proteins (glycoproteins), membrane production**



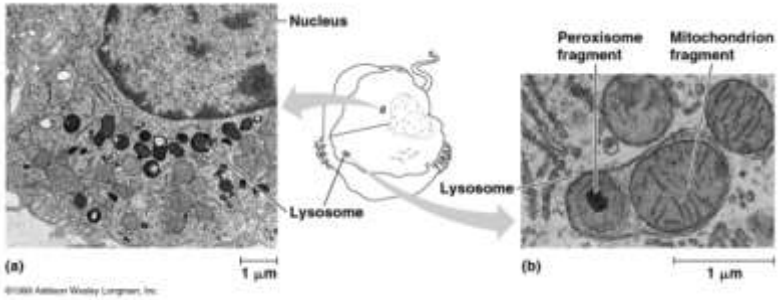
Endomembrane system, II

- <u>Golgi apparatus</u>
  - ER products are modified, stored, and then shipped
- Cisternae (sacs)
- *trans* & *cis* face
  - shipping/receiving
- Transport vesicles



Endomembrane system, III

- Lysosomes •sac of hydrolytic enzymes; digestion of macromolecules
- Phagocytosis
- Autophagy
- Tay-Sachs disease



Endomembrane system, IV

- Vacuoles
  - membrane-bound sacs (larger than vesicles)
- Food (phagocytosis)
- Contractile (pump excess water)
- Central (storage in plants)
  - tonoplast membrane