Chapter 4

The organization of Cells

The Cell Theory

✓All organisms are composed of cells
✓All cells come from preexisting cells

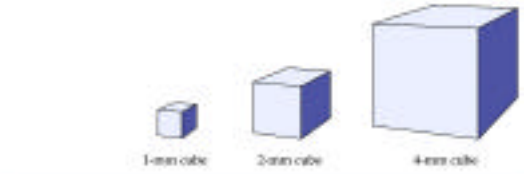
Three features of a cell

✓A boundary -
- ➧plasma membrane

✓A set of genetic instructions
- ➧DNA
  - ⇨Eukaroyotes
    - ✍nucleus
  - ⇨Prokaryotes
    - ✍no nucleus (nucleoid)

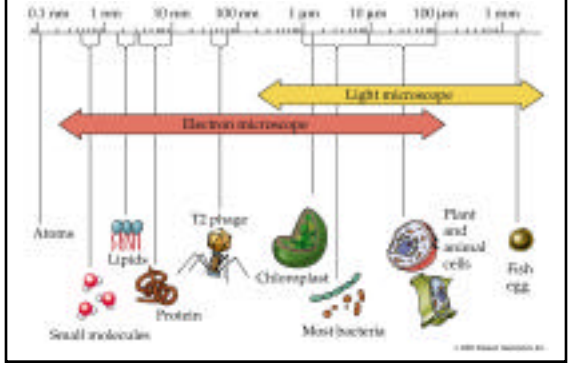
✓A cell body
- ➧cytoplasm
  - ⇨organelles (eukaryotes)
  - ⇨cytosol
  - ⇨cytoskeleton

Surface to volume ratio

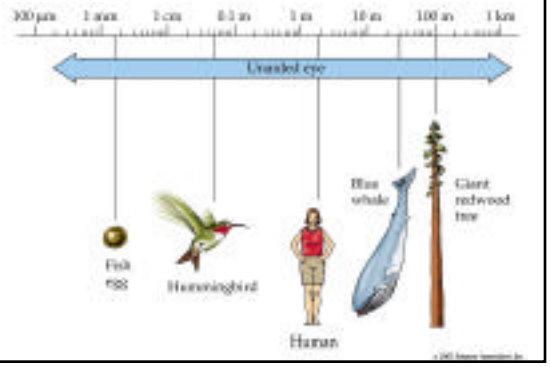


Surface area	6 sides × 1^2 = 6 mm^2	6 sides × 2^2 = 24 mm^2	6 sides × 4^2 = 96 mm^2
Volume	1^3 = 1 mm^3	2^3 = 8 mm^3	4^3 = 64 mm^3
Surface area-to-volume ratio	6/1	3/1	1.5/1

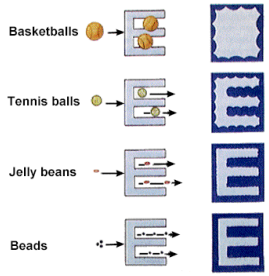
Scale of life



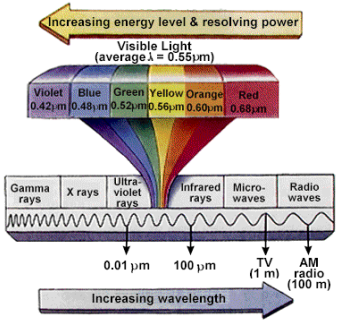
Scale of life (cont.)



Microscope resolution



Wavelength verse resoluton



Light vs electron microscope

Light microscopy: 10-2000X
about 0.2 µm
Electron microscopy:
10X-200,000-400,000X
about 0.5 nm

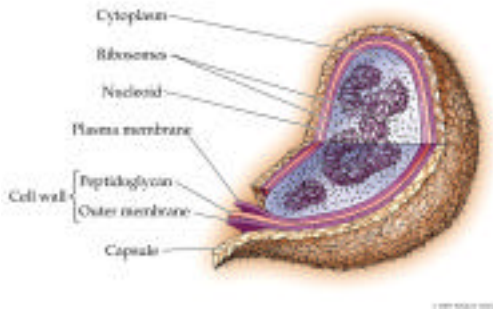
Plasma membrane

- ✓Selectively (Semi) permeable barrier
  - ✒Regulation of movement of materials in and out of the cell
- ✓Communication with adjacent cells and receives and translates chemical and environmental signals from outside of the cell
- ✓Constant internal environment

Two organization patterns

- ✓Prokaryotic cells (Eubacteria & Archae)
  - ✒Lack a membrane-bound nucleus
  - ✒Lack membrane-bound organelles
- ✓Eukaryotic cells
  - ✒Are much more complex
  - ✒Containing a membrane-bound nucleus
  - ✒Membrane-bound organelles.
    - ✑Animals, plants, protists, fungi

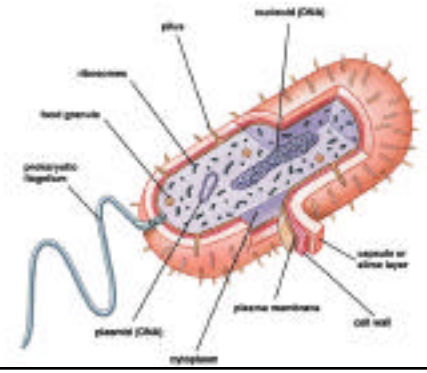
Prokaryotic cell



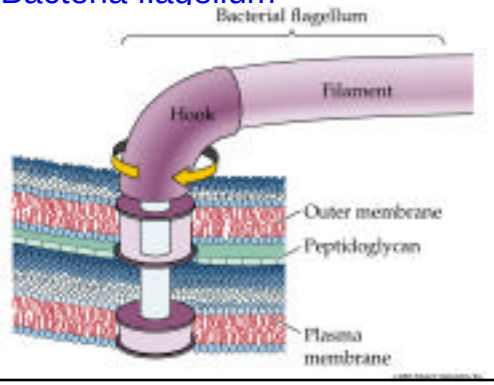
Prokaryotes

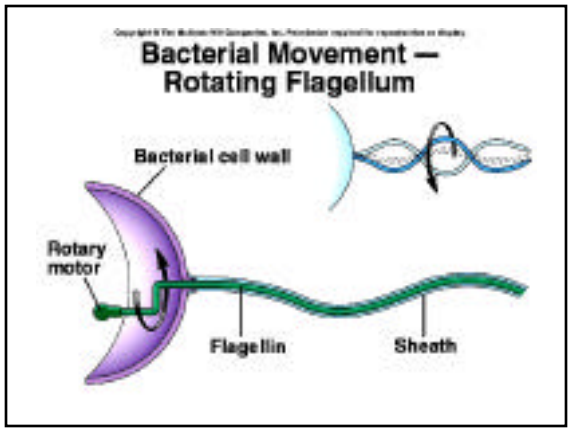
- ✓ Common to all
  - ✒ Plasma membrane
  - ✒ Nucleoid
  - ✒ Cytoplasm
    - ✑ Cytosol
    - ✑ Ribosomes
- ✓ Most have
  - ✒ Cell wall
    - ✑ Peptidoglycan
  - ✒ Capsule
  - ✒ photosynthesis (Cyanobacteria)
  - ✒ mesosomes
  - ✒ Flagella
  - ✒ pili

Prokaryotic cell



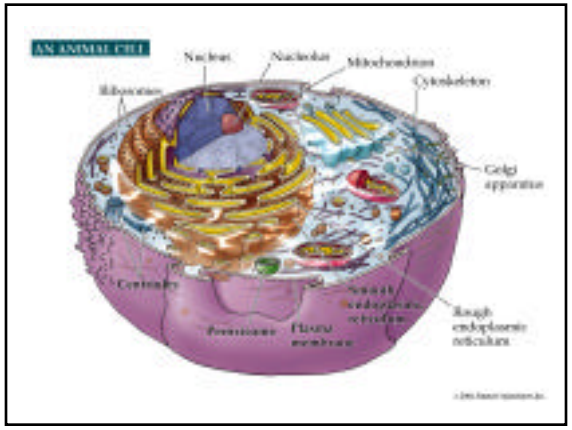
Bacteria flagellum

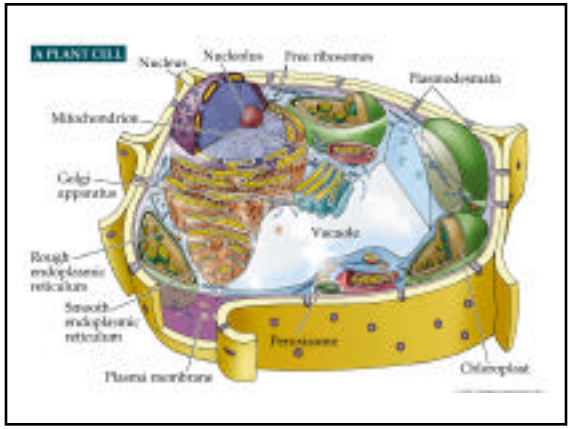




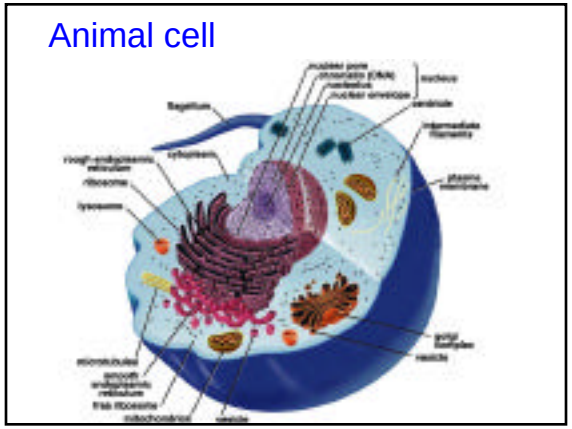
Eukaryotic cells

- ✓ Generally 10x larger than prokarotes
- ✓ Plasma membrane
- ✓ Cytoplasm
- ✓ Ribosomes
- ✓ Cytoskeleton
- ✓ Membrane bound organelles
  - ✒ Nucleus
  - ✒ Mitochondria
  - ✒ ER, Golgi, lysosomes, vacuoles, chloroplasts

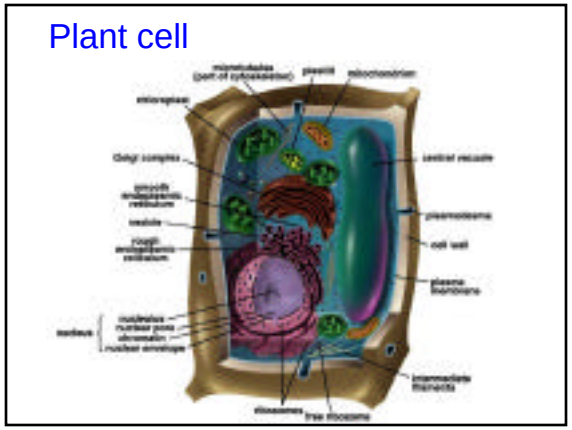




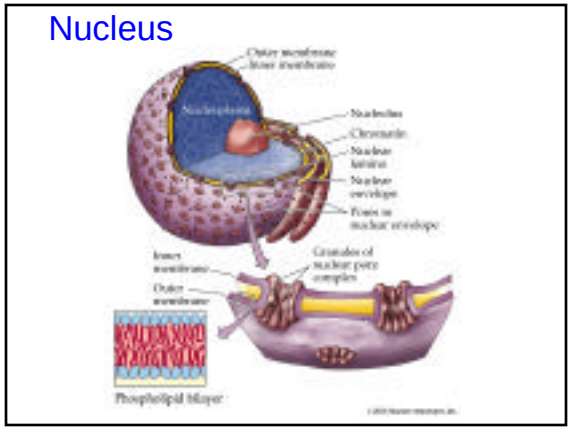
Animal cell



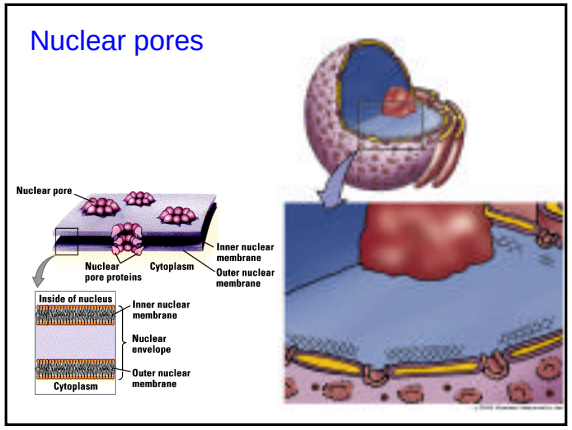
Plant cell



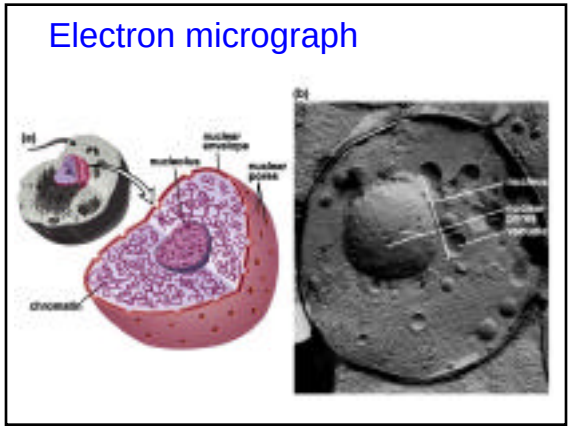
Nucleus



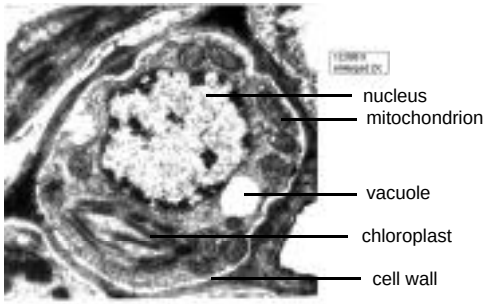
Nuclear pores



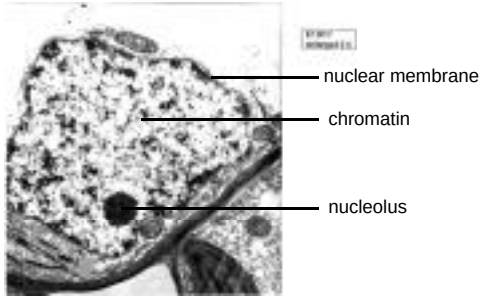
Electron micrograph



Plant Cell



Nucleus



Nucleolus

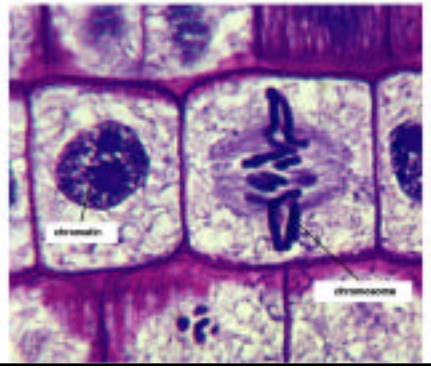
✓Structure found within nucleus.

✓Involved in the synthesis of ribosomes.

Chromatin

✓A complex of DNA and protein.

Chromatin/chromosome



Intracellular Traffic

✓Endoplasmic reticulum

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

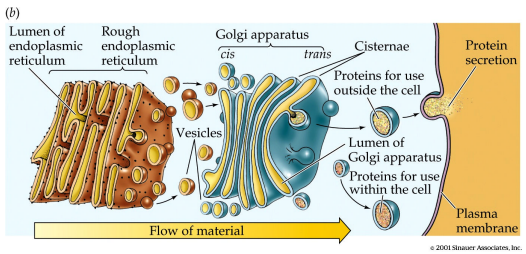
✓Golgi complex

- ☞packaging center and traffic director

✓Lysosomes

- ☞Enzymes -- breakdown macromolecules

traffic

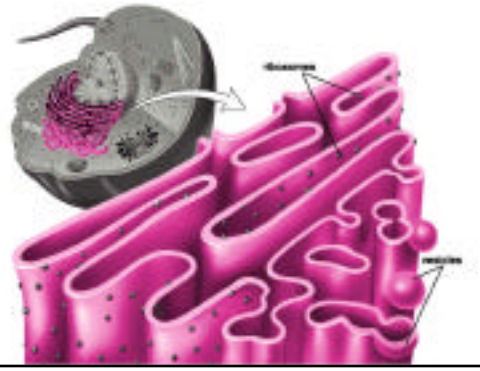


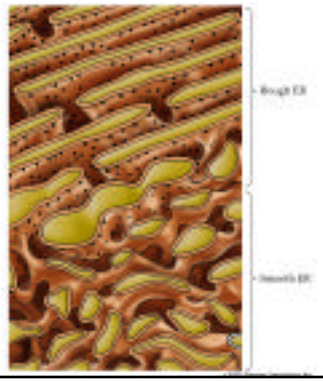
Endoplasmic reticulum

A heterogeneous collection of adaptable membranous channels, vesicles and sacs.

Consists of 2 components: the rough ER and the smooth ER.

Endoplasmic reticulum





Endoplasmic reticulum

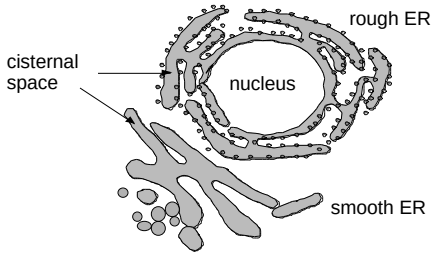
Rough ER

- 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

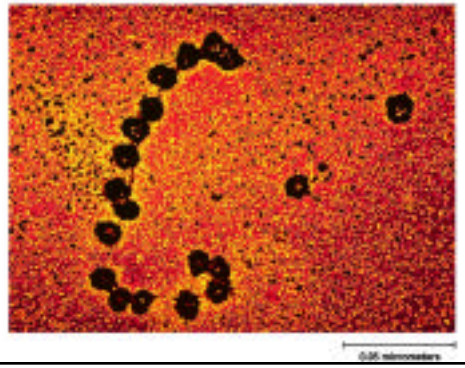
Endoplasmic reticulum



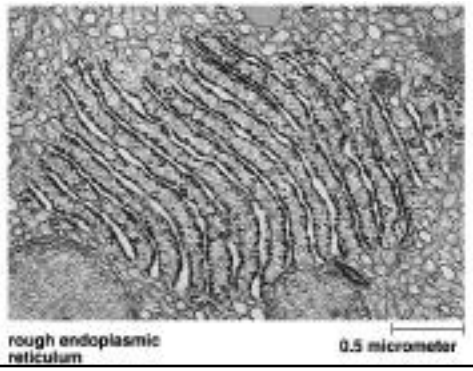
Functions of the rough ER

- ✓Protein targeting
- ✓Modification of proteins

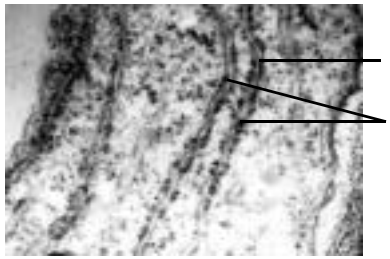
Ribosomes



Rough ER



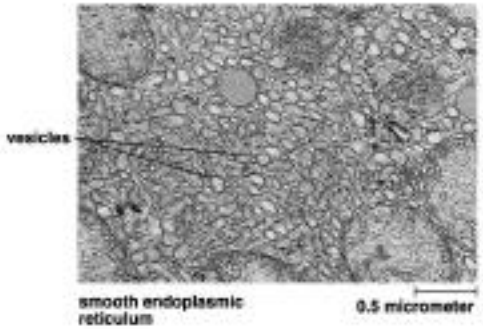
Rough ER



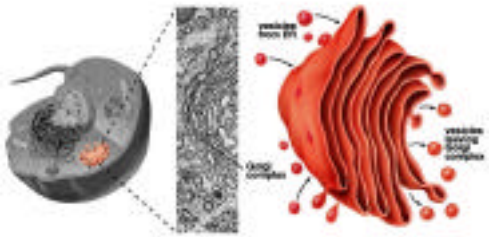
Functions of the smooth ER

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

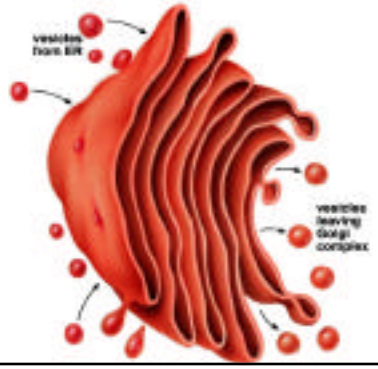
Smooth ER



Golgi complex

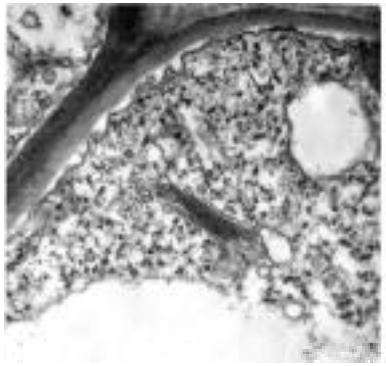


Golgi complex

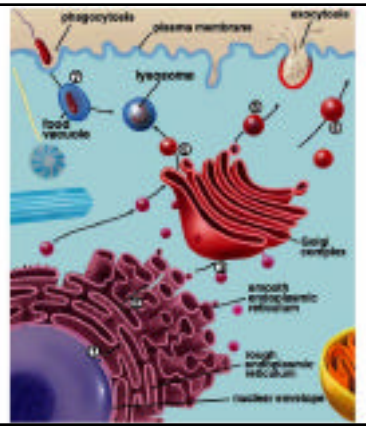


Functions of the Golgi apparatus

- ✓Modifies proteins
- ✓Concentrates, packages, and sorts proteins
- ✓Some polysaccharide synthesis in plants



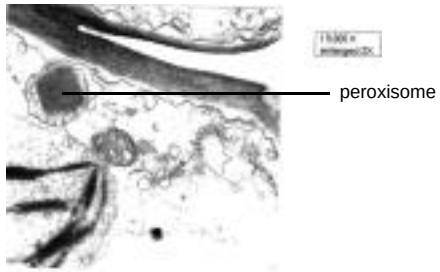
Golgi complex



Lysosomes

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

Peroxisomes



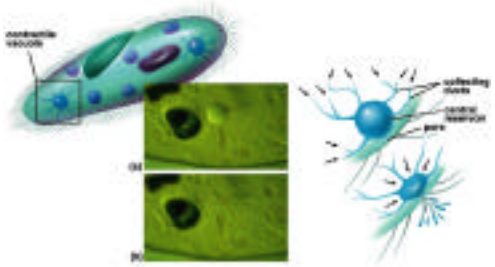
Function of peroxisomes

- ✓Contain degradative enzymes that use oxygen (H_2O_2)
- ✓Contain the protective enzyme, catalase.

Vacuole

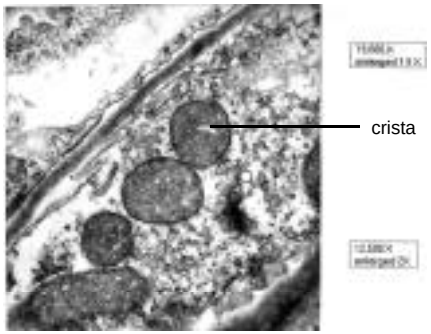
- ✓Provide turgor pressure in plant cells
- ✓Contain water and waste materials
- ✓Store sugars and amino acids, pigments and other substances that may be harmful in the cytoplasm

Contractile vacuole



Vacuoles provide turgor pressure in plants

Mitochondria (the powerhouse)

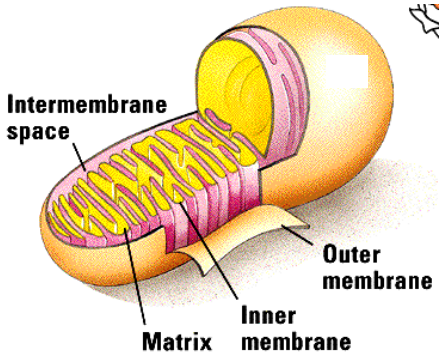


Function of the mitochondria

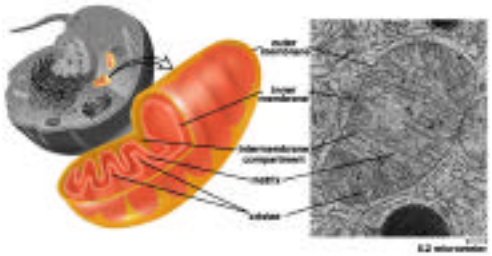
✓Cellular respiration

- ✒Site of Krebs cycle.
- ✒Phosphorylating ATP using a proton motive force.

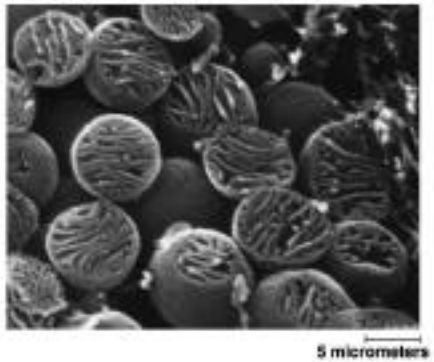
Structure of a mitochondrion



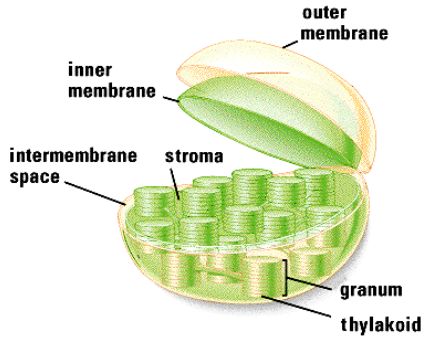
Mitochondria



Mitochondria



Structure of a chloroplast

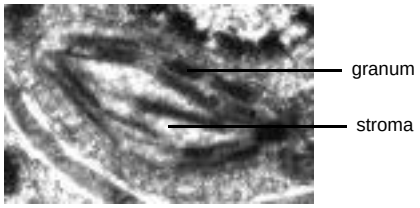


Function of the chloroplast

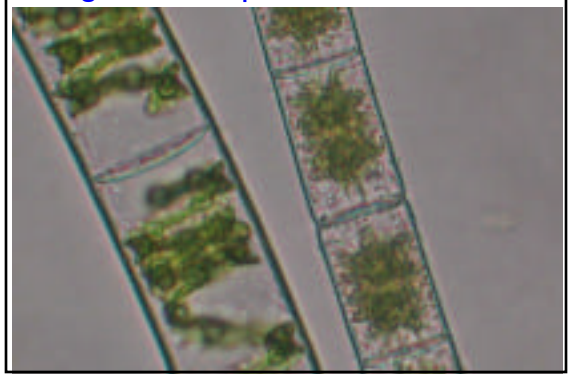
✓Site of photosynthesis.

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

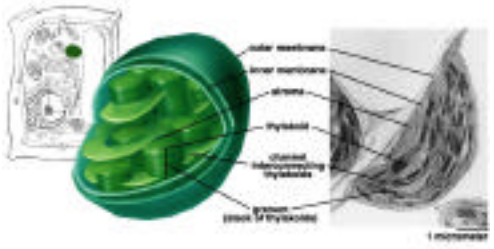
Chloroplast



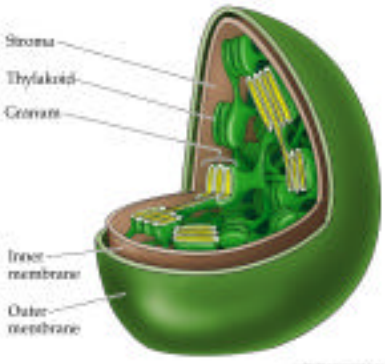
Algae chloroplasts



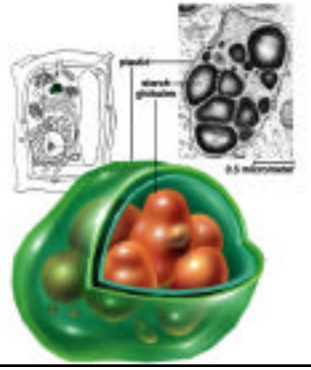
Chloroplasts



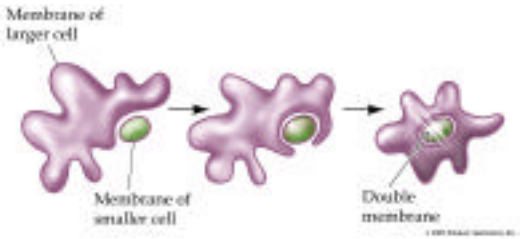
Chloroplasts



Plastids (storage organelles)

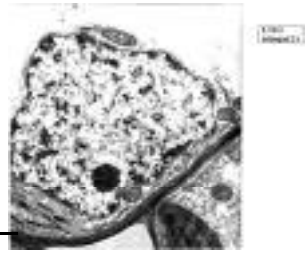


Endosymbiosis theory



Cell Wall

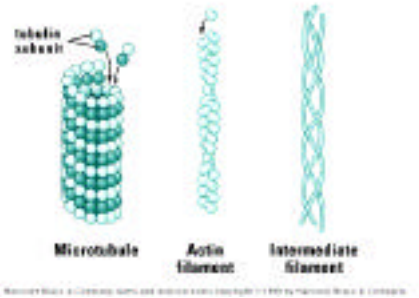
- ✓Containment
- ✓Protection
- ✓Support



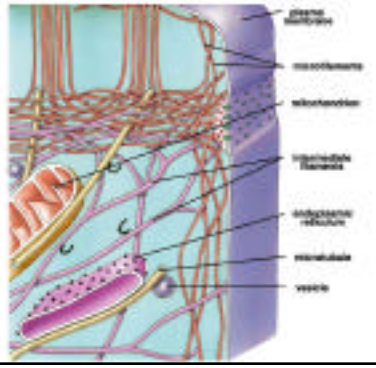
Cytoskeleton

- ✓Imagine mobile bones and muscles
- ✓Comprised of 3 types of protein filaments.
  - ✒Microtubules
  - ✒Actin filaments (microfilaments)
  - ✒Intermediate filaments

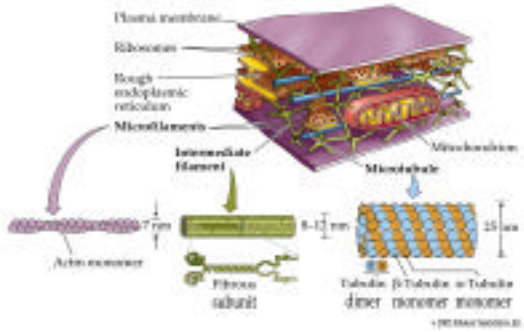
Cytoskeleton of a cell is a complex network of protein filaments



Cytoskeleton



Cytoskeleton

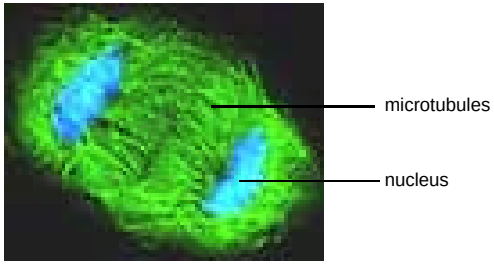


Function of the cytoskeleton

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

Microtubules

Cell division



tubulin subunits

Actin filaments

- ✓Anchored to cell surface
  - ✒force for movement and shape changes
- ✓Actin is one of the main proteins in muscle cells
  - ✒Constantly being build and destroyed

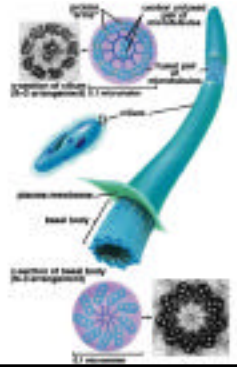
Intermediate filaments

- ✓Strengthen cells and tissues by providing protection from mechanical stress.
- ✓Found in all parts of the cell

Flagellum/Cilium

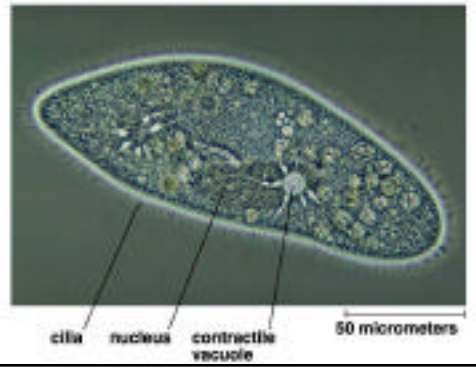
- ✓Plurals: flagella and cilia
- ✓Flagella - whip-like
- ✓cilia - hair-like
- ✓Move cell through its environment or its environment past the cell!
- ✓Have “9+2” arrangement of fused microtubules

Microtubules of a cilium

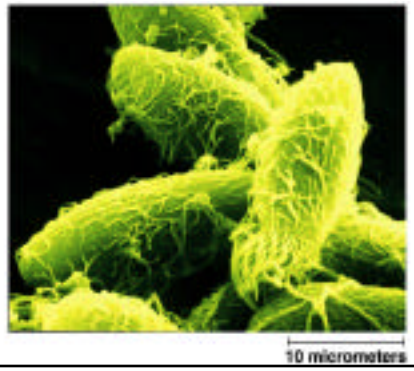


Eukaryotic - cilia & flagella

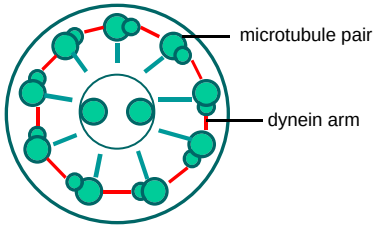
Paramecium

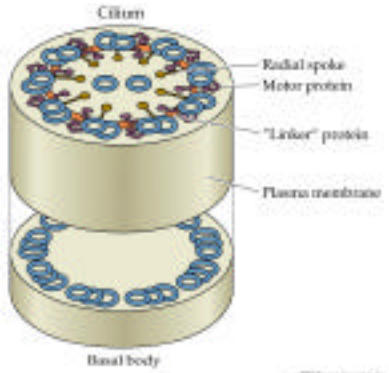


Cilia on a paramecium

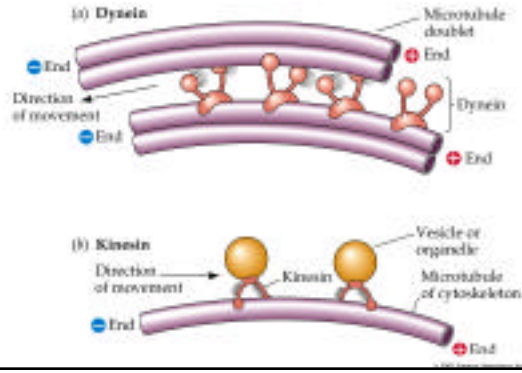


"9+2" arrangement

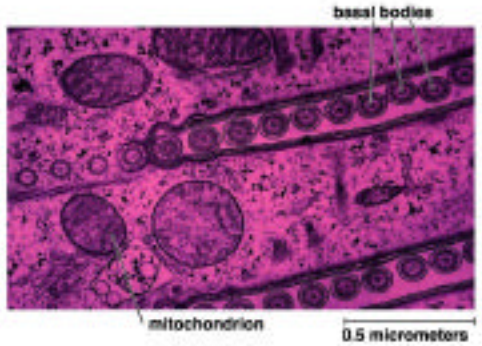




Dynein and Motor proteins



Basal bodies/mitochondia



Microvilli and support