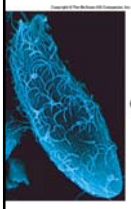
Cell structure

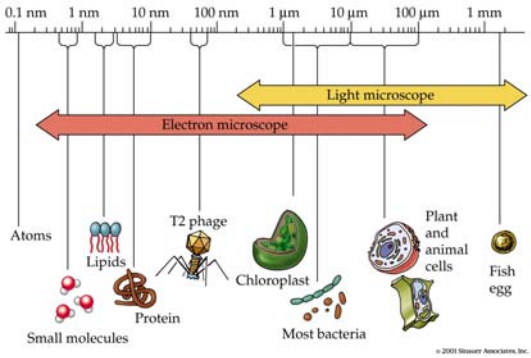


Single-Celled Organism *Dileptus*

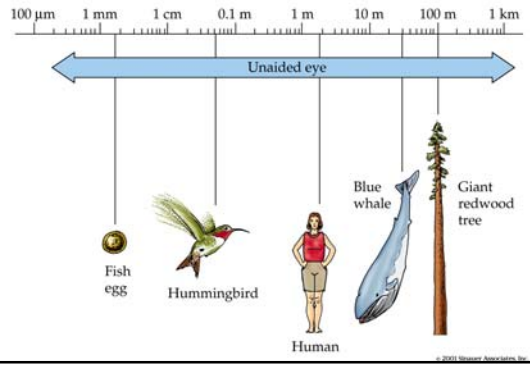
Measuring microorganisms

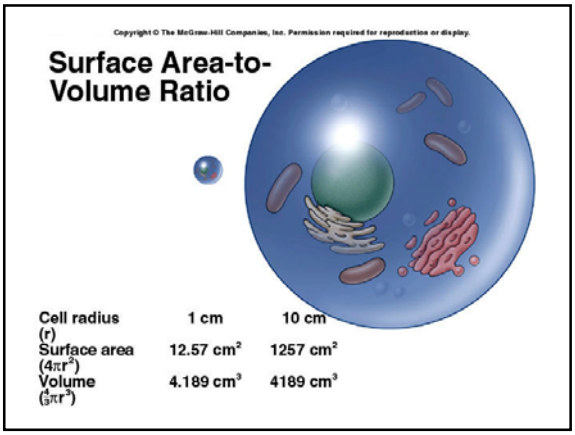
- 1 meter (m) 10^0m
- 1 centimeter (cm) 10^{-2}m
- 1 millimeter (mm) 10^{-3}m
- 1 micrometer (μm) 10^{-6}m
- 1 nanometer (nm) 10^{-9}m
- 1 angstrom (A) 10^{-10}m

Scale of life

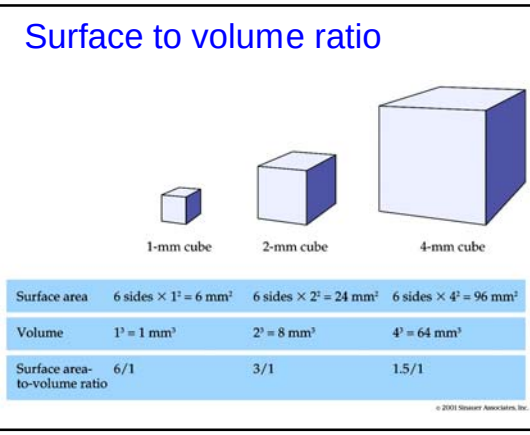


Scale of life (cont.)

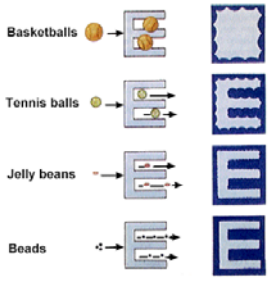




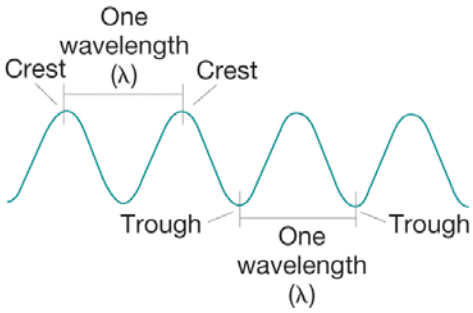
Surface to volume ratio



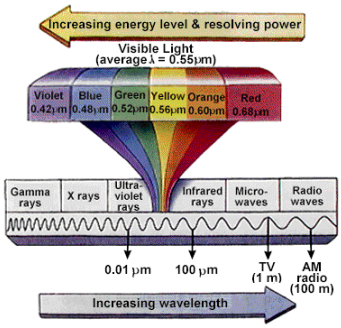
Resolution



Wavelength

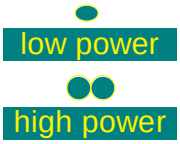


Wavelength Spectrum

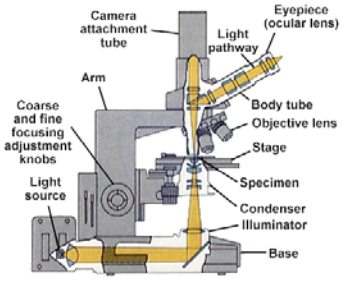


Resolving Power

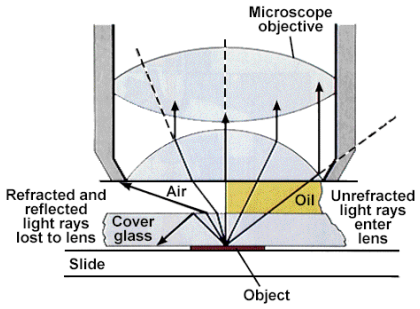
- The ability to determine the relationship between two objects.
- Are they two bacteria or just
- one bacterium?

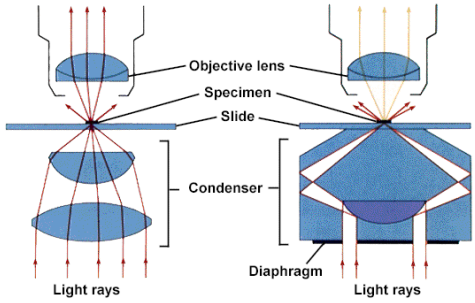


The Light Microscope (page 55)



Refracted Light





Bright field Dark field

Flagellum stain

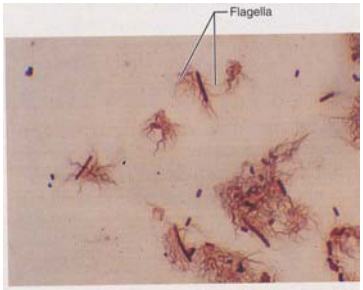


FIGURE 3.36 Peritrichous flagella of *Proteus vulgaris* (3600×).

Negative stain (bacillus)

FIGURE 3.5 A negative stain of the rod *Bacillus* (3600×).

Diplobacilli

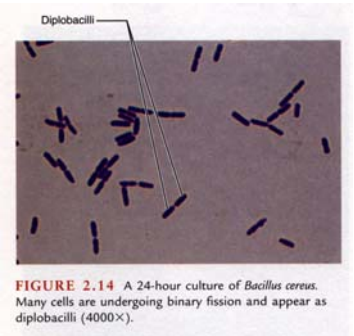
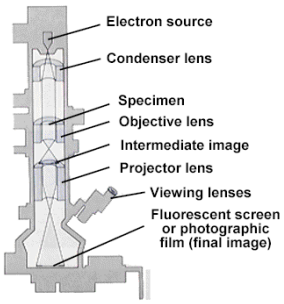


FIGURE 2.14 A 24-hour culture of *Bacillus cereus*. Many cells are undergoing binary fission and appear as diplobacilli (4000×).

Electron Microscope



Electron microscopy

Electrons are generated, condensed, and focused onto an object. An image is created and magnified on a fluorescent screen.

Staining for electron microscopy

1. Heavy metals
2. Radioactive materials

Why?

It is difficult for electrons to pass through very dense materials.

Types of electron microscopy

1. Transmission EM
2. Scanning EM
3. Scanning-Tunneling EM
4. Immuno-EM
5. Atomic force Microscopy

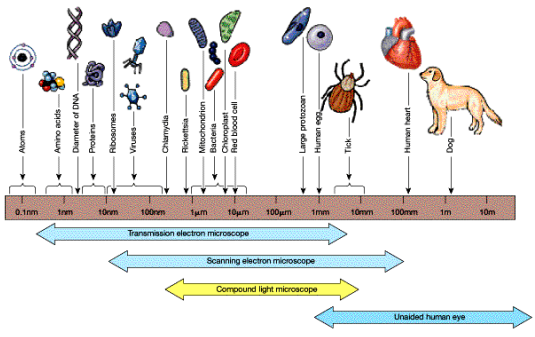
Pseudomonas syringae

- Gram negative bacteria
- Aerial surfaces of plants
- Produces antifungal molecules

Magnification (EM)

Light microscopy: 10-2000X

Electron microscopy:
10X-200,000-400,000X



The Cell Theory (Schleiden & Schwann)

✓ All organisms are composed of one or more cells.
✓ Living cells are the fundamental units of life.
✓ All cells come from other 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

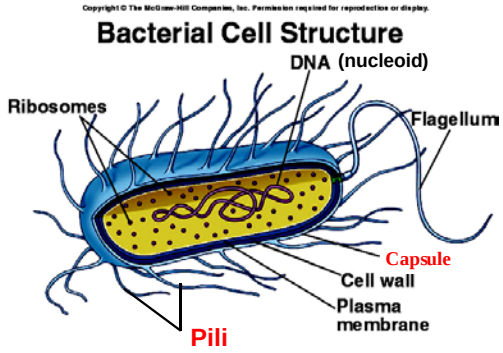
Prokaryote vs. eukaryote

- ✓ Prokaryotic cells
  - ✒ Lack a membrane-bound nucleus
  - ✒ Lack membrane-bound organelles
    - ⇨ Ex. Bacteria and Archaebacteria
- ✓ Eukaryotic cells
  - ✒ Are much more complex
  - ✒ Containing a membrane-bound nucleus
  - ✒ Membrane-bound organelles.
    - ⇨ Animals, plants, protists, fungi

Bacterial internal structures

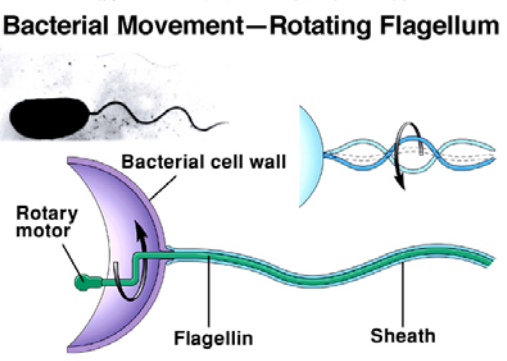
- ✓ Cytoplasm
- ✓ Ribosomes
  - ✒ Polyribosomes
- ✓ Nucleoid (nuclear region)

- ✓ Chromatophores (photosynthetic bacteria)
- ✓ Vacuoles (photosynthetic bacteria)
- ✓ Endospores

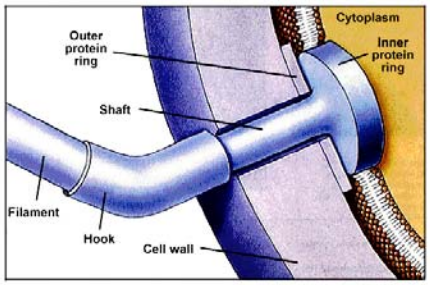


External structures

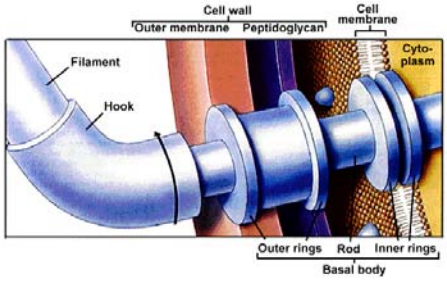
- ✓ Flagella
  - ✒ Polar -- on the end
    - ⇨ Monotrichous -- one on the end
    - ⇨ Amphitrichous -- one on each end
    - ⇨ Lophotrichous -- more than one on one or both ends
  - ✒ Peritrichous -- all over the surface of the cell
  - ✒ Atrichous -- no flagella



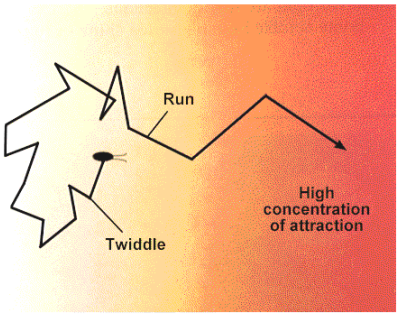
Flagellum in Gram (+)

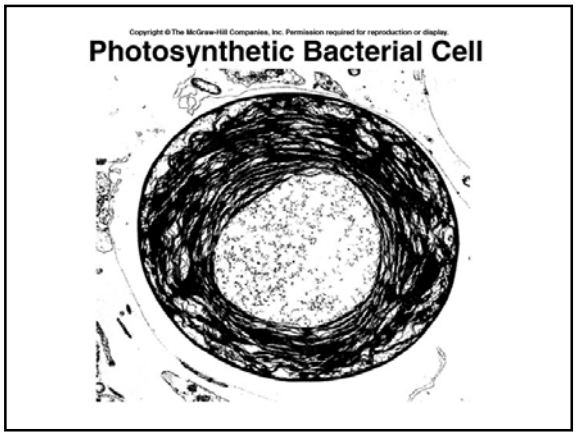


Flagellum in Gram (-)

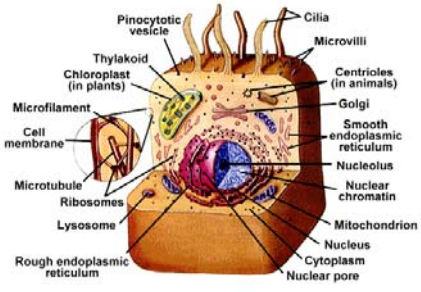


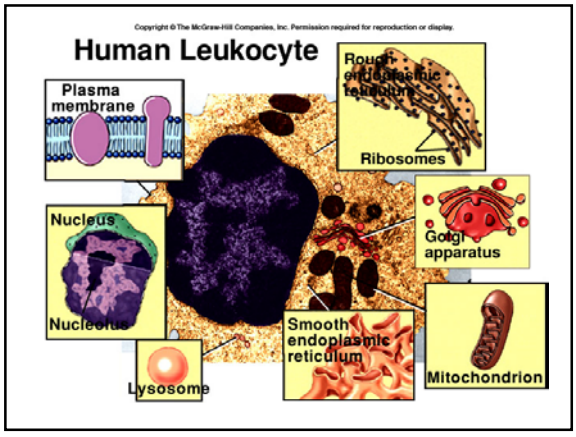
Chemotaxis

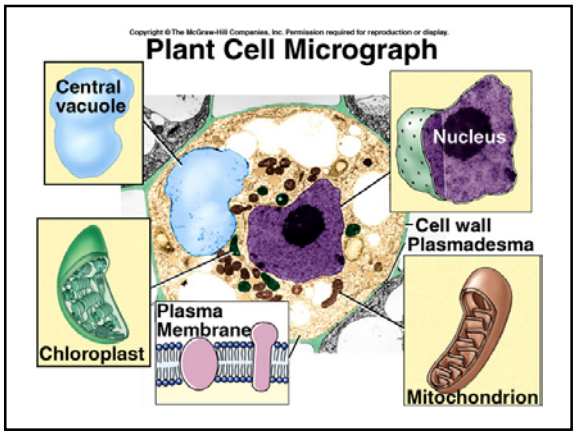




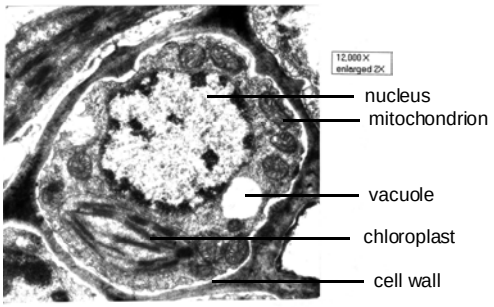
Eukaryotic cell



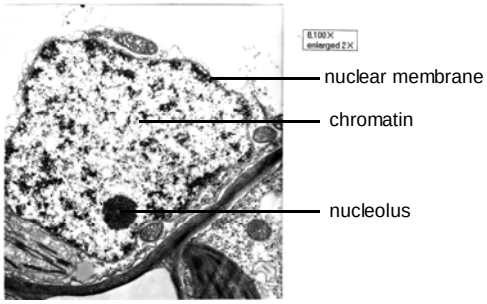




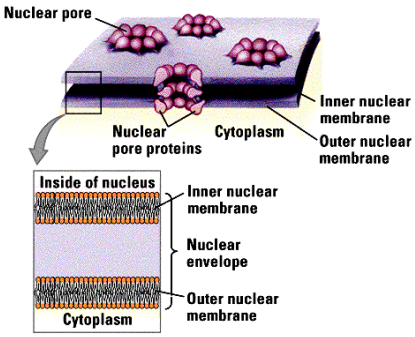
Plant Cell

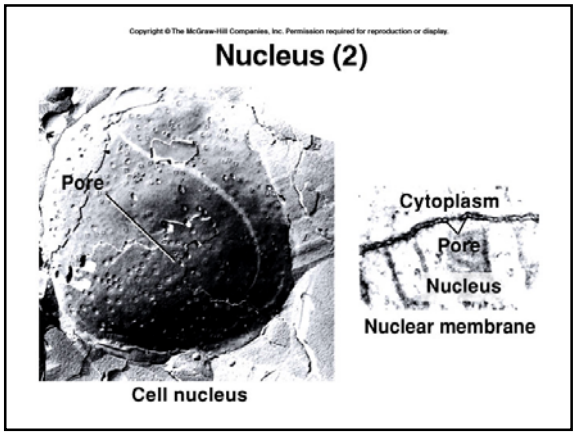


Nucleus



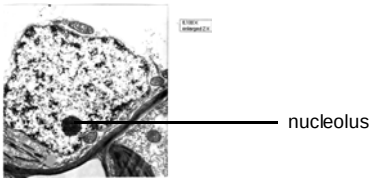
Nuclear envelope





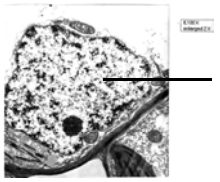
Nucleolus

- ✓ 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.

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

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

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

Endoplasmic reticulum

Rough ER

Large, flattened, membrane sacs

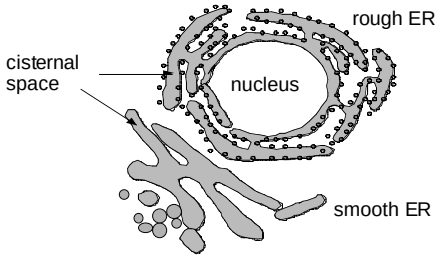
Predominates in cells actively synthesizing protein for export

Smooth ER

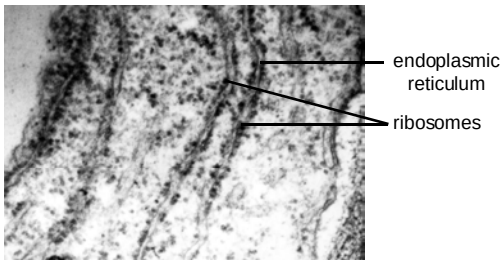
Interconnected membrane tubules

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

Endoplasmic reticulum

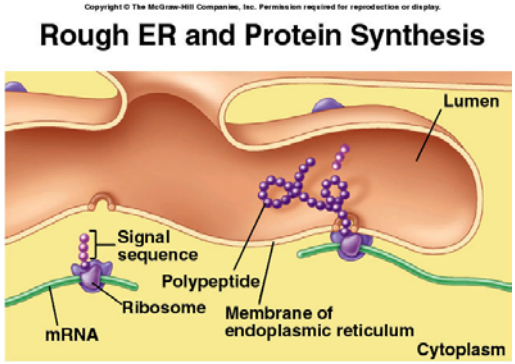


Rough ER



Functions of the rough ER

- ✓Protein targeting
- ✓Modification of proteins

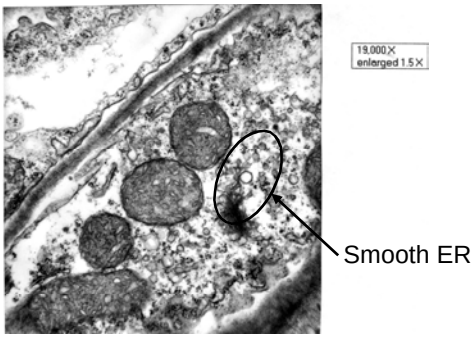


Ribosomes

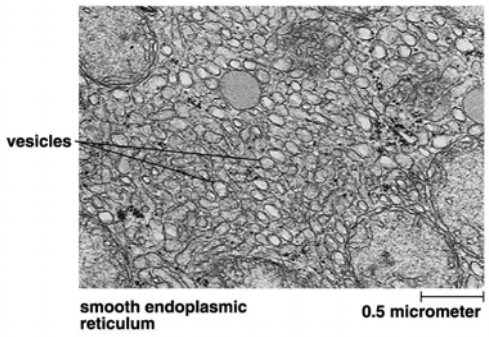
- ✓Protein synthesis
- ✓RNA called rRNA & protein
- ✓Large and small subunit

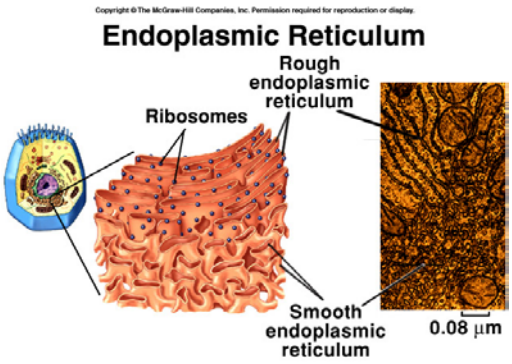
Functions of the smooth ER

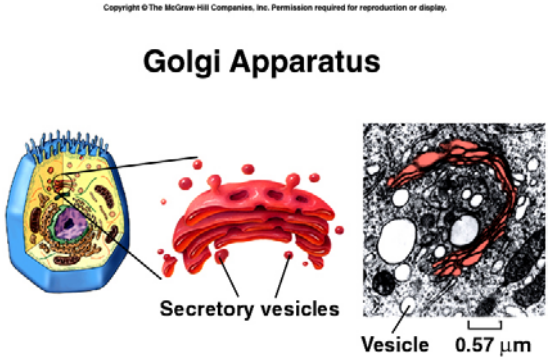
- ✓A receptacle of metabolic enzymes.
- ✓Synthesis of triacylglycerols and steroids.
- ✓Synthesis of phospholipids.
- ✓Detoxification of drugs, pesticides, toxins, and pollutants.



Smooth ER



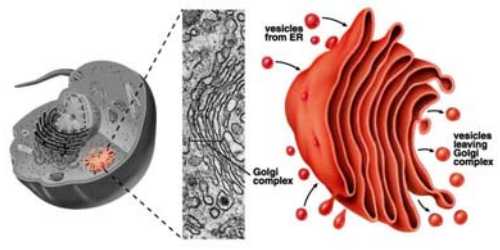


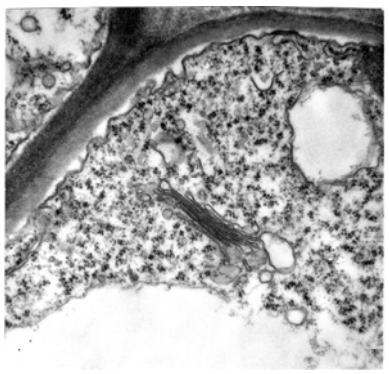


Functions of the Golgi apparatus

- ✓ "US postal service"
  - ✒ Collection
  - ✒ Packaging
  - ✒ Distribution
- ✓ Glycolation - glycoprotein and glycolipids
- ✓ cis face - vesicles enter
- ✓ trans face - vesicles exit

Golgi complex





Golgi complex

19,000X enlarged 2X

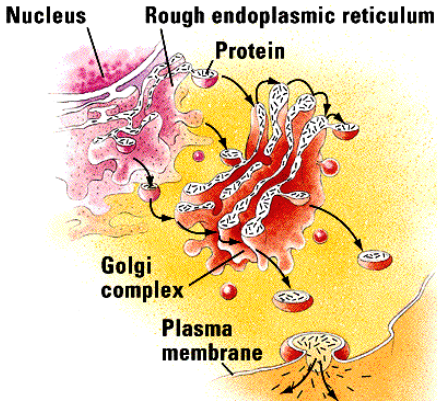
Lysosomes

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

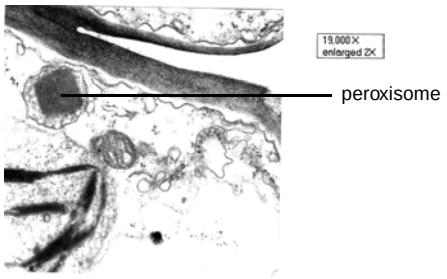
Lysosomes

Primary lysosome contains only degradative enzymes.

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

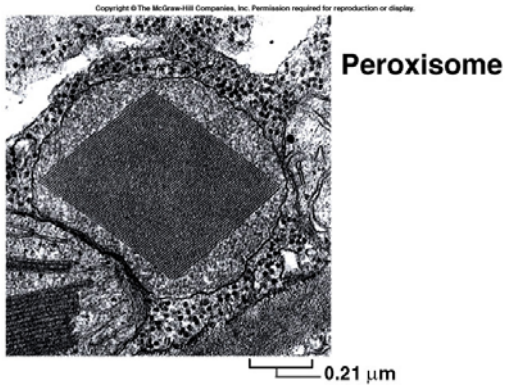


Peroxisomes

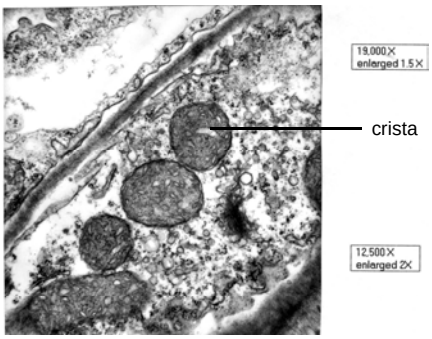


Function of peroxisomes (microbody)

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



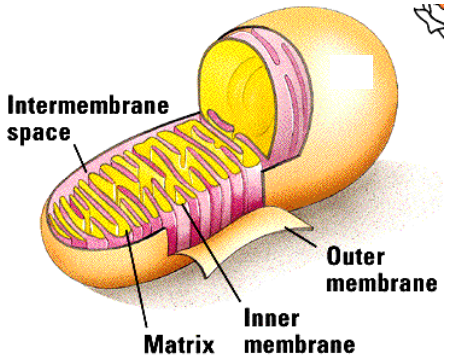
Mitochondria (the powerhouse)



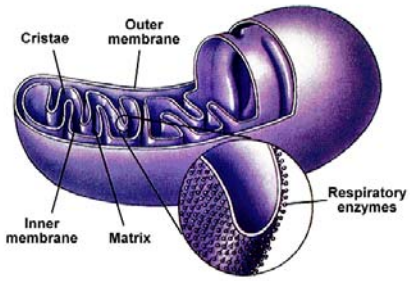
Function of the mitochondria

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

Structure of a mitochondrion



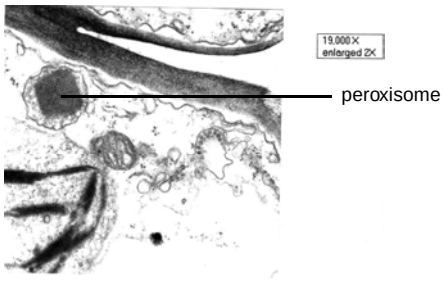
Mitochondria



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

Peroxisomes



Function of peroxisomes

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

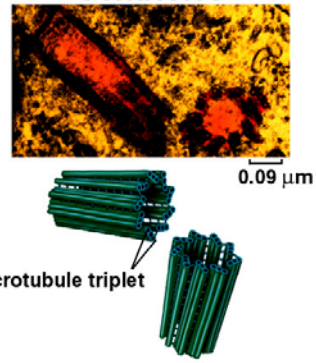
Mitochondria, Cross Section

Found in animals and most protists near nuclear membranes

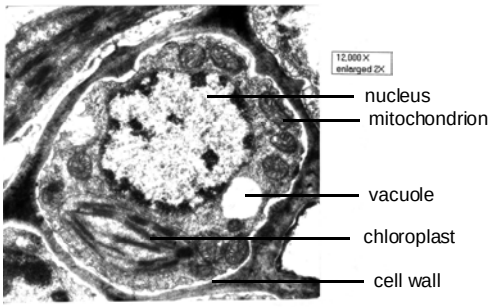
Help to assemble microtubules

MTOCs (microtubule organizational centers

Centrioles



Plant Cell



Vacuole

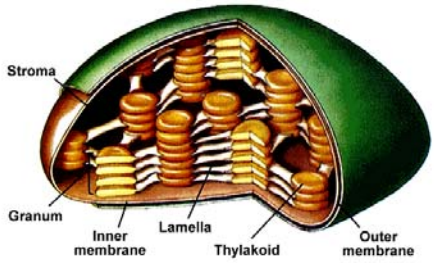
- ✓Provide turgor pressure in plant cells.
- ✓Contain water and waste materials.
- ✓Store sugars and amino acids, pigments and other substances that may be harmful in the cytoplasm.

Vacuoles provide turgor pressure in plants

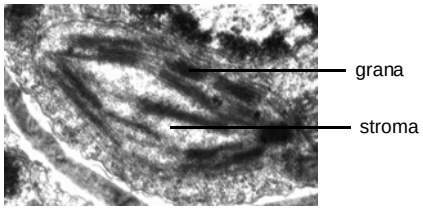
Function of the chloroplast

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

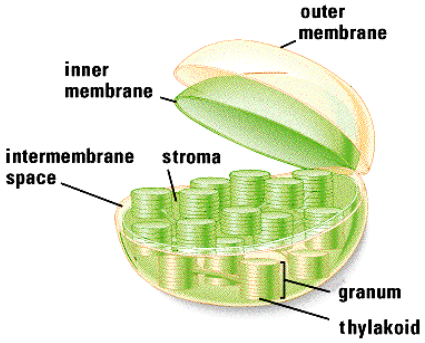
Structure of a chloroplast



Chloroplast

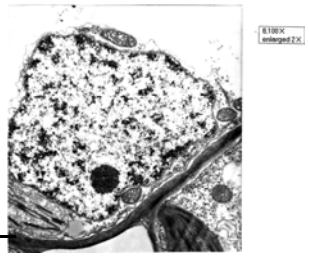


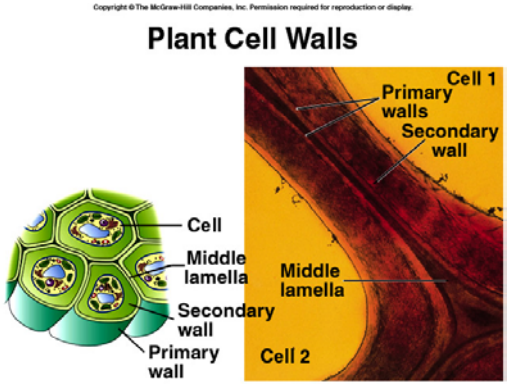
Structure of a chloroplast



Cell Wall

- ✓ Containment
- ✓ Protection
- ✓ Support

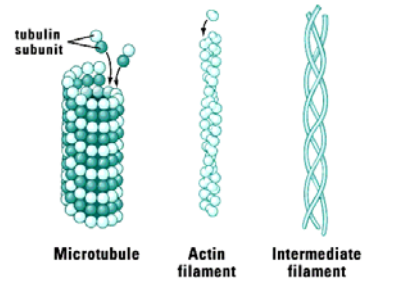




Cytoskeleton

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

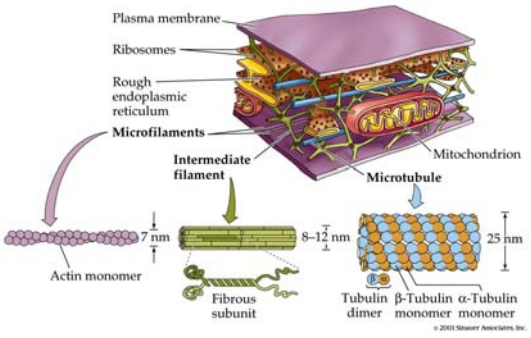
Cytoskeleton of a cell is a complex network of protein filaments



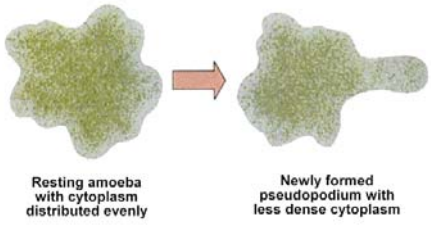
Function of the cytoskeleton

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

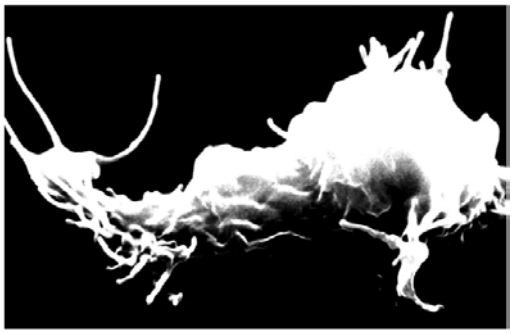
Cytoskeleton



Amoeboid movement



Cell Movement

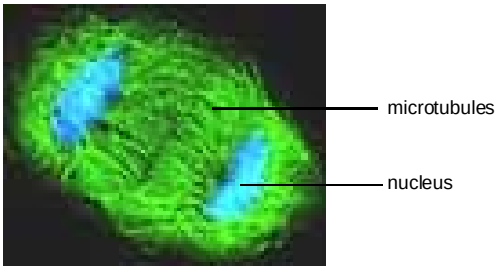


Actin filaments

- ✓ 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

Microtubules

Cell division



tubulin subunits

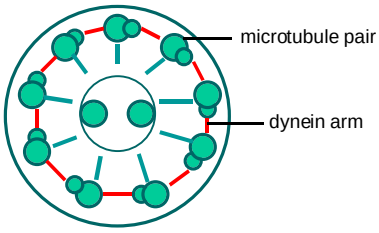
Intermediate filaments

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

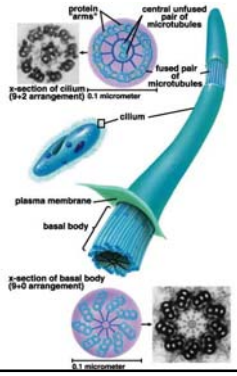
Flagellum/Cilium

- ✓ 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

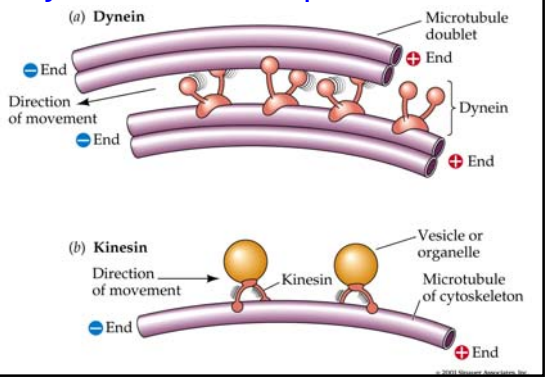
“9+2” arrangement



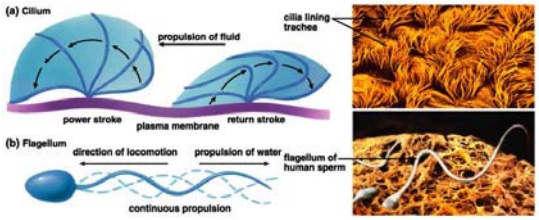
Microtubules of a cilium



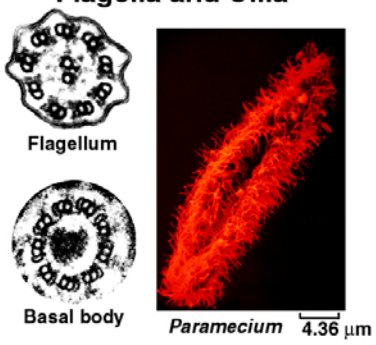
Dynein and Motor proteins



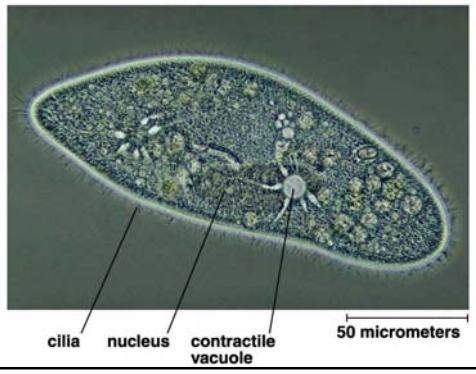
Eukaryotic - cilia & flagella



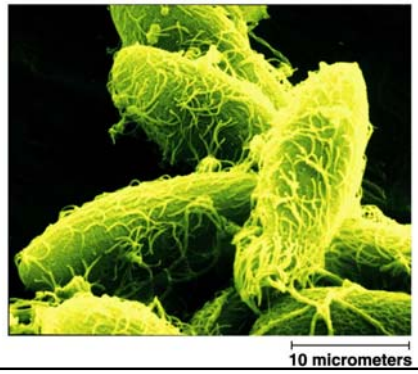
Flagella and Cilia



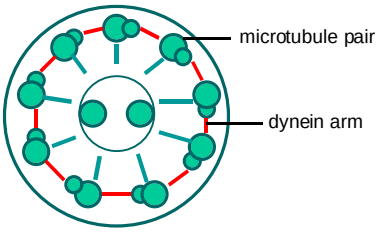
Paramecium

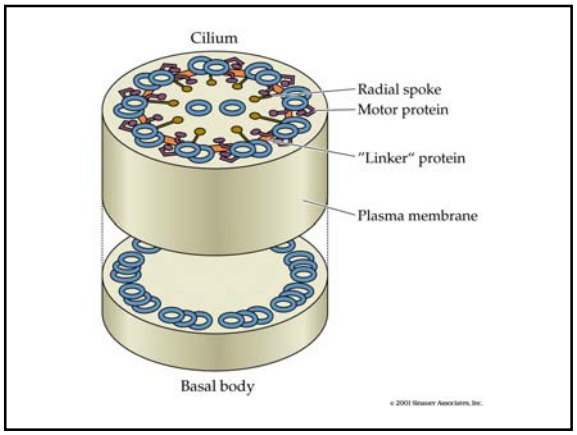


Cilia on a paramecium

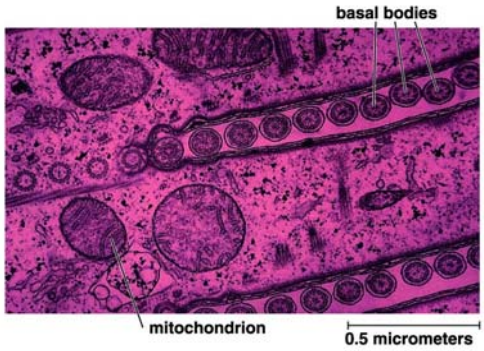


"9+2" arrangement

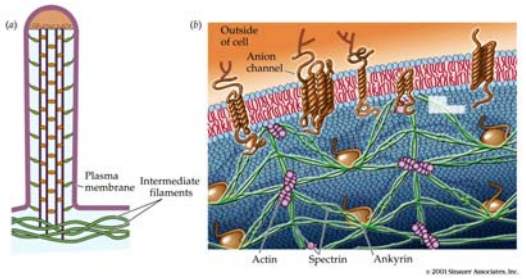




Basal bodies/mitochondia



Microvilli and support



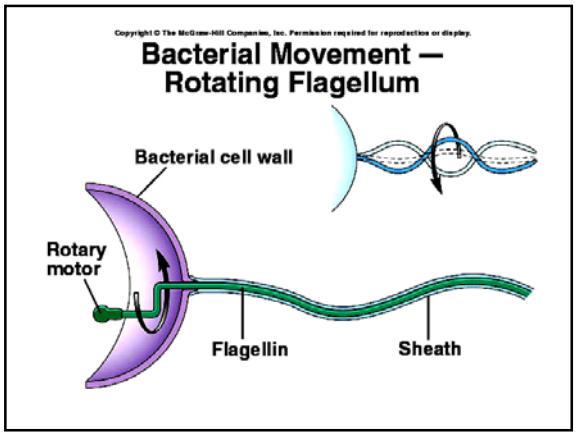


Table 5.2 A Comparison of Bacterial, Animal, and Plant Cells

	Bacterium	Animal	Plant
EXTERIOR STRUCTURES			
Cell wall	Present (protein-polysaccharide)	Absent	Present (cellulose)
Cell membrane	Present	Present	Present
Flagella	May be present (single strand)	May be present	Absent except in sperm of a few species
INTERIOR STRUCTURES			
ER	Absent	Usually present	Usually present
Ribosomes	Present	Present	Present
Microtubules	Absent	Present	Present
Centrioles	Absent	Present	Absent
Golgi apparatus	Absent	Present	Present
Nucleus	Absent	Present	Present
Mitochondria	Absent	Present	Present
Chloroplasts	Absent	Absent	Present
Chromosomes	A single circle of DNA	Multiple; DNA-protein complex	Multiple; DNA-protein complex
Lysosomes	Absent	Usually present	Present
Vacuoles	Absent	Absent or small	Usually a large single vacuole