Cell Theory

- The Cell is the smallest unit of life
- Cells come from existing cells
- All cells use energy and have a metabolism
- All cells have a plasma membrane
- All cells have genetic information in the form of DNA
Cell Size
Cell Size

Surface area increases while total volume remains constant

<table>
<thead>
<tr>
<th></th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total surface area</td>
<td>6</td>
<td>150</td>
<td>750</td>
</tr>
<tr>
<td>(height x width x number of sides x number of boxes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total volume</td>
<td>1</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>(height x width x length x number of boxes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface-to-volume ratio</td>
<td>6</td>
<td>1.2</td>
<td>6</td>
</tr>
<tr>
<td>(area + volume)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prokaryotic Cells

(a) A typical rod-shaped bacterium

(b) A thin section through the bacterium *Bacillus coagulans* (TEM)
Eukaryotic Cells
Eukaryotic Cells

- NUCLEUS
  - Chromatin
  - Nucleolus
  - Nuclear envelope

- Centrosome
- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum
- Ribosomes
- Central vacuole
- Tonoplast
- Microfilaments
- Intermediate filaments
- Microtubules

- Golgi apparatus
- Mitochondrion
- Peroxisome
- Plasma membrane
- Cell wall
- Wall of adjacent cell
- Plasmodesmata

Not in plant cells:
- Lysosomes
- Centrioles
- Flagella (in some plant sperm)
Nucleus

- Nuclear Envelope
- Nuclear Lamina
- Chromosomes
- Chromatin
- Nucleolus
Ribosomes
Rough Endoplasmic Reticulum

- Secretes glycoproteins
- Produce membranes
- Produce vessicles
Smooth Endoplasmic Reticulum

- Synthesis of lipids
- Detoxify the cell
- Stores calcium ions
Golgi Apparatus

- The warehouse of the cell
  - Modifies
  - Stores
  - Ships

- Cis Face

- Trans Face
Lysosomes

(a) Lysosomes in a white blood cell

(b) A lysosome in action
Vacuoles / Vesicles
Endomembrane System
Mitochondrion
Chloroplast / Plastid
Peroxisome
# Cytoskeleton

<table>
<thead>
<tr>
<th>Property</th>
<th>Microtubules (Tubulin Polymers)</th>
<th>Microfilaments (Actin Filaments)</th>
<th>Intermediate Filaments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Hollow tubes</td>
<td>Two intertwined strands of actin</td>
<td>Fibrous proteins coiled into cables</td>
</tr>
<tr>
<td>Diameter</td>
<td>25 nm with 15-nm lumen</td>
<td>7 nm</td>
<td>8–12 nm</td>
</tr>
<tr>
<td>Protein subunits</td>
<td>Tubulin, a dimer consisting of α-tubulin and β-tubulin</td>
<td>Actin</td>
<td>One of several different proteins (such as keratins)</td>
</tr>
<tr>
<td>Main functions</td>
<td>Maintenance of cell shape (compression-resisting “girders”); cell motility (as in cilia or flagella); chromosome movements in cell division; organelle movements</td>
<td>Maintenance of cell shape (tension-bearing elements); changes in cell shape; muscle contraction; cytoplasmic streaming in plant cells; cell motility (as in amoeboid movement); division of animal cells</td>
<td>Maintenance of cell shape (tension-bearing elements); anchorage of nucleus and certain other organelles; formation of nuclear lamina</td>
</tr>
</tbody>
</table>

**Table 6.1 The Structure and Function of the Cytoskeleton**

**Fluorescence micrographs of fibroblasts.** Fibroblasts are a favorite cell type for cell biology studies. In each, the structure of interest has been tagged with fluorescent molecules. The DNA in the nucleus has also been tagged in the first micrograph (blue) and third micrograph (orange).
Microtubules

- Maintenance of cell shape
- Cell motility
- Chromosome division
- Organelle movement
Centrioles, Cilia and Flagella

Figure 1

(a) Motion of flagella

(b) Motion of cilia

Direction of swimming

Direction of organism’s movement

Direction of active stroke

Direction of recovery stroke

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Microfilaments

- Maintenance of Cell Shape
- Changes in Cell Shape
- Muscle Contractions
- Cytoplasmic Streaming
- Cell Motility
- Cell Division
Intermediate Filaments

- Maintenance of Cell Shape
- Anchorage of Nucleus and Organelles
- Formation of Nuclear Lamina
Cell Walls

Plant cell walls

Vacuole

Cytosol
Plasma membrane

Plant cell wall layers:
Middle lamella
Primary wall
Secondary wall

Plasmodesma

Primary wall
Three layers of secondary wall
Middle lamella

CELL 1

CELL 2

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Extracellular Matrix
Intercellular Junctions

- Tight Junctions
- Desmosomes (anchoring junctions)
- Gap Junctions
Plasmodesmata
Autogeneous & Endosymbiosis