Cell Theory

- 1665 - Robert Hooke
  - Describes small rooms in tree bark

- 1838-39 Matt Schleiden & Ted Schann
  - All organisms are composed of one or more cells.
  - Cells are the smallest living units of all living organisms.

- Late 1800’s Rudolf Virchow’s contribution
  - Cells arise only by division of a previously existing cell.
  - Life on earth represents a continuous line of descent

Modern Cell Concept

Cell Theory
1. All organisms are composed of cells.
2. Cells are the smallest living things.
3. Cells arise only from pre-existing cells.
4. All cells today represent a continuous line of descent from the first living cells.
5. Cells contain a mechanism for protein synthesis
Why Are Cells Small?
Small cells have an optimum surface area to volume ratio

<table>
<thead>
<tr>
<th>Cell radius (r)</th>
<th>Surface area (4πr²)</th>
<th>Volume (4/3πr³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 unit</td>
<td>12.57 units²</td>
<td>1.07 units³</td>
</tr>
<tr>
<td>10 units</td>
<td>125.7 units²</td>
<td>419.9 units³</td>
</tr>
</tbody>
</table>

Surface area to volume ratio → 3:1

0.3:1

Why Are Cells Small?

Electron microscopes resolve structures 0.2nm apart.

Light microscopes resolve structures 200nm apart.

Microscope Properties

- Magnification – “enlarge” objects
- Resolution - minimum distance two points can be distinguished as separate points
  - Light microscopes
  - Electron microscopes
    - Transmission (TEM)
    - Scanning (SEM)
    - Scanning Tunneling (STEM)

Light Microscopy

- Compound Light Microscope
- Phase Contrast Microscope
- Dark-field Microscope
- Fluorescence Confocal Microscope
All cells have certain structures in common.

1. genetic material – in a nucleoid or nucleus
2. cytoplasm – a semifluid matrix
3. plasma membrane – a phospholipid bilayer
1. Prokaryotic
   - Bacteria
   - Archaeabacteria

2. Eukaryotic
   - Plants
   - Animals
   - Fungi
   - Protists

Prokaryotic Cell Structure

- Simplest organisms – all bacteria
  - Plasma Membrane – barrier & regulates
  - Inside the Plasma Membrane
    - Cytoplasm
      - Ribosomes
      - DNA
  - Outside the Plasma Membrane
    - Cell wall – Peptidoglycan layer(s)
      - gram-positive or gram-negative
    - Capsule – Polysaccharide: Adhesion & Hydration
    - Pili - cell adhesion or DNA transfer
**Eukaryotic Cell Structure**

- Characterized by compartmentalization
  - Nucleus
  - Plasma Membrane
  - Cytoplasm

**Plant Cell Unique Characteristics**

- **Central vacuole**
  - Large compartments in mature plant cells,
  - Storage facility for water & other materials
  - Produce turgor (pressure) for cell rigidity

- **Cell wall**
  - Cellulose & other polysaccharides
  - Support of Cells, Tissues, Organs, Whole Plant

- **Chloroplasts**
  - Membranes: 2 in envelope & many internal
  - Semiautonomous: DNA & ribosomes
  - Photosynthesis
**Nucleus**

1. Repository of genetic information
2. Synthesis of RNA for ribosome construction for protein synthesis

**Ribosomes**

- Ribosomes
  - RNA-protein complexes composed of two subunits
  - Site of protein synthesis
  - Assembled in nucleoli

**Ribosomes and Endoplasmic Reticulum**

- Forms compartments
- Large surface area for metabolism
  - Rough ER
    - Protein synthesis by ribosomes
    - Transport
  - Smooth ER
    - Lipid synthesis
    - Detoxification
Golgi Apparatus

- Outgoing Vesicles
- Incoming Transport Vesicles

Collect, package, and distribute molecules

Endomembrane System

Lysosomes - membrane-bound digestive vesicles
Mitochondrion

- Exterior and interior membranes
- Semi-autonomous
  - DNA
  - Ribosomes
- Function: ATP synthesis
  - Energy Metabolism
  - Aerobic respiration

Mitochondrion

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Cytoskeleton

- Network of protein fibers supporting cell shape and anchoring organelles
  - Actin filaments
    - cell movement
  - Microtubules
    - centrioles
  - Intermediate filaments
    - cell structure

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Energy converting organelle: Mitochondrion

- Interior and exterior membranes
- Semi-autonomous
  - DNA
  - Ribosomes
- Function: ATP synthesis
  - Energy Metabolism
  - Aerobic respiration

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Energy converting organelle: Chloroplast

- Two external membranes
- Internal membranes
- DNA
- Ribosomes
- Function: Photosynthesis

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Cytoskeleton

- Network of protein fibers supporting cell shape and anchoring organelles
  - Actin filaments
    - cell movement
  - Microtubules
    - centrioles
  - Intermediate filaments
    - cell structure
Cytoskeleton

Amoeboid Movement

http://video.google.com/videoplay?docid=4349197081937999314&q=elodea&total=23&start=0&num=10&so=0&type=search&plindex=0

http://video.google.com/videoplay?docid=-5522357274832025243&q=mitosis&total=329&start=0&num=10&so=0&type=search&plindex=4

SEM 4,100×
LM 600×

Cilia and Flagella

Flagellum
Plasma membrane
Basal body

SEM 4,100×
TEM 206,500×
TEM 206,500×

Network of protein fibers supporting cell shape, movement and anchoring organelles

Actin subunit
Microfilament

Fibrous subunits
Intermediate filament

Tubulin subunit
Microtubule

Actin and Microfilaments
Cytoskeleton - Summary

- Network of protein fibers
  - Shape
  - Movement
  - anchoring organelles

Microfilaments - made of Actin protein
  - Cell shape & movement

Microtubules - made of tubulin protein
  - Organelle & chromosome movement

Intermediate filaments – fibrous protein
  - Structural stability