

## History of the microscope and cell

1500's: Europe

Merchants used magnifying glasses to determine quality of cloth

Mid 1600's: Holland, development of the microscope and telescope

1665: **Robert Hooke** (English)

\*\* first to observe DEAD CELLS



1675: **Anton van Leeuwenhoek** (Dutch)

\*\* first to observe LIVING CELLS



## History, cont.

1833: **Robert Brown** (Scottish)  
Discovered nucleus



1838: **Matthias Schleiden** (German)  
Stated "all plants are made of cells"



1839: **Theodor Schwann** (Dutch)  
Stated "all animals are made of cells"



1855: **Rudolf Verchow** (German MD)  
Stated "all cells arise from other cells"



## CELL THEORY

1. all living things are composed of cells
2. cells are basic units of structure and function
3. all cells come from pre- existing cells

## Characteristics of Microscopes

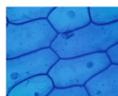
**magnification:** ability to make an image larger than actual size

**resolution:** power to show details clearly while enlarged (if poor, objects seem fuzzy)

## Types of Microscopes

### compound light

- light passes through one or more lenses
- object must be sliced thinly enough to be transparent
- upper limitation is 2000X or 0.5 microns (um) in diameter



## II. Electron Microscopes

- limited by physical characteristics of light
- can magnify an image up to 200,000 X
- beams of electrons produces enlarged image



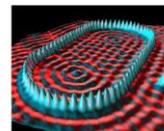
Transmission



Scanning



Scanning Tunneling



## How cells differ

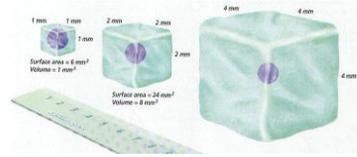
### 1. size

- most cells are 5-50 microns surface area ratio (limits size of cells)

inside of cell grows faster: cubed  
 $(V = L \times W \times H)$

outside of cell grows slower: squared  
 $(A = L \times W)$

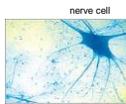
## Relationship of Surface Area to Volume



LENGTH OF SIDE (CM)	TOTAL SURFACE AREA (CM <sup>2</sup> )	TOTAL VOLUME (CM <sup>3</sup> )	SURFACE AREA TO VOLUME RATIO
1	(1X1X6)= 6	(1X1X1)=1	6:1
2	(2X2X6)=24	(2X2X2)=8	24:8 3:1
3	(3X3X6)= 54	(3X3X3)=27	54:27 2:1

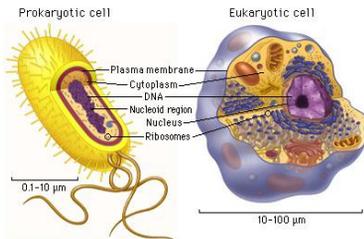
### 2. shape

- most spherical or cuboidal
- different shapes determine function



## All cells contain:

- cell membrane (plasma membrane)
- cytoplasm: gel like, holds cellular structures
- cytoskeleton: microscopic protein fibers that keep cells shape
- ribosomes: make proteins
- DNA: controls all cell activities

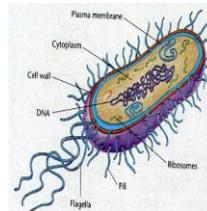


### 3. internal organization

- organized by nucleus and organelles

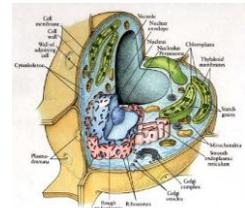
#### 1. prokaryotes (bacteria)

- primitive cells
- no nucleus
- no membrane bound organelles
- free floating DNA
- cell walls



#### 2. eukaryotes:

- more complex cells
- contain nucleus and membrane bound organelles



## CELL STRUCTURE

### Main components of eukaryotic cells

- cell membrane (outer boundary)
- nucleus (control center)
- cytoplasm (material between nucleus and membrane)

## ANIMAL CELLS

### Cell Membrane (plasma membrane)

**Functions:**

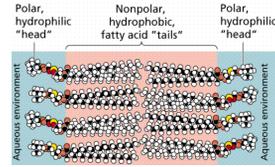
- separates cells from surroundings
- regulates substance movement (bring in nutrients, remove wastes)
- selectively permeable (pores)
- protection and support
- gives shape and flexibility



### Fluid mosaic model of Cell Membrane

**liquid phospholipid bilayer** (water insoluble, no movement through)

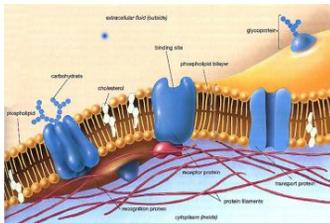
- polar outside
- non-polar inside
- polar outside



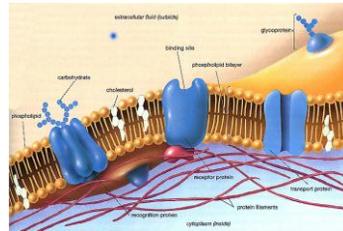
animation - permeability

### Membrane Proteins

- transport proteins:**
  - go through the entire membrane
  - inside of pore allows water to move through
- recognition proteins:** (like tips of icebergs)
  - recognize substances
  - identify different cell types

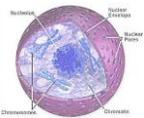


- receptor proteins:** accepts cell messages and cause cell to react (do something)
- enzymes:** embedded in cell membrane to cause chemical reactions



lipids and protein are liquid in nature and constantly move around each other

animation - fluid mosaic

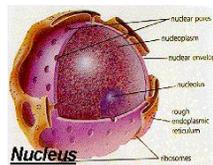


### Nucleus

- control center of cell: directs all cell activities
- contains chromosomes
- site of DNA and RNA synthesis
- located in center of most cells

**Structure:**

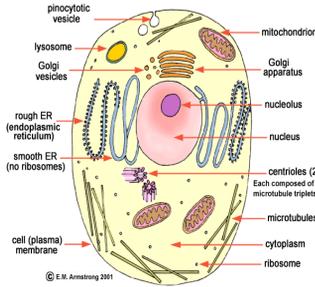
- **nuclear envelope** (double membrane)
- contains **chromatin:** combination of strands of DNA and protein
- **nuclear pores:** control substance movement
- **nucleoplasm:** dense, protein rich
- **nucleolus:** partially assembles ribosomes for protein synthesis



### Cytoplasm

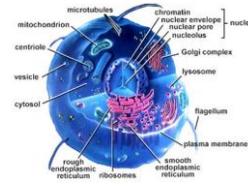
(between membrane and nucleus)

- contains **cytosol**
- gel like material between nucleus and cell membrane
- contains water, salts, organic molecules
- in constant motion (cytoplasmic streaming)
  - [animation](#)
- holds organelles
  - [Cell virtual tour](#)



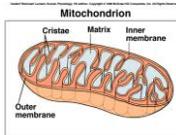
### Organelles

Organelle: tiny structure that performs special functions in the cell to maintain life



### Mitochondria

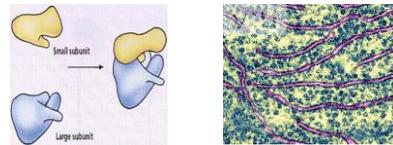
- powerhouse of cell (cell respiration)
- provides energy for cell in form of ATP
- membrane bound
- most numerous in cells which use a lot of energy (muscle)



- **cristae:** greatly enlarge surface area of inner membrane (more area for chemical reactions of respiration)

### Ribosomes

- spherical structures which make proteins
- not surrounded by membrane
- composed of protein and nucleic acids
- site of protein synthesis



### Endoplasmic reticulum: (ER)

intercellular highway  
complex membrane system of folded sacs and tunnels

#### Rough ER

- ribosomes stuck to membrane surface
- newly produced proteins are inserted into ER
- can be stored or exported to smooth ER



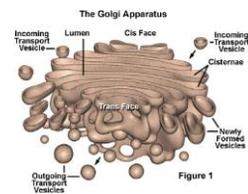
#### Smooth ER

- no ribosomes
- also stores and acts as an intercellular highway for proteins and enzymes



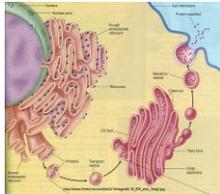
### Golgi Apparatus

- flattened system of membranes and sacs piles on each other (like pancakes)
- very close to ER
- processes, packages, and secretes proteins to other parts of cell



## Steps of Protein Production and Transport

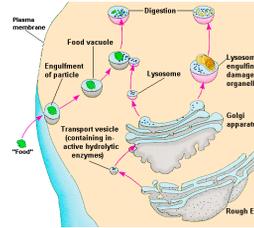
1. ribosomes make proteins on the rough ER- packaged into vesicles (sacs)
2. vesicles transport the newly made proteins from the rough to the Golgi apparatus
3. in Golgi, proteins are processed and then packaged into NEW vesicles
4. vesicles move thru Golgi to cell membrane and release contents outside cell



[animation](#)

## Lysosomes

- small round membrane bound sacs that contain digestive enzymes
- formed from Golgi Apparatus
- digest and remove waste from cell (old organelles, byproducts, bact., viruses)



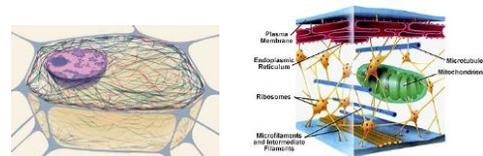
[animation](#)

## Peroxisomes

- Similar to lysosomes, have different enzymes
- Produce H<sub>2</sub>O<sub>2</sub> (hydrogen peroxide)
- In liver cells: detox alcohol and drugs, kill bacteria, break down fatty acids

## Cytoskeleton (cell framework)

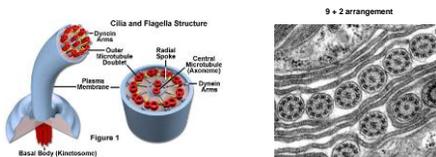
- maintains shape and size of cell
- composed of network of long protein strands located in cytosol
- provides movement for organelles within cytosol



**flagella:** long whip-like structures for movement

**cilia:** short numerous hairlike projections used in movement or to move substances across cell

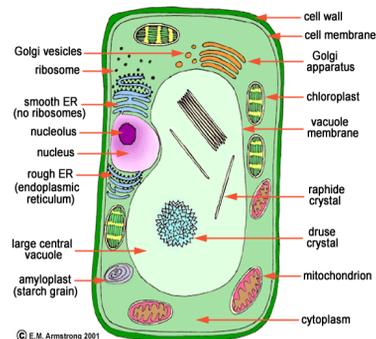
ex: ear drum: picks up and transmits sound waves  
respiratory tract: moves mucus etc



[animation](#)

[respiratory system animation](#)

## PLANT CELLS



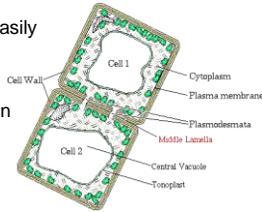
Contain the same organelles as animal cells plus the following:

1. cell walls
2. vacuoles
3. plastids

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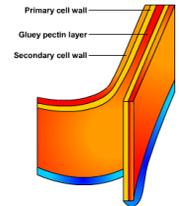
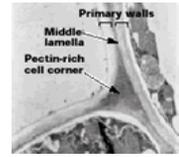
## Cell wall

- rigid covering of plant cells, algae, and some bacteria
- composed of long chains of cellulose embedded in hardened lignin and pectin
- very porous (O, H<sub>2</sub>O, CO<sub>2</sub> easily pass through)
- function: support & protection



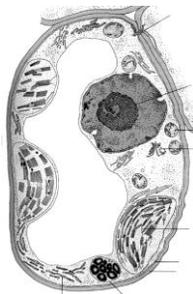
## Structure

- **middle lamella**  
pectin: gluey substance holds cells together
- **primary cell wall**  
cellulose: structure and support
- **secondary wall**  
lignin: very stiff and hard, in woody plants in bark structure and support



## Central Vacuoles

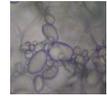
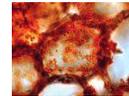
- sac like structures that store water, salts, enzymes, and wastes
- usually take up ~ 90% of cell volume
- push membrane against wall and responsible for turgidity



## Plastids

Convert solar energy into chemical energy to be stored.

1. **chloroplasts**- chlorophyll (green pigment) used in photosynthesis
2. **chromoplasts**- synthesize and store red, orange, and yellow pigments (give plants unusual colors)
3. **leucoplasts**- store starches, proteins, and lipids colorless

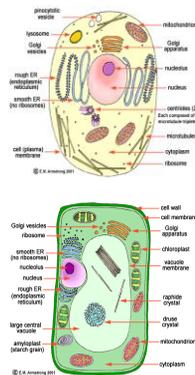


## Cell Differences

Shape: animal- round  
plant- square

Animal cells do not contain:  
cell wall  
central vacuole  
plastids

Plant cells do not contain:  
centrioles  
lysosomes



## Levels of Structure

