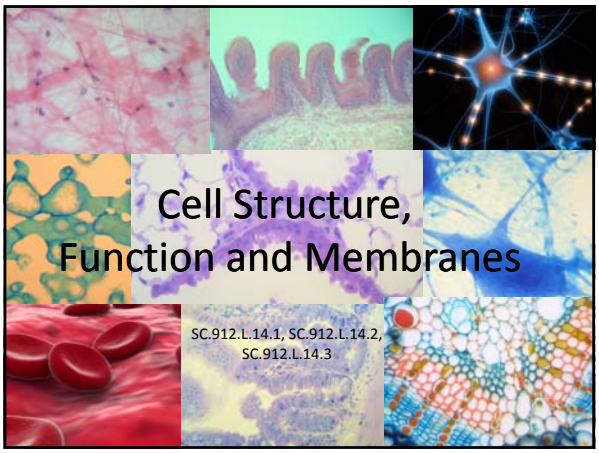


Cells: The Basic Units of Life

I. The History of Cells

A. The Discovery of Cells

1. All living things are made of cells.
2. A cell is the smallest unit that can carry on the processes of life.
3. Robert Hooke
   a. Discovered cells in a slice of cork.
4. Leeuwenhoek
   a. First to observe living cells.

5. Cell Theory
   a. All living things are made of cells.
   b. Cells are the basic unit of structure and function.
   c. Cells come only from preexisting cells.
   d. Developed by Schwann, Schleiden and Virchow.

B. Cellular Basis of Life

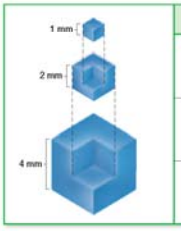
1. All living things are made of organized parts, obtain energy from their surroundings, perform chemical reactions, change with time, respond to their environment, and reproduce.
   a. These are the characteristics of life.

II. Introduction to Cells

A. Cell Diversity

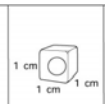
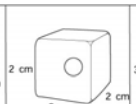
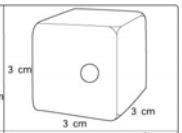
1. Cells Shape
   a. A cell's shape reflects its function.

2. Cell Size
   a. Cell size is limited by a cell's surface area-to-volume ratio.



Side length	Surface area	Volume	Surface area/ volume ratio
1 mm	6 mm^2	1 mm^3	6:1
2 mm	24 mm^2	8 mm^3	3:1
4 mm	96 mm^2	64 mm^3	3:2

Ratio of Surface Area to Volume in Cells

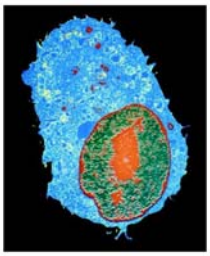
Cell Size			
Surface Area (length x width x 6)	1 cm x 1 cm x 6 = 6 cm^2	2 cm x 2 cm x 6 = 24 cm^2	3 cm x 3 cm x 6 = 54 cm^2
Volume (length x width x height)	1 cm x 1 cm x 1 cm = 1 cm^3	2 cm x 2 cm x 2 cm = 8 cm^3	3 cm x 3 cm x 3 cm = 27 cm^3
Ratio of Surface Area to Volume	6 / 1 = 6 : 1	24 / 8 = 3 : 1	54 / 27 = 2 : 1

- Surface area and volume do not increase at the same rate
- Larger cells have difficulty exchanging oxygen and waste in and out of the cell
- Before cell becomes too large it undergoes cellular division and forms 2 daughter cells

B. Basic Parts of the Cell

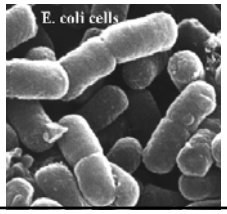
1. Plasma Membrane
   a. Acts as a barrier between the inside and outside of the cell.
   b. Made mostly of phospholipids and proteins.
2. Cytoplasm
   a. The region of the cell that is within the plasma membrane except the nucleus.
   -That includes the fluid, the cytoskeleton, and all of the organelles.

3. Nucleus
   a. A membrane-bound organelle that contains a cell's DNA.

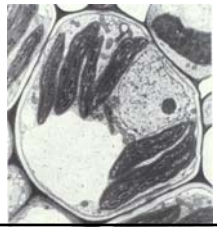


C. Two Basic Types of Cells

1. Prokaryotes
   a. Lack a nucleus and membrane-bound organelles.

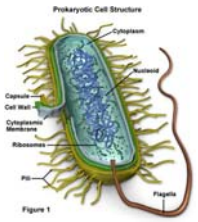


2. Eukaryotic
   a. Have a nucleus and a membrane-bound organelle.
   b. They are larger and more complex than prokaryotic.

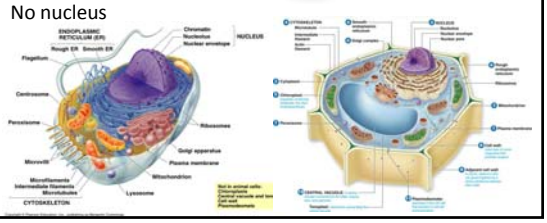


Review

Prokaryotic
- Simple
- Small
- Bacteria
- No organelles
- No nucleus

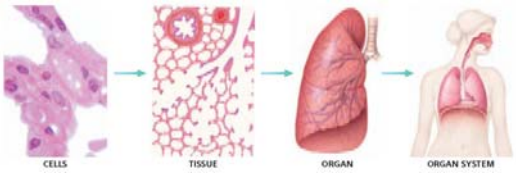


Eukaryotic
- Complex
- Larger
- Organelles
- Nucleus

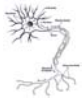


D. Cellular Organization

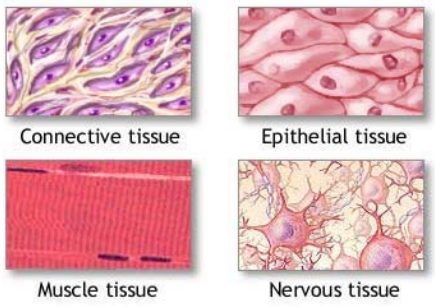
1. In multicelluar organisms, cells form tissues, organs, organ systems, and finally organisms.

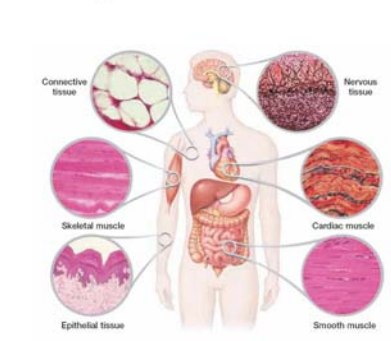


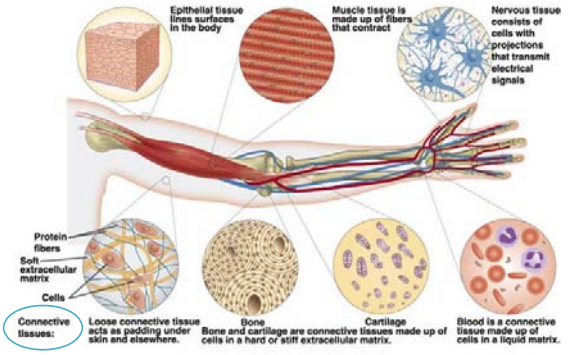
2. Cell Specialization
   - Occurs in multicellular organisms
   - Each type of cell will have one job
   - They will develop a specific shape
   - Examples:
     - Nerve Cells
     - Root Hair Cells



3. Tissues and Organs
   a) Tissues
      - Composed of hundreds of a few types of cells.
      - Have similar functions because the tissue has a specific function



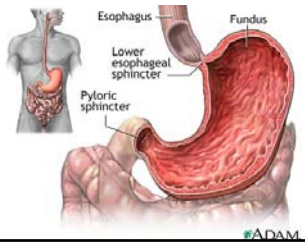




b. Organs

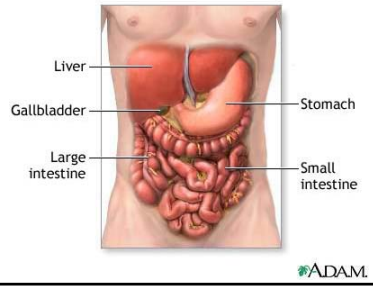
-Consists of several tissues grouped together.

-Perform a specific function.



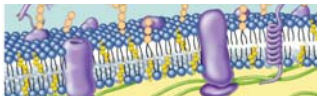
c. Organ System

-A group of organs whose functions are closely related.



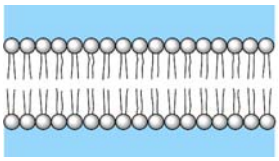
III. Structure and function

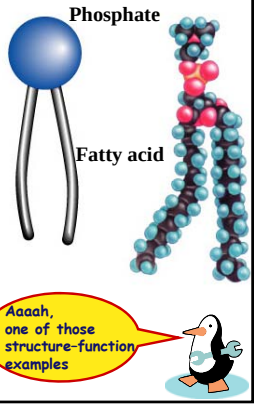
- Cell membrane separates living cell from nonliving surroundings
  - thin barrier = 8 nm thick
- Controls traffic in & out of the cell
  - selectively permeable
  - allows some substances to cross more easily than others
    - hydrophobic vs hydrophilic
- Made of phospholipids, proteins & other macromolecules



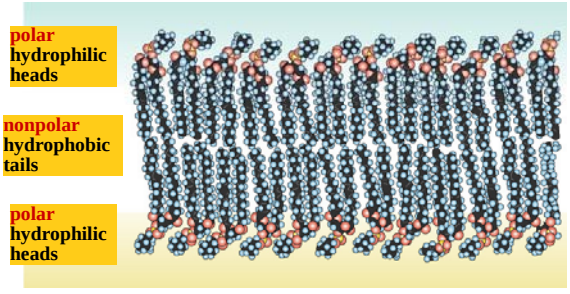
Phospholipids

- Fatty acid tails
  - hydrophobic
- Phosphate group heac
  - hydrophilic
- Arranged as a bilayer



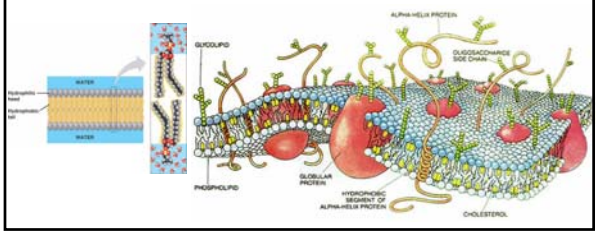


Phospholipid bilayer



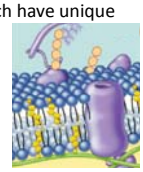
A. Plasma Membrane

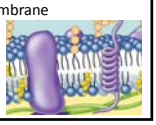
1. Membrane Lipids
   a) Cell membrane consists of a phospholipid bilayer.
   b) Proteins, cholesterol, carbohydrates



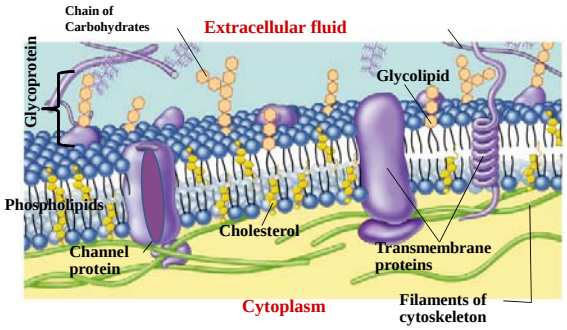
Membrane Proteins

- Proteins determine membrane's specific functions
  - cell membrane & organelle membranes each have unique collections of proteins
- Membrane proteins:
  - peripheral proteins
    - loosely bound to surface of membrane
    - cell surface identity marker (antigens)
  - integral proteins
    - penetrate lipid bilayer, usually across whole membrane
    - transmembrane protein
    - transport proteins
      - channels, permeases (pumps)

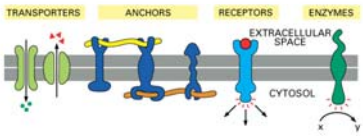




Membrane is a collage of proteins & other molecules embedded in the fluid matrix of the lipid bilayer

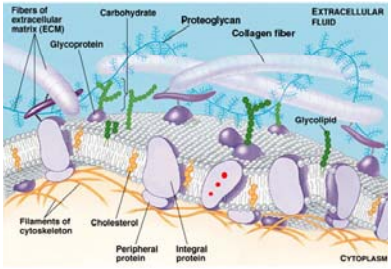


2. Membrane Proteins
   a. Allow certain substances in and out of the cell
   b. Maintain balance



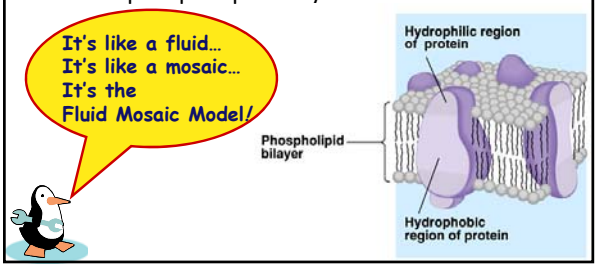
3. Fluid Mosaic Model

a. The fluid mosaic model states that the phospholipid bilayer behaves like a fluid more than it behaves like a solid.



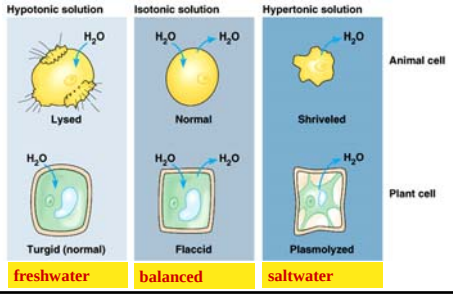
More than lipids…

- In 1972, S.J. Singer & G. Nicolson proposed that membrane proteins are inserted into the phospholipid bilayer



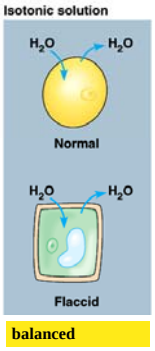
Managing water balance

Cell survival depends on balancing water uptake & loss



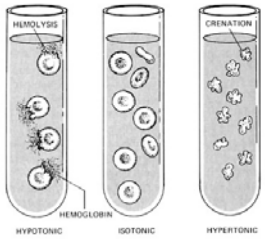
Managing water balance

- Isotonic
  - animal cell immersed in mild salt solution
  - example: blood cells in blood plasma
- no net movement of water
  - flows across membrane equally, in both directions
- volume of cell is stable



Blood

- A red blood cell placed in a **hypotonic** solution (pure water) bursts immediately from the influx of water.
- When red blood cells are placed in a 0.9% salt solution, they neither gain nor lose water by osmosis.
  - solution is **isotonic**
- If red cells are placed in sea water (about 3% salt), they lose water by osmosis and the cells shrivel up.
  - Sea water is **hypertonic** to their cytosol.

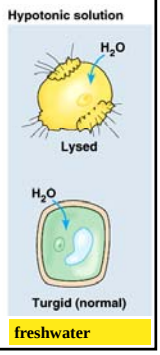


(Kimball, 2011)

Managing water balance

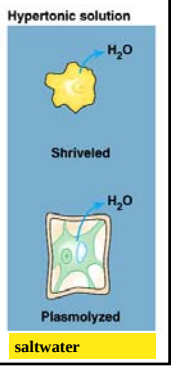
- Hypotonic
  - a cell in fresh water
    - example: *Paramecium*
    - problem: gains water, swells & can burst
      - water continually enters *Paramecium* cell
    - solution: contractile vacuole
      - pumps water out of cell
      - ATP
  - plant cells
    - Turgid- pressure built up

ATP



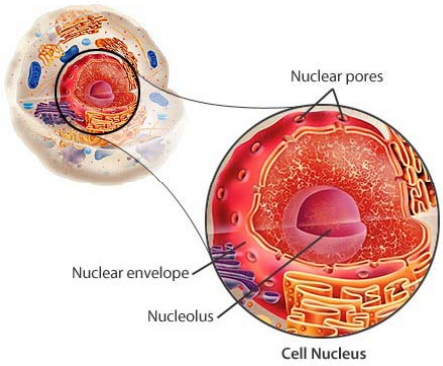
Managing water balance

- Hypertonic
  - a cell in salt water
    - example: shellfish
    - problem: lose water & die
    - solution: take up water or pump out salt
  - plant cells
    - plasmolysis = wilt



B. Nucleus

1. Directs the cell's activities and stores DNA.
2. Nuclear Envelope
   a. A double membrane that surrounds the nucleus
3. Nucleolus
   a. The place where DNA is concentrated when it is in the process of making ribosomal RNA.

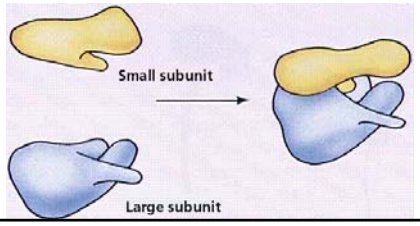


C. Mitochondria

1. Transfers the energy in organic compounds into a form the cell can use: ATP

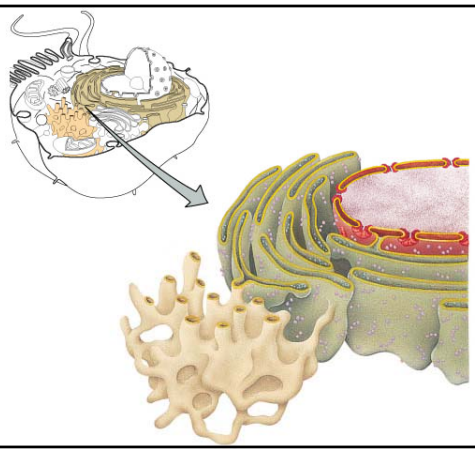
D. Ribosomes

1. Found either free-floating or attached to the endoplasmic reticulum.
2. Build protein.
3. No membrane



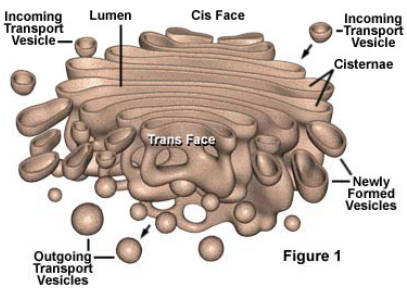
E. Endoplasmic Reticulum

1. The **rough ER** produces phospholipids and proteins for export or insertion into the cell membrane. *Includes digestive enzymes.*
2. The **smooth ER**
   - builds lipids (cholesterol)
   - produces steroid hormones (estrogen & testosterone) in the ovaries and testes
   - releases calcium in the skeletal and heart muscle cells
   - participates in detoxification of toxins in the liver and kidney



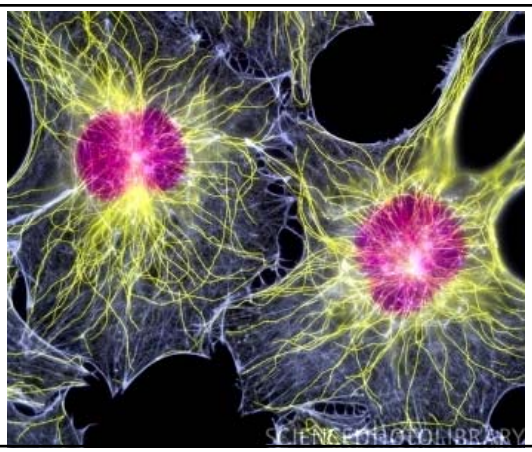
F. Golgi Apparatus

1. Processes and packages proteins.

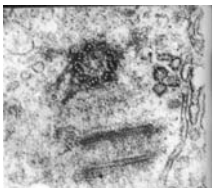


G. Vesicles
1. Are classified by their contents.
a. Lysosomes: contain digestive enzymes
b. Peroxisomes: contain detoxification enzymes
2. Membrane-bound sacs

H. Cytoskeleton
1. Is made of protein fibers that help the cell move and also maintain its shape.
a. Fibers: Microtubules, microfilaments, and intermediate filaments.
2. Cilia and Flagella
a. Hairlike structures that extend from the surface of the cell.
b. Assist in movement of the cell.

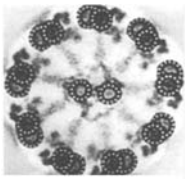


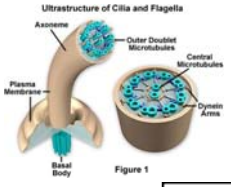
3. Centrioles
a. Consists of two short cylinders of microtubules at right angles to each other.
b. Involved in cell division.

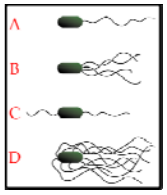


(Childs, 1996)

Cilia and Flagella

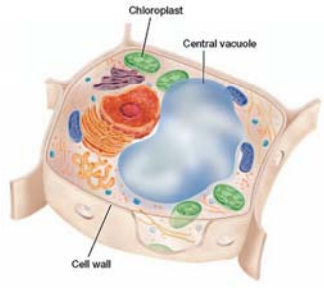






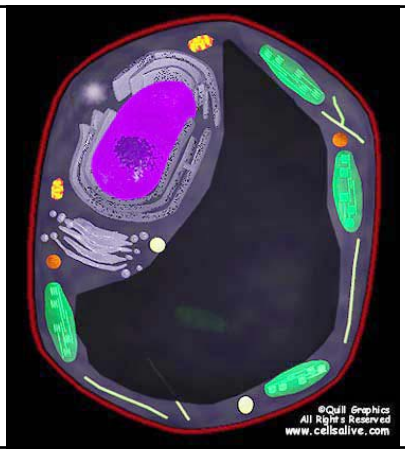
IV. Unique Features of Plant Cells

A. Plant Cells

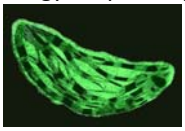


1. Cell Wall
   a. A rigid wall that covers the cell membrane and provides support and protection.

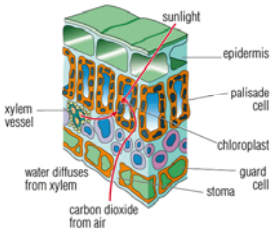
2. Central Vacuole/Tonoplast
   a. Store water, enzymes, and waste products.
   b. Provides support for plant and tissue.



3. Plastids
   a. 3 types: **chloro**plasts, **chromo**plasts and **leuco**plasts
   b. Surrounded by double membrane and contain their own DNA (like mitochondria)
   c. Store starch and pigments
   d. Chloroplast: converts light energy into chemical energy via photosynthesis.



Palisade Cell



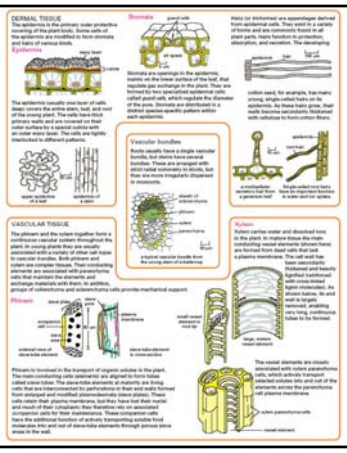
- Closely packed, columnar cells, lying in the upper surfaces of leaves
- Contain many chloroplasts (where photosynthesis takes place) and are well adapted to receive and process the components necessary for photosynthesis – carbon dioxide, water, and sunlight.
- Vertical arrangement means that there are few cross-walls to interfere with the passage of sunlight.

(Farlex, 2009)

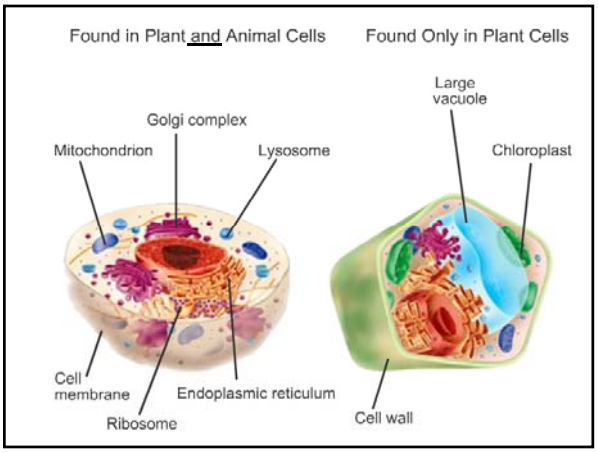
Plant Dermal Tissue

- **Xylem** carries water and minerals salts
- **Phloem** transports sugars and amino acids

(Access Excellence, 2009)



(Access Excellence, 2009)



Cell Comparison

	Animal	Plant
Exterior Structures		
Cell wall	Absent	Present (cellulose)
Cell membrane	Present	Present
Flagella	May be present	Absent except in sperm of a few species
Interior Structures		
Endoplasmic reticulum	Usually present	Usually present
Ribosomes	Present	Present
Microtubles	Present	Present
Centrioles	Present	Absent
Golgi Apparatus	Present	Present
Nucleus	Present	Present
Mitochondria	Present	Present
Chloroplasts	Absent	Present
Chromosomes	Multiple; DNA-protein complex	Multiple; DNA-protein complex
Lysosomes	Usually present	Present as "spherosomes"
Vacuoles	Absent or small	Usually a large single vacuole

(Mrskingsbioweb, 2009)

Common Misconceptions

Remember

- Animal cells never have a cell wall, chloroplasts or sap vacuoles
  - (may have temp vacuoles where food is stored)
- Not all cells have all cell parts when mature
  - Red blood cells do not have a nucleus
  - Xylem cells do not have a nucleus or cytoplasm
- Animal cells have 3 parts: MNC…
  - **m**embrane, **n**ucleus, and **c**ytoplasm

- Plant cells are usually larger than animal cells
- It is **not** true that all plant cells contain chloroplasts
  - Epidermis cells and root cells do not
- Chloroplasts are different from chlorophyll
  - Chloroplasts = organelle
  - Chlorophyll = chemical found in chloroplasts

Resources

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