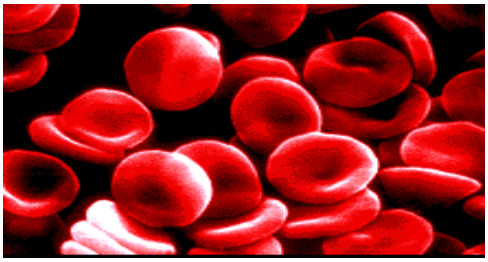
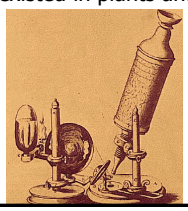
The History of Cells & the Cell Theory



Discovery of Cells

- 1665- English Scientist, Robert Hooke, discovered cells while looking at a thin slice of cork.
- He described the cells as tiny boxes or a honeycomb
- He thought that cells only existed in plants and fungi



Anton van Leuwenhoek

- 1673- Used a handmade microscope to observe pond scum & discovered single-celled organisms
- He called them "animalcules"

- He also observed blood cells from fish, birds, frogs, dogs, and humans
- Therefore, it was known that cells are found in animals as well as plants

150-200 Year Gap???

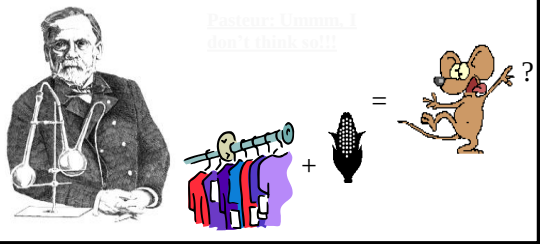
- Between the Hooke/Leuwenhoek discoveries and the mid 19th century, very few cell theory advancements were made.
- This is probably due to the widely accepted, traditional belief in Spontaneous Generation.
- Examples:

  -Mice from dirty clothes/corn husks

  -Maggots from rotting meat

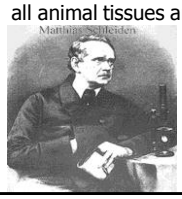
19th Century Advancement

- Much doubt existed around Spontaneous Generation
- Conclusively disproved by Louis Pasteur



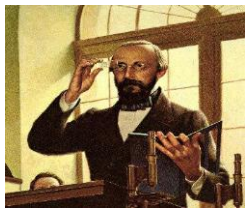
Development of Cell Theory

- 1838- English Botanist, Matthias Schleiden, concluded that all plant parts are made of cells
- 1839- German physiologist, Theodor Schwann, who was a close friend of Schleiden, stated that all animal tissues are composed of cells.



Development of Cell Theory

- 1858- Rudolf Virchow, Russian physician, after extensive study of cellular pathology, concluded that cells must arise from preexisting cells.

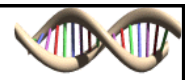


3 Basic Components of the Cell Theory

- 1. All organisms are composed of one or more cells.
  - (Schleiden & Schwann)(1838-39)
- 2. The cell is the basic unit of life in all living things.
  - (Schleiden & Schwann)(1838-39)
- 3. All cells are produced by the division of preexisting cells.
  - (Virchow)(1858)

Theory

A set of statements or principles devised to explain a group of facts or phenomena, especially one that has been repeatedly tested or is widely accepted and can be used to make predictions about natural phenomena.



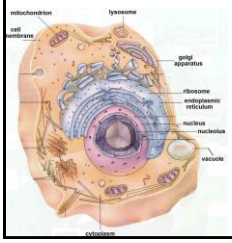
Modern Cell Theory

- Modern Cell Theory consists of the 3 basic components of cell theory, plus 4 additional statements:
  - 4. The cell pass information from cell to cell during cell division using DNA.
  - 5. All cells have basically the same chemical composition and metabolic activities.
  - 6. All cells have basically the same chemical & physiological functions.(movement, digestion, etc)
  - 7. Cell activity depends on the activities of structures within the cell. (organelles, nucleus, plasma membrane)

How Has The Cell Theory Been Used?

- The previously discovered truths about cells listed in the Cell Theory are the basis for things such as:
  - Disease/Health/Medical Research and Cures(AIDS, Cancer, Vaccines, Cloning, Stem Cell Research, etc.)

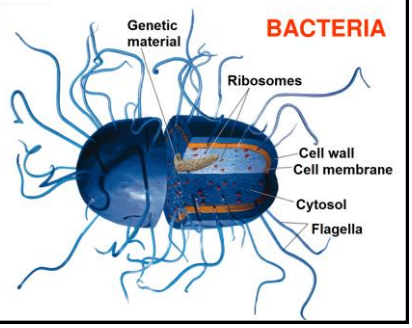
Characteristics of Cells

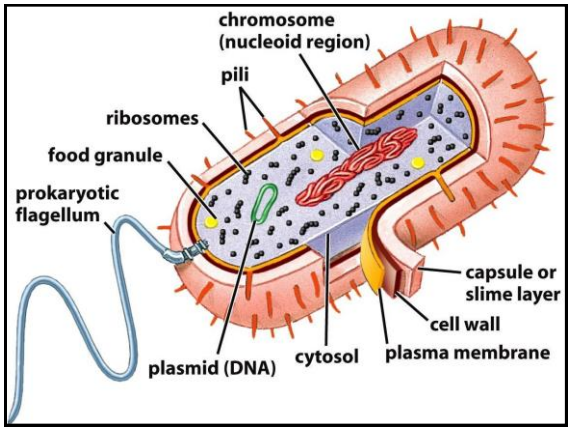


All Cells have common structures
- Cell Membrane
- Ribosomes
- Cytoplasm

- Cells contain DNA
  - Found in the nucleus
- Cells are independent units of life

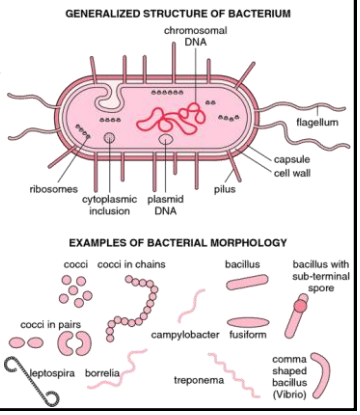
Prokaryotic cells

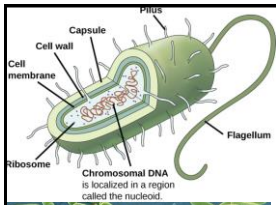




Components

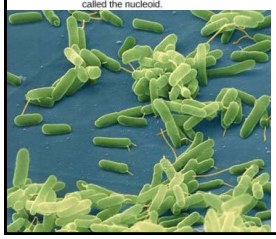
- Cytosol
- Ribosomes
- Nucleoid region
- Circular DNA
- Plasmid
- Cell Membrane
- Cell Wall
- Capsule (or slime layer)
- Pili
- Flagellum





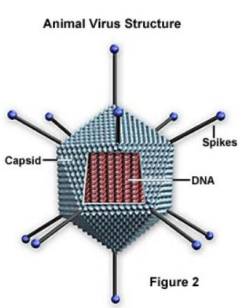
Characteristics of Prokaryotes

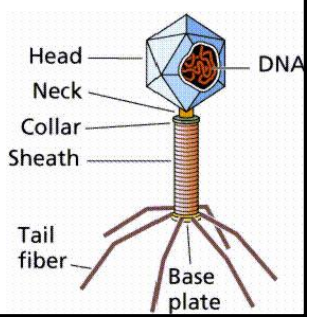
- does not have a nucleus
- single celled organisms
- have few organelles
- perform few functions
  - Eat
  - Respire
  - Reproduce
- smaller than other cells
- Bacteria are the only known prokaryotes



Virus

Bacteriophage
"bacteria eater"

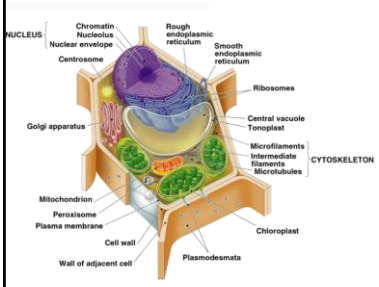




Characteristics of Viruses

- Viruses are not living because they:
  - are not made of cells
  - need a host cell to reproduce
- A virus is very small compared to a cell
- Like cells, viruses contain nucleic acids

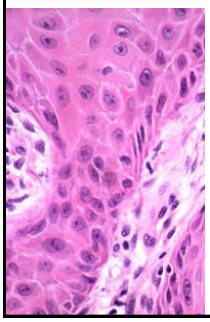
Eukaryotic cells



Components

- Cytosol
- Nucleus
- Mitochondria
- Chloroplast
- Ribosomes
- Rough ER
- Smooth ER
- Golgi body
- Vacuoles
- Lysosomes
- Cytoskeleton
- Centriole
- Cilium and Flagellum
- Cell membrane
- Cell Wall

Characteristics of Eukaryotes



- has a nucleus
- can be single or multicellular
- have many organelles, performing complex functions
- specialized to perform specific functions
- larger than prokaryotic cells
- Animals, plants, fungi and protists are made of eukaryotic cells

Summary of Differences

Prokaryotic Cells	Eukaryotic cells
small cells (< 5 mm)	larger cells (> 10 mm)
always unicellular	often multicellular
no nucleus or any membrane-bound organelles	always have nucleus and other membrane-bound organelles
DNA is circular, without proteins	DNA is linear and associated with proteins to form chromatin
ribosomes are small (70S)	ribosomes are large (80S)
no cytoskeleton	always has a cytoskeleton
cell division is by binary fission	cell division is by mitosis or meiosis
reproduction is always asexual	reproduction is asexual or sexual

Animal and Plant Cells Both Have:

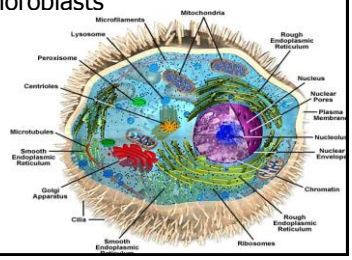
- A nucleus
- Ribosomes that make protein
- Rough and smooth endoplasmic reticulum
- Golgi bodies
- Mitochondria
- Cytoplasm
- Vacuoles that store food, water and waste products.

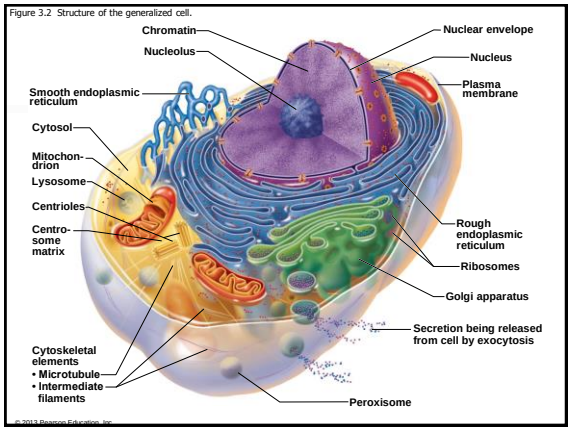
Animal Cells

- Can not make their own food
- Have many lysosomes
- Are more round shaped
- Have centrioles
- Use mitochondria to release energy
- Have many Golgi bodies
- Have more extensive cytoskeleton than plant cells

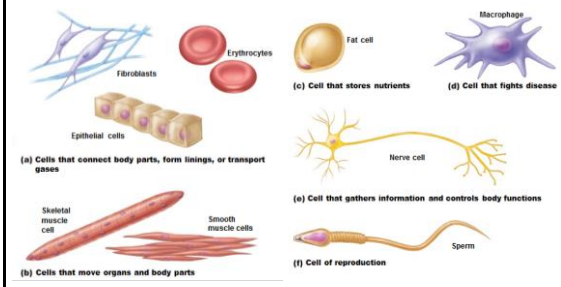
Animal cells cont.

- Do not have a cell wall
- Do not have a large vacuole
- Do not have chloroplasts

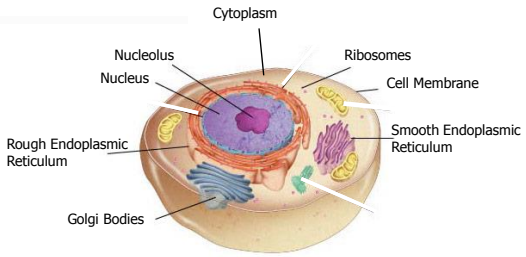




Animal Cell Diversity



Animal Cell



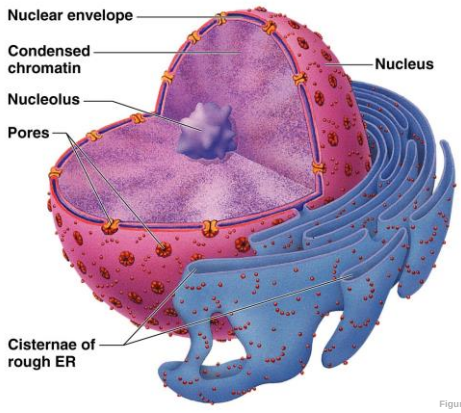
Eukaryotic Cell Organelles and Function

1. **Nucleus**
   - Nickname: "The Control Center"
   - Function: holds the DNA
   - Parts:
     1. Nucleolus: dark spot in the middle of the nucleus that helps make ribosomes

Nucleus – largest organelle; control center of the cell; consists of:

- ***Nuclear envelope*** – double membrane structure containing pores
- ***Nucleoli*** – synthesize ribosomes
- ***Chromatin*** – threadlike material composed of DNA (genes) & proteins

  Note: during cell division, chromatin condenses to form chromosomes



Cytoplasm

Consists of:

- Cytosol – liquid portion
- Organelles – specialized cellular compartments
- Inclusions – chemical substances
  - Glycogen (muscle & liver cells)
  - Lipid droplets (fat cells)
  - Melanin granules (skin & hair cells)

Mitochondria

- Nickname: "The Powerhouse"
- Function: Energy formation
  - Breaks down food to make ATP
    - ATP: is the major fuel for all cell activities that require energy

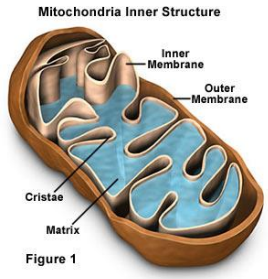
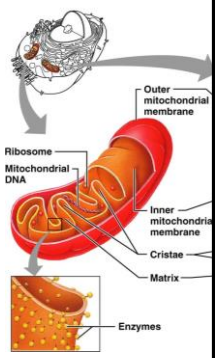


Figure 1

- ***Mitochondria*** – double membrane structures; site of cellular respiration (ATP synthesis)
  - Contain their own DNA & RNA
  - Able to replicate themselves



Ribosomes

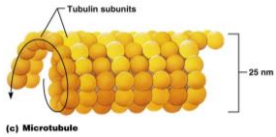
- Function: makes proteins
- Found in all cells, prokaryotic and eukaryotic

Ribosomes – dense particles of rRNA and protein

- Free ribosomes – synthesize proteins that function within the cell
- Attached ribosomes – synthesize proteins incorporated into cell membranes or exported outside the cell

Cytoskeleton – network of rods that support the cell

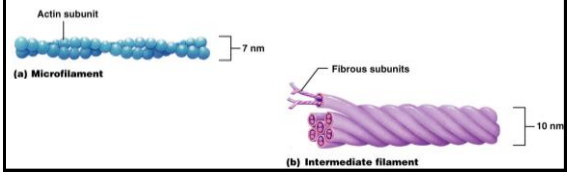
- *Microtubules* – thick rods composed of *tubulin*
  - form cilia, flagella & centrioles



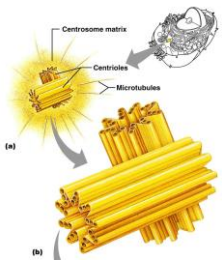
Microfilaments – thin filaments composed of *actin*

- involved in muscle contraction
- form *cleavage furrow* during cell division

Intermediate filaments – tough protein fibers attached to desmosomes

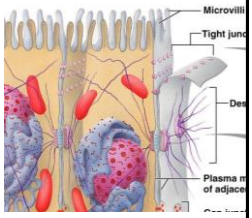


- ***Centrioles*** – paired cylindrical bodies composed of microtubules
  - Organize spindle apparatus (cell division)



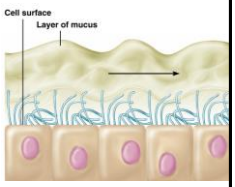
Cellular extensions

Microvilli: fingerlike projections of the plasma membrane; increase surface area for absorption



Cilia: short hair-like projections; propel substances over surface of cell

Flagella: long hair-like projections; propel the cell



Endoplasmic Reticulum (ER)

- Nickname: "Roads"
- Function: The internal delivery system of the cell

Endoplasmic Reticulum

- 2 Types:
  1. Rough ER:
     - Rough appearance because it has ribosomes
     - Function: helps make proteins, that's why it has ribosomes
  2. Smooth ER:
     - NO ribosomes
     - Function: makes fats or lipids

- **Endoplasmic reticulum (ER)** – extensive membrane system

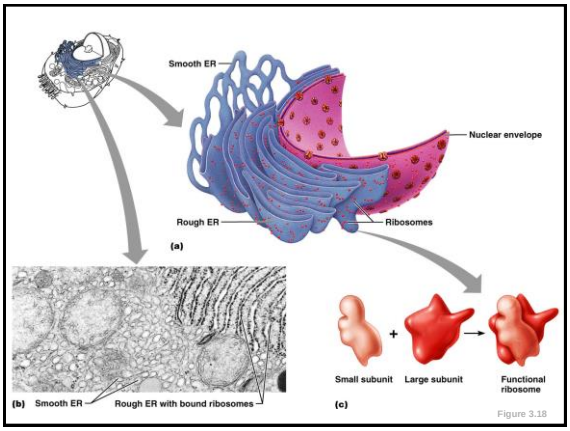
Functions

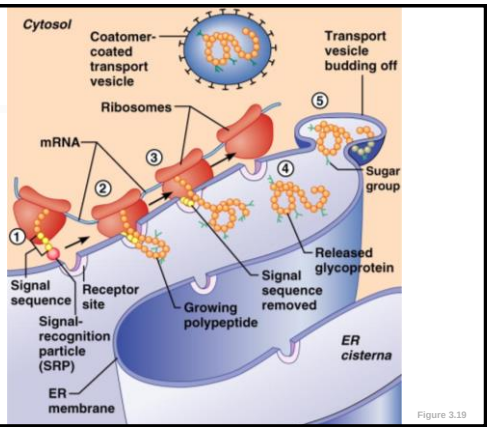
1. *Synthesis* of proteins, carbohydrates, and lipids
2. *Storage* of synthesized molecules and materials
3. *Transport* of materials within the ER
4. *Detoxification* of drugs or toxins

Rough ER – studded with ribosomes; abundant in secretory cells

Smooth ER – free of ribosomes

- Synthesizes lipids and steroids
- Detoxifies drugs/poisons (liver cells)
- Stores calcium ions (muscle cells)

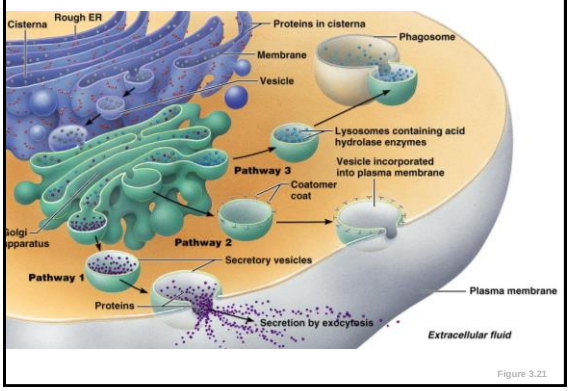




Golgi Apparutus

- AKA Golgi Body or Golgi complex
- Nickname: The shippers
- Function: packages, modifies, and transports materials to different location inside/outside of the cell
- Appearance: stack of pancakes

- ***Golgi apparatus*** – stack of flattened membranous sacs
  - Packages proteins for secretion from the cell (exocytosis)
  - Packages proteins for incorporation into plasma membrane
  - Forms lysosomes



Lysosomes: circular (but bigger than ribosomes)

- Nickname: "Clean-up Crews"
- Function: to break down food into particles the rest of the cell can use and to destroy old cells

Lysosomes – membranous sacs of hydrolytic enzymes; sites of intracellular digestion

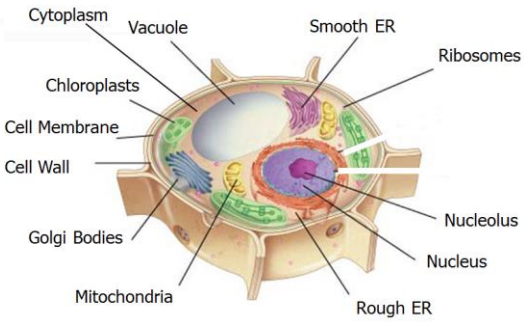
- *Primary lysosome*
  - Formed by Golgi apparatus and inactive enzymes
- *Secondary lysosome*
  - Lysosome fused with damaged organelle
  - Digestive enzymes activated
  - Toxic chemicals isolated

Peroxisomes – membranous sacs of oxidase & catalase enzymes; detoxify alcohol & neutralize dangerous free radicals

Plant Cells

- Have a cell wall and cell membranes
- Have a large vacuole unlike the animal cell which only has small vacuoles
- Have mitochondria to convert sugar to usable energy for the cell
- Have a few lysosomes
- Are more rectangular in shape
- Have chloroplasts to carry out photosynthesis
  - Make sugar to store solar energy

Plant Cell



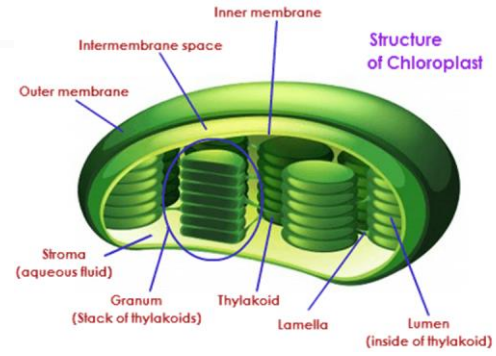
Vacuoles

- Function: stores water
  - This is what makes lettuce crisp
    - When there is no water, the plant wilts

Chloroplasts

- Function: traps energy from the sun to produce food for the plant cell
- Green in color because of chlorophyll, which is a green pigment

Chloroplasts



Cell Wall

- Function: provides support and protection to the cell membrane
- Found outside the cell membrane in plant cells