Unit 3, Chapter 4: Structure and Function of the Cell

(Link in Purple Packet – Cell Word Map – back of page 1; Magic of Cells video)

What is it?
The basic unit of life that can function and carry out the characteristics of life

Feature 1
Small, tiny

Feature 2
Have structure, are organized

Feature 3
found in all living organisms

Feature 4
Use energy, reproduce, grow, respond

Cells

Type 1: **Prokaryotes** Single celled organisms like bacteria	**Type 2:** **Eukaryotes** Multi-cellular organisms like plants and animals	**Leave Blank**	**Leave Blank**

Cells:

Definition: The smallest unit of structure and function in all living organisms which can carry on all of life's processes or displays all of the characteristics of life.

- ✓ Humans are made up over 50 trillion cells

Discovery of the cell (Scientists involved in the discovery of the cell)

1. **Robert Hooke**

- ✓ English scientist
- ✓ In 1665, he viewed cork and coined the term "cells"

2. **Anton Van Leeuwenhoek**

- ✓ Dutch microscope maker
- ✓ In 1673, viewed the first living cells

Hooke and Leeuwenhoek laid the foundation for the modern day Cell Theory

3. **Matthias Schleidan**

- ✓ German Botanist
- ✓ 1n 1838, observed that all plants are made of cells

4. **Theodor Schwann**

- ✓ German Zoologist
- ✓ In 1839, observed that all animals are made of cells

5. **Rudolph Virchow**

- ✓ German Physician
- ✓ In 1855, observed that all cells come from pre-existing cells

The fathers of Modern Biology.

Discovered the tenets of The Cell Theory.

(Link in Purple Packet – Anticipation Guide – page 2)

Cell Theory

1. All living things are made of cells
2. Cells are the basic unit of structure and function in all living things
3. Cells come from other or pre-existing cells

(Link in Purple Packet – Cell Theory Arguments – page 2)

Dispute 1: scientists are arguing that viruses are in fact living and if they are, they do not have cells

Dispute 2: If viruses are living, then DNA may be the basic structure of all living things b/c viruses contain DNA

Dispute 3: Where did the first cell come from?

How was the cell theory developed and how does it explain life?

*In biology, **cell theory** is the historic scientific theory, now universally accepted, that living organisms are made up of cells, that they are the basic structural/organizational unit of all organisms, and that all cells come from pre-existing cells. Cells are the basic unit of structure in all organisms and also the basic unit of reproduction. With continual improvements made to microscopes over time, magnification technology advanced enough to discover cells in the 17th century. This discovery is largely attributed to Robert Hooke, and began the scientific study of cells, also known as cell biology. Over a century later, many debates about cells began amongst scientists. Most of these debates involved the nature of cellular regeneration, and the idea of cells as a fundamental unit of life. Cell theory was eventually formulated in 1839. This is usually credited to Matthias Schleiden and Theodor Schwann. However, many other scientists like Rudolf Virchow contributed to the theory. It was an important step in the movement away from spontaneous generation.*

The three tenets to the cell theory are as described below:

1. *All living organisms are composed of one or more cells.*
2. *The cell is the basic unit of structure and organization in organisms.*
3. *Cells arise from pre-existing cells.*

The first of these tenets is disputed, as non-cellular entities such as viruses are sometimes considered life-forms.[1] *(Wikipedia)*

(Link in Purple Packet – Prokaryote vs. Eukaryote word map – page 3)

Cells

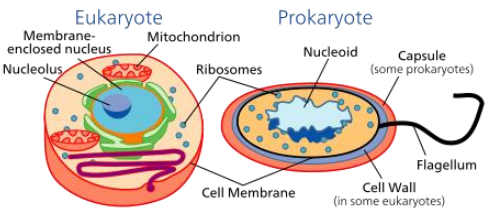
Prokaryote	Eukaryote
Definition: a microscopic single-celled organism that has neither a distinct nucleus with a membrane nor other specialized organelles.	**Definition:** an organism consisting of a cell or cells in which the genetic material is DNA in the form of chromosomes contained within a distinct nucleus.
Characteristics: Smaller, primitive No membrane bound organelles, No nucleus Have a membrane and a cell wall Have hair-like structures and may have tails	**Characteristics:** Bigger, more organized and complex Membrane bound organelles Have a nucleus
Examples: Bacteria: blue-green algae, E.coli, staphylococcus , salmonella, streptococcus	**Examples:** Animals Plants Fungus Protista

(Link in Purple Packet – Prokaryote vs. Eukaryote Cell Structure chart – back page 2)

Notes on the chart:

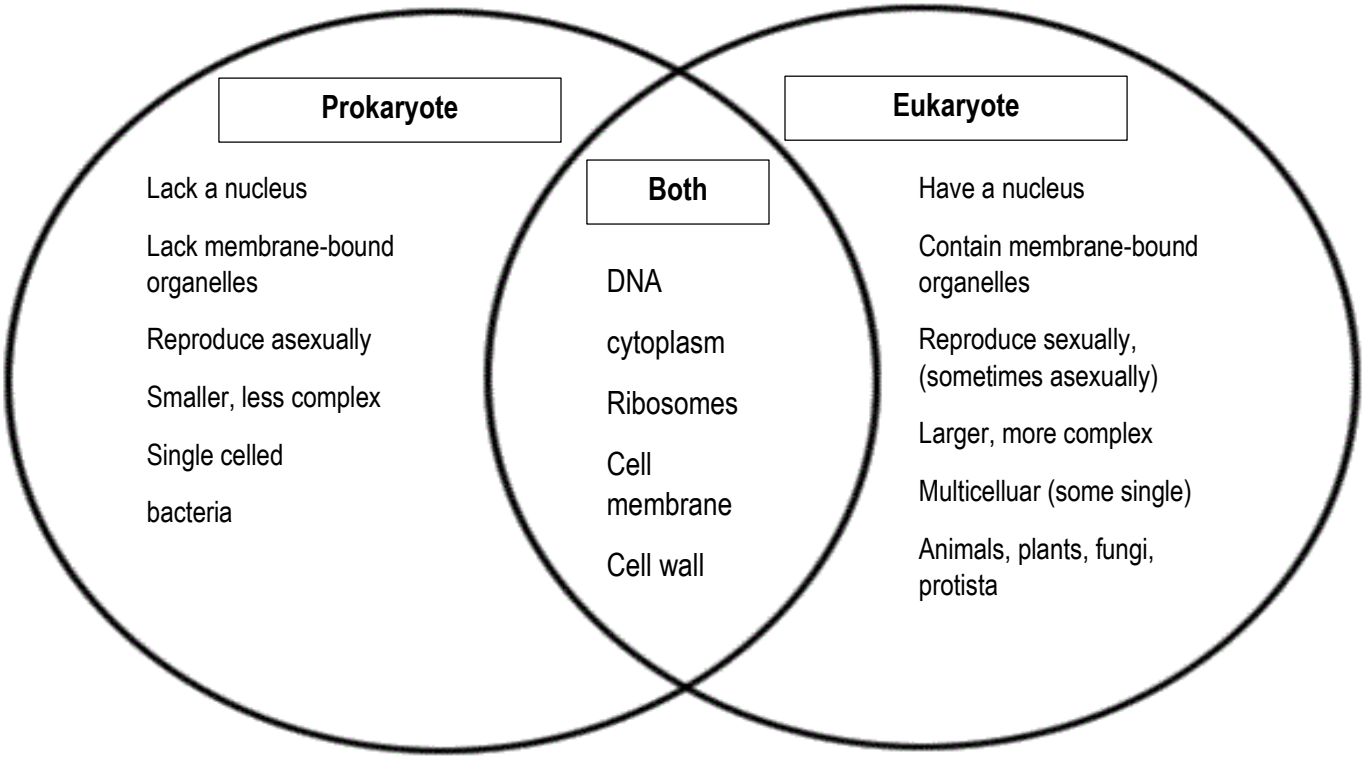
- **All cells contain:** plasma membrane, ribosome, DNA, cytoplasm (draw a dark line under cytoplasm)
- **Cell Wall** is **not** an organelle; found only in plants (draw a dark line under cell wall)
- **Chloroplast to cytoskeleton** are organelles are only found in eukaryotes

Prokaryotes vs. Eukaryotes



1. **Prokaryotes**
   a. **Definition**
      i. Lack a nucleus and membrane bound organelles
   b. **Characteristics**
      i. smaller, less complex
      ii. reproduce asexually (no genetic material combines, they simply split)
      iii. single celled
      iv. less complex chromosomes
   c. Features
      i. Have DNA, ribosomes, cell membranes, and cell walls
   d. **Examples**
      i. Bacteria

2. **Eukaryotes**
    a. **Definition**
        i. Have a "true nucleus" and membrane bound organelles
    b. **Characteristics**
        i. Larger, more complex and organized
        ii. Reproduce sexually (genetic material must combine), but may also reproduce asexually
        iii. Single or multicellular
        iv. More complex chromosomes
    c. **Features**
        i. Have DNA, ribosomes, cell membranes, cell walls, and membrane-bound organelles
    d. **Examples**
        i. Animals
        ii. Plants
        iii. Fungus
        iv. Protista



How are prokaryotic and eukaryotic cells alike and different?

See Venn Diagram Above

(Link activity – Surface area to volume ratio lab)

Surface area: Volume

Surface area – decreasing 2 fold

Cell Size

Volume decreases 3 fold

Objective: To determine the effect of cell size on the surface area to volume ratio.

Part A:

Procedures:

1. Cut out the shapes on the attached sheet of graph paper.
2. Fold them so that they make a cube and tape them together.
3. Determine the surface area of the cube by taking the length times the width. (L x W) x 6
   **Each block on the graph paper represents one unit in size
4. Now determine the volume of the cube by taking the length times the width times the height (L x W x H)
5. Determine the surface area to volume ratio: SA : V
6. In the space provided, describe any relationships between the surface area to volume ratio as the cell size changes.

Divide both sides by volume

	SA (L x W x 6)	V (L x W x H)	SA:V Ratio	SA:V Ratio Reduced (SA:V ratio divided by the V)
2 x 2	24	8	$\frac{24}{8}$ = 3 : 1	3 : 1
4 x 4	96	64	$\frac{96}{64}$ = 1.5 : 1	1.5 : 1
6 x 6	216	216	1 : 1	1 : 1
8 x 8	384	512	0.75 : 1	0.75 : 1
10 x 10	600	1000	0.6 : 1	0.6 : 1

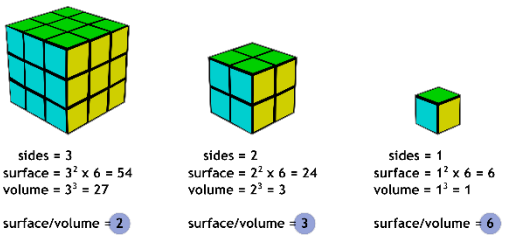
Important Note:

Cells: more surface area per unit of volume allows more exposures for substrates to come into the membrane with allows for more binding to enzymes; We can be more complex!

Remember: increased enzyme concentration can speed up reactions

Cell Size:

1. Surface area to volume ratio
   - ✓ **Increases Efficiency**
     - Allows the cell to deliver more substrate to the enzyme
       - ***Remember:*** Every time you cut something in half, it gets smaller, but it also exposes more surfaces
       - ***Example:***
         - Big Log – doesn't burn fast
         - Chop the log in half or in quarters – will burn faster but will last overnight
         - Add twigs, smaller – start the fire because they burn fast and efficiently
   - ✓ **Allows for Cell differentiation / tissue specialization**



(Link activity – Dust Explosion) – demonstration in class

How does a cell's size affect its function?

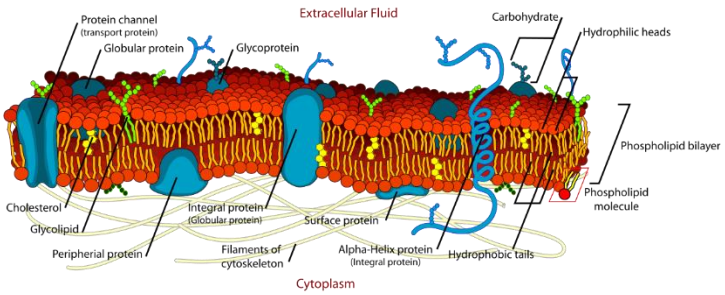
If the cell gets bigger, there will be less surface area compared to the area within the cell. ... If less of it comes in contact, less of it can cross the cell membrane. So -- the greater the size of the cell, the lower the surface to area ratio and the harder it is for anything to diffuse out of the cell.

Cellular Structures: Organelle Frayer

(Link activity – Necessary for Survival)

- ✓ Think of three (3) things that all cells would need for survival. As we go through this section, think of the organelle that helps the cell attain those 3 needs.

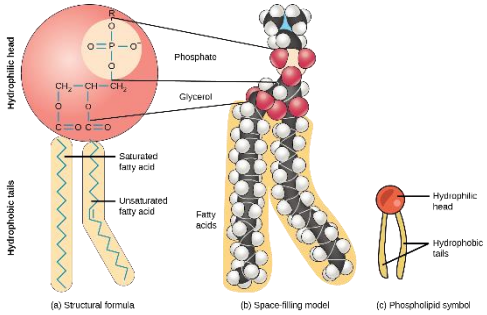
Plasma or Cell Membrane



- ✓ Found in plants, animals, bacteria
- ✓ Made of **phospholipids and proteins**
- ✓ **Controls/Regulates** what is going into and what comes out of the cell
- ✓ Selectively or **Semi-Permeable**
  - Allows only certain materials to enter while keeping other things out

(Link activity – Plastic bag cell Lab)

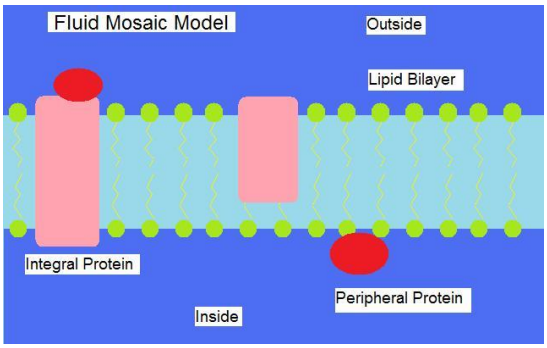
Phospholipids



- ✓ Glycerol, 2 Fatty Acids, and a Phosphate Group
- ✓ Polar (Hydrophilic) Heads and Non-Polar (Hydrophobic)Tails

Structure

- ✓ **Fluid Mosaic Model**
  - Phospholipid bilayer with proteins spread throughout – very dynamic
    - ***Fluid*** – means liquid flowing; the membrane is constantly flowing and moving
    - ***Mosaic*** – made up of many pieces to create a full picture; the cell membrane is made up of many molecules



- ✓ **Membrane Proteins**
  - i. Integral
  - ii. peripheral

Will not be tested on the 2 types, only responsible for knowing the cell membrane contains proteins

Cellular Organelles → See Organelle Chart

Multiple Links / Activities

1. Group pair share the cellular organelles. Write each of the above organelle functions on the "Cell Organizer".
    a. **Organelle Info Sheet Needs to contain the following**
        i. Organelle name
        ii. Function (from the note sheet)
        iii. Plant or animal or both
        iv. Picture of the organelle
        v. Analogy (what part of a town it is like)
        vi. Rationale for the analogy (explain the analogy)
        vii. Picture of the town part

2. Color your cell diagrams and note diagram activity
3. Cell Survivor Extended Thinking Activity
4. Cellville Activity
5. Things Necessary for Survival Activity

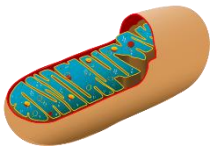
Organelles and Cell Parts

1. **Organelle**
    - ✓ Membrane bound cell structures with a distinct function
    - ✓ Allow for cell specialization
    - ✓ Only found in eukaryotes

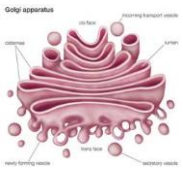
2. **Cytoplasm**
    - ✓ Jelly-like, nutrient rich substance which surrounds all of the cellular organelles.
    - ✓ Site of metabolic

Other Organelles / Cell Parts (red = NON-organelle)

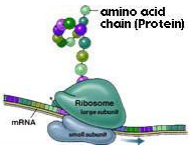
1. **Mitochondrion (Mitochondria)**
    a. "Powerhouse"
    b. Energy producing organelle of the cells
    c. Makes ATP from glucose
    d. Has folds to increase the surface area
    e. Found in muscles and the brain
    f. Has its own DNA that can be extracted
    g. Very similar to a bacteria in shape, size, look
    h. The mother donates the mitochondria to their offspring's' cells



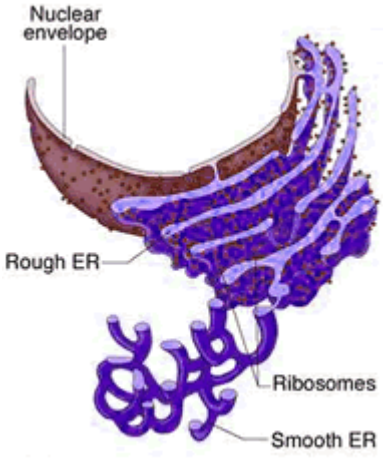
2. **Golgi Apparatus**
    a. Responsible for packaging, sorting, and secreting of materials made in other parts of the cell
    b. Free standing…not attached to anything
    c. Has **vesicles** coming off of it (look like little pods)



3. **Ribosome**
    a. Make proteins
    b. May attach to the ER, may be floating

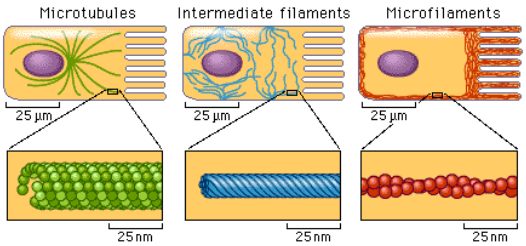


4. **Endoplasmic Reticulum**
    a. **Smooth**
        i. Manufactures lipids, hormones, carbs
        ii. Detoxification of drugs and poisons
        iii. Regulation of calcium
        iv. Found near the nucleus
        v. Liver, fat cells, glands, testes, ovaries
    b. **Rough**
        i. Have ribosomes on it that are making the proteins on the ER (little dots)
        ii. Manufactures and stores proteins
        iii. Rough ER is always around the nucleus because the nucleus has DNA…DNA codes for proteins
        iv. Muscles, Heart, Hair, Fingernails, glands that produce enzymes, blood → would all have Rough ERs



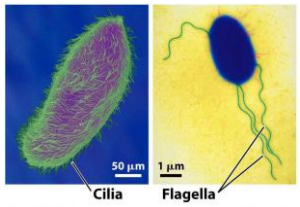
5. **Lysosome**
    a. Responsible for intracellular digestion
    b. Contains hydrolytic (water breaking – process of hydrolysis) enzymes

6. **Microfilaments and Microtubules**
    a. **Make up the Cytoskeleton**
        i. Provide cell shape and movement in the cell
        ii. Help arrange organelles
        iii. Move chromosomes in cell division
        iv. Cell shape and organelle position



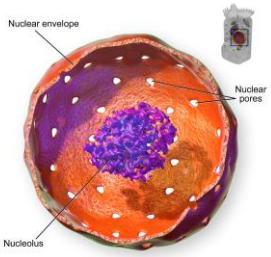
7. Cilia and Flagella

- **a. Clila**
  - **i.** Hair-like projections involved in movement
  - **ii.** Movement of certain microscopic organisms
  - **iii.** Help move debris in the respiratory system
  - **iv.** Move the eff along the fallopian tubes
- **b. Flagella**
  - i. Whip-like tail used for locomotion in certain organisms or cells
  - ii. Sperm have flagella for locomotion



8. Nucleus

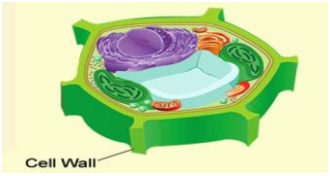
- **a. Chromosomes**
  - **i.** Made of DNA
  - **ii.** Controls heredity
  - **iii.** Contains genes which code for proteins
- **b. Nucleolus**
  - **i.** Makes and stores RNA
  - **ii.** Small sphere inside the nucleus
- **c. Nuclear Envelope and Pores**
  - **i.** Regulates what goes into and what comes out of the nucleus



Nucleus

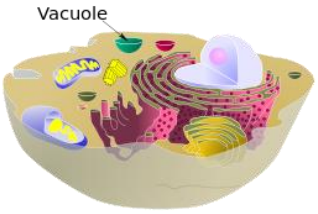
9. Cell Wall

a. Made of cellulose
b. Provides protection and support to plant cells



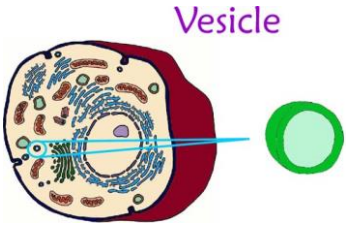
10. Vacuole

a. A membrane-bound sac
b. Stores food, water, enzymes, and waste
c. Turgor pressure

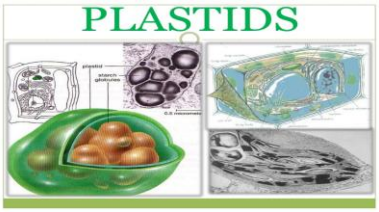


11. Vesicle

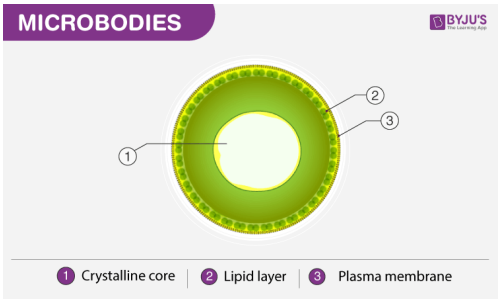
a. A small sac containing various materials
b. Often found near the golgi apparatus



12. **Plastid**
    a. **Leucoplasts (amyloplasts)**
        i. Storage of starch
    b. **Chromoplasts**
        i. Stores accessory pigments
    c. **Chloroplasts**
        i. Responsible for photosynthesis
        ii. Makes plants appear green



13. **Microbodies**
    a. **Peroxisomes**
        i. Break down purines, alcohols, fats, and other toxins by adding hydrogens (reduction)
        ii. Form hydrogen peroxide as a byproduct
        iii. Contain catalase to breakdown peroxide
    b. **Glyoxisomes**
        i. In plants they turn lipids into carbohydrates



14. **Centrioles**
    a. Found only in animals
    b. Organize the mitotic spindle for cell division