

Chapter 5:

Cell Structure and Function



The Cell is the Basic Unit of Life

Early History:

Robert Hooke (1660's): Made first observation of cells (cork)

- **Cell** = “Tiny rooms” occupied by monks

Anton van Leeuwenhoek (1670's): Early observations of protists

Theodor Schwann (1830's): Early observations of animal cells

- Lack of cell wall delayed discovery (made observation difficult)

Rudolf Virchow (1850's): **Principles of Modern Cell Theory**

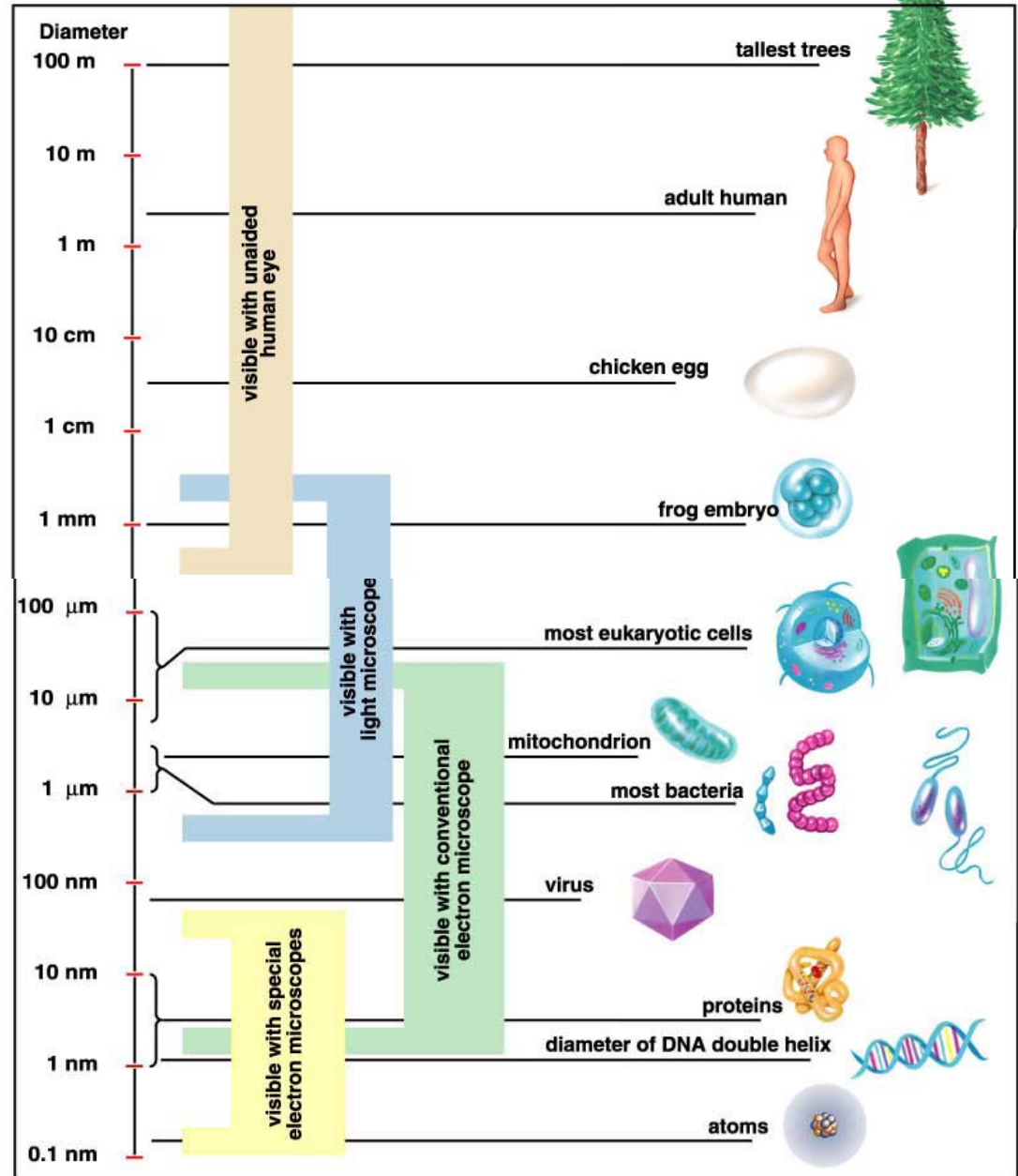
1) Every living organism is made up of 1 or more cells

- Smallest organisms = Single cells
- Cells are functional units of multi-cellular organisms

2) All cells arise from pre-existing cells

Past / present discoveries of cell nature enabled via microscopy:

- 1) Light Microscopes
- 2) Electron Microscopes



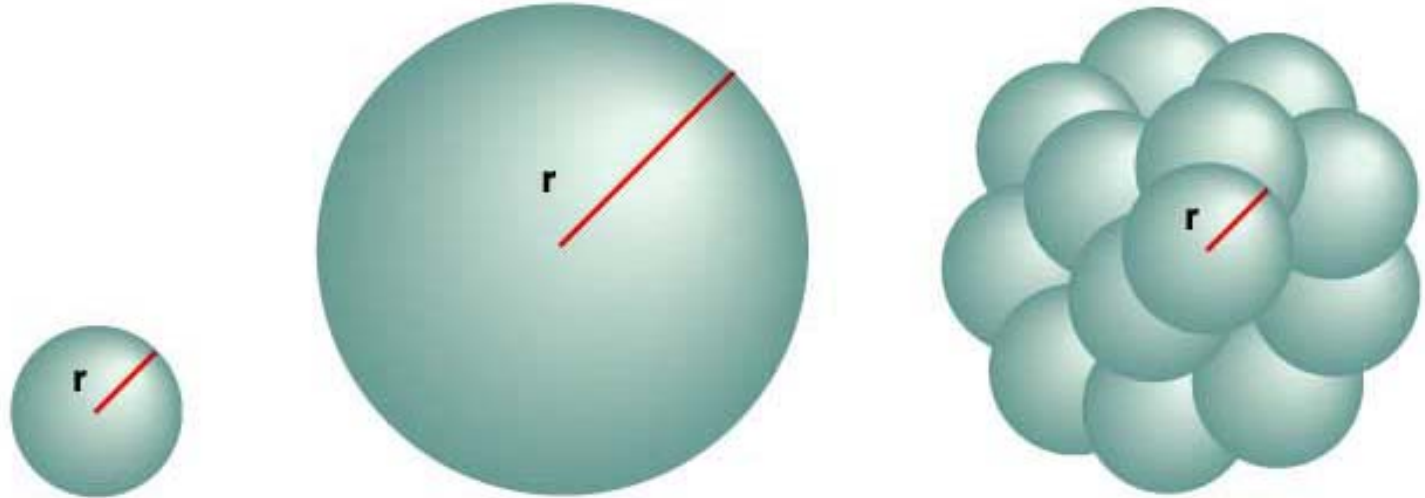
Basic Features of All Cells:

- 1) **Plasma membranes** enclose cells and regulate cell / cell and cell / environment interactions
- 2) **Genetic Information = DNA**
 - **Eukaryotic cells** (plants/animals): DNA contained in membrane-bound nucleus
("True Nucleus")
 - **Prokaryotic cells** (bacteria): DNA located to nucleoid region (not membrane-bound)
("Before Nucleus")
- 3) **Cytoplasm present**
 - Aqueous environment inside plasma membrane
 - Location of cell metabolic activity (e.g. protein synthesis)
 - Contain ribosomes (protein factories)

What are the Basic Features of All Cells?

- 4) Energy / Nutrients Obtained from Environment
- 5) Cell Function Limits Cell Size
 - Diffusion too slow in large cells
 - Surface area to volume ratio too low to receive adequate nutrients

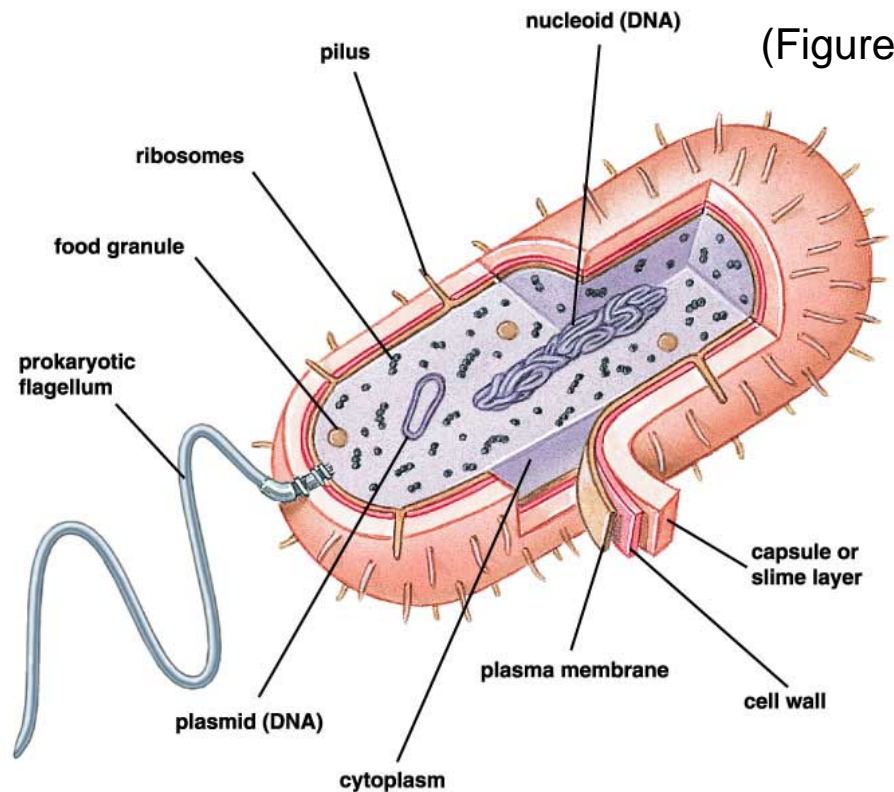
Surface Area to Volume Ratio:



distance to center (r)	1.0	3.0	1.0
surface area ($4 \pi r^2$)	12.6	113.1	339.4
volume ($\frac{4}{3} \pi r^3$)	4.2	113.1	113.1
area/volume	3.0	1.0	3.0

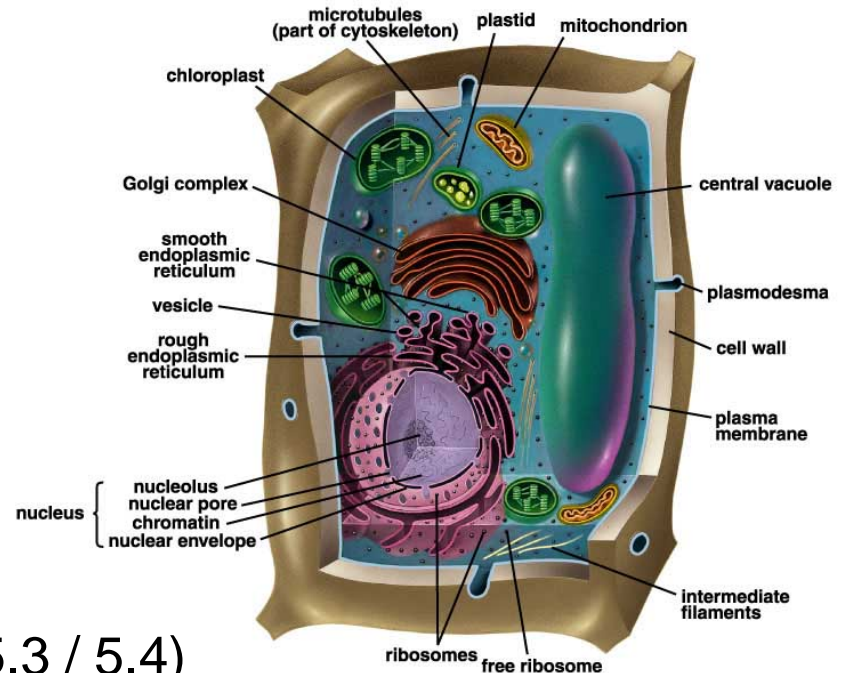
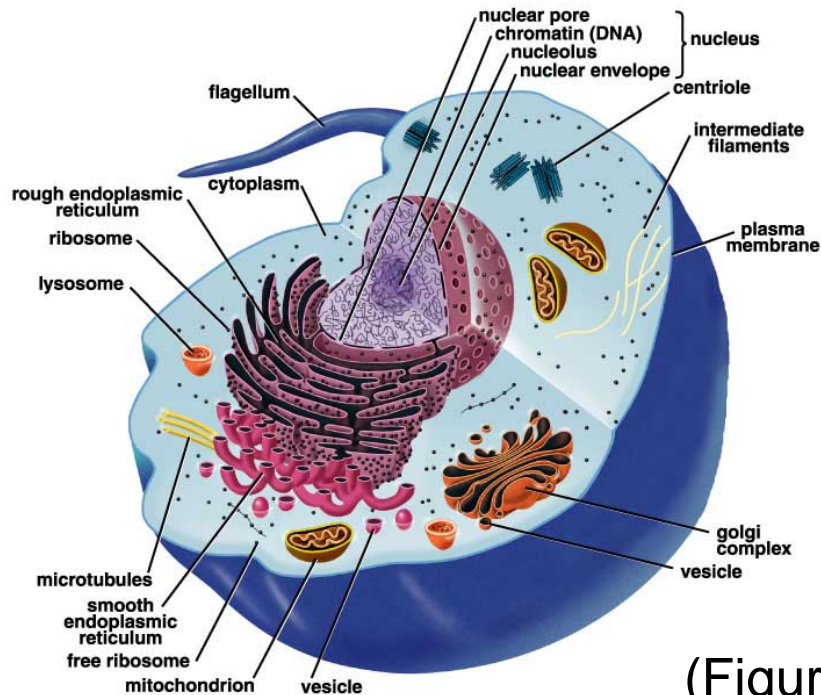
Features of Prokaryotic Cells:

- Small (e.g. bacteria)
- Simple in structure
- **External features:**
 - Cell walls
 - Flagellum (movement)
 - **Pili** (attachment / genetic exchange)
 - Capsule / Slime Layer (host attachment)
- **Internal features:**
 - Plasma membrane
 - Cytoplasm (w/ ribosomes); Food granules
 - **Nucleoid:** Central region of coiled DNA



Features of Eukaryotic Cells:

- Large and complex in structure (e.g. our cells)
- Internal Features:
 - Plasma membrane
 - Cytoplasm (w/ ribosomes)
 - Membrane-bound **organelles** / **cytoskeleton** (Table 5.2)



(Figure 5.3 / 5.4)

The Cell as A City:

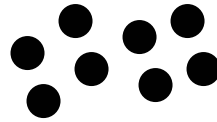
City Wall

Plasma Membrane



City
Hall

(Nucleus)



City Workers
(Ribosomes)



Road
System
(Endoplasmic
reticulum)



Post
Office

(Golgi Complex)



Recycling
Service
(Lysosomes)



Storage
Units

(Vacuoles)



Power
Plants

(Mitochondria)



Food
Production

(Chloroplasts)



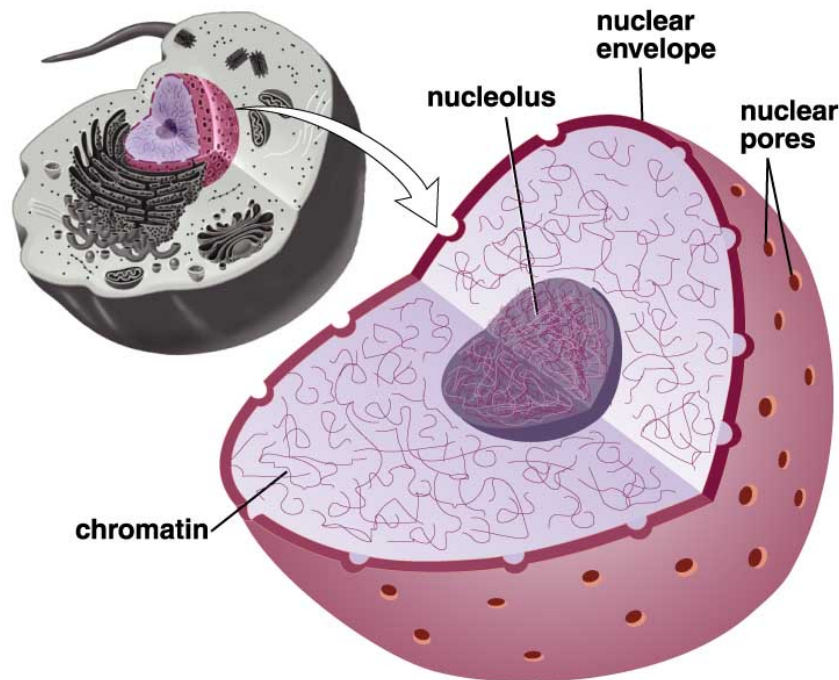
City
Infrastructure

(Cytoskeleton)

Nucleus: Large organelle housing genetic information

Parts:

- 1) **Nuclear Envelope:** Double membrane containing pores
- 2) **Chromatin** (“colored substance”):
 - DNA and associated proteins (chromosomes)
- 3) **Nucleolus:** Site of ribosome synthesis



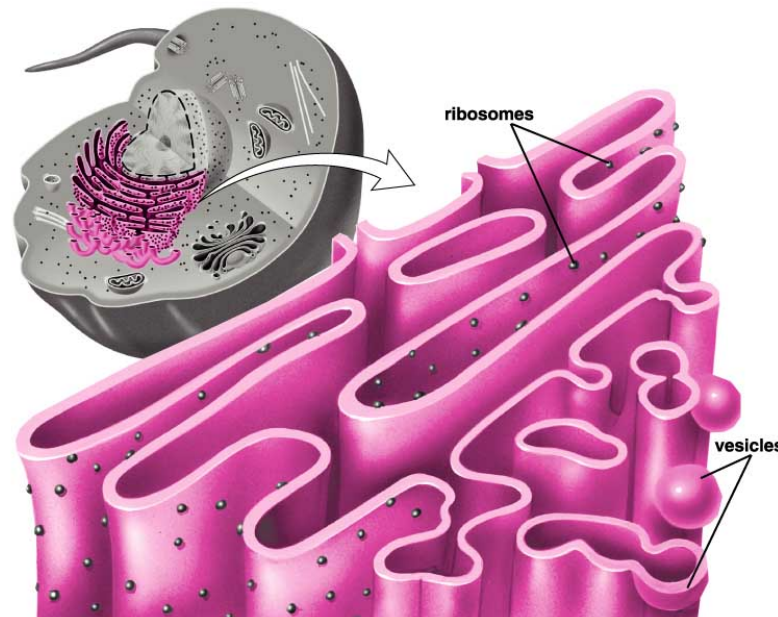
(Figure 5.5)

Membrane System of Eukaryotic Cells:

1) Plasma Membrane

2) Endoplasmic Reticulum (ER)

- Interconnected tubes and channels
 - Continuous with nuclear membrane
- A) **Rough ER:** Major site of protein synthesis (contain ribosomes)
- B) **Smooth ER:** Major site of lipid synthesis (e.g. cholesterol)



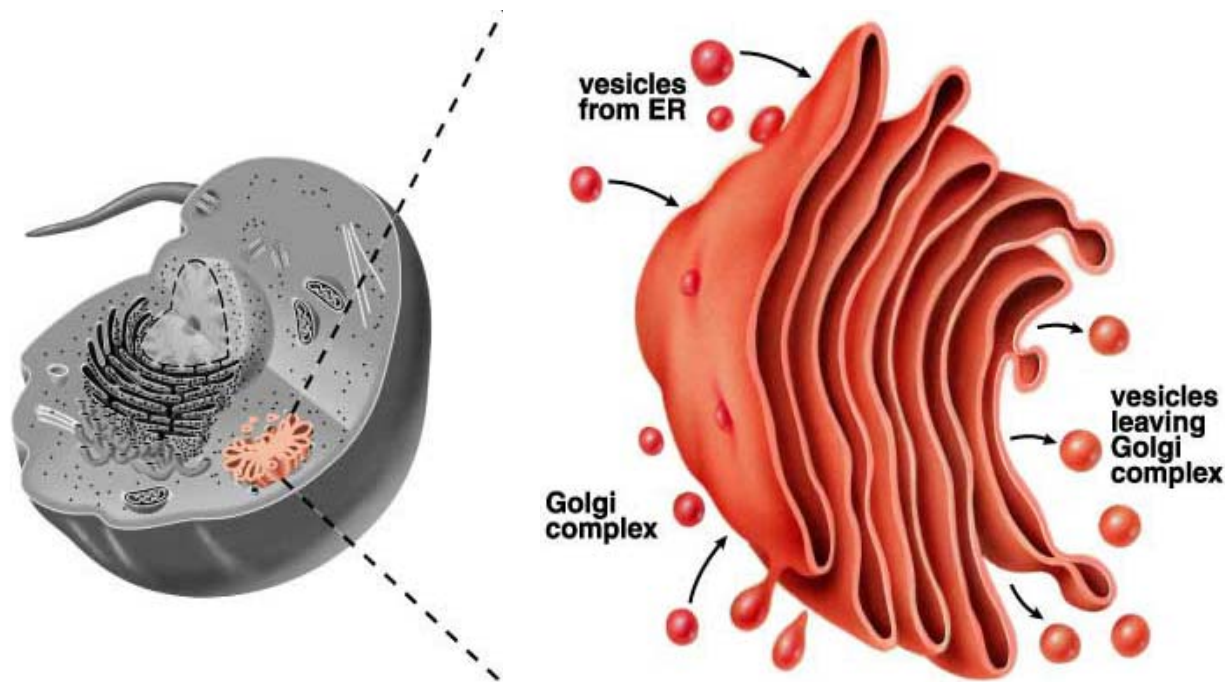
(Figure 5.8)

Membrane System of Eukaryotic Cells:

3) **Golgi Complex:** Series of flattened, stacked membranes

- **Functions:**

- a) Sorts proteins & lipids received from ER
- b) Modifies proteins (e.g. adds sugar units)
- c) Packages material into vesicles for transport

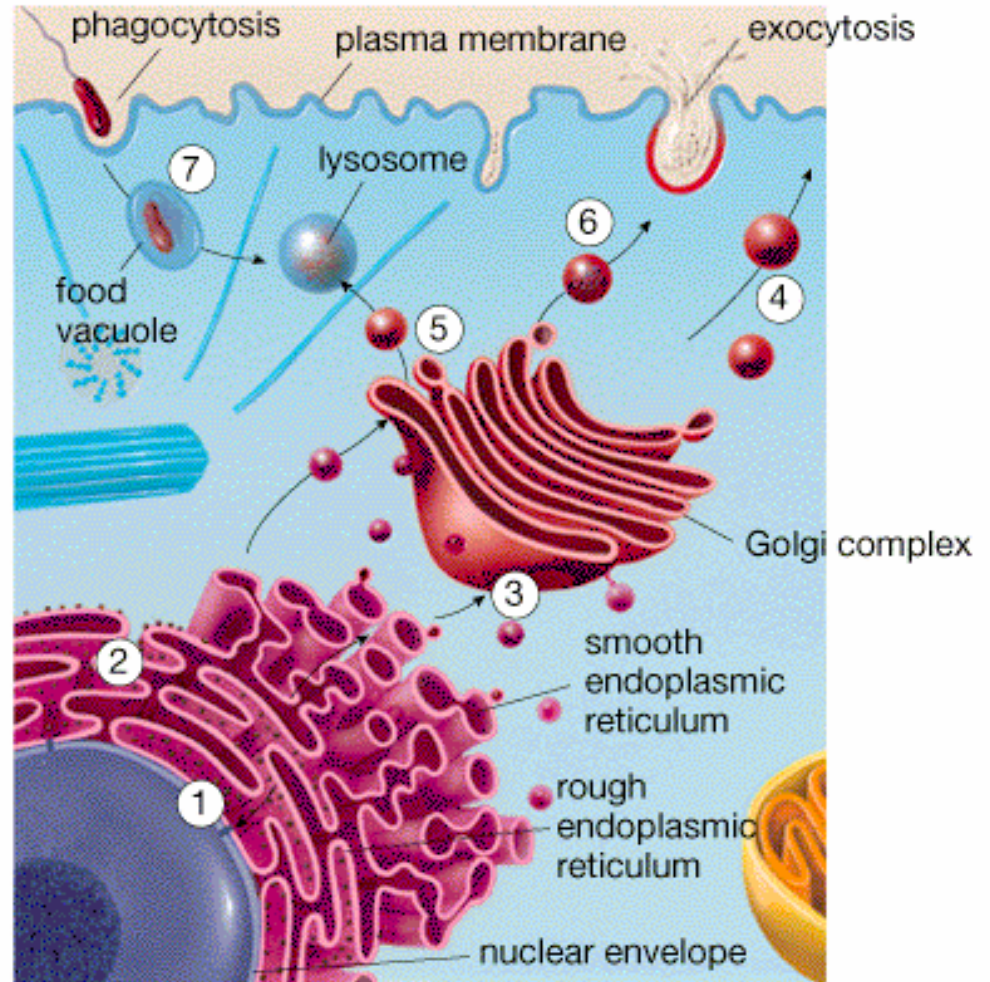


(Figure 5.9)

Membrane System of Eukaryotic Cells:

- 4) **Lysosomes:** Vesicles filled with digestive enzymes that function to break down food / cellular debris

Membrane System in Action:



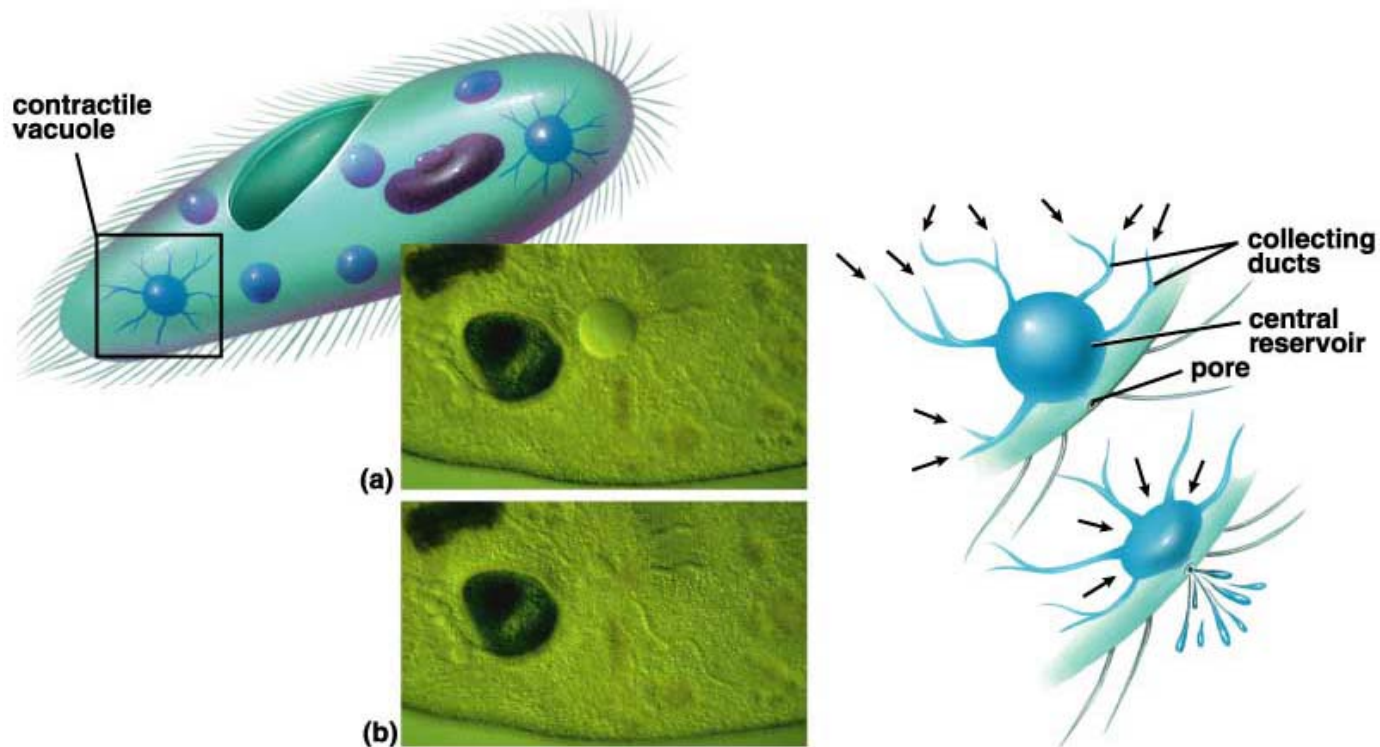
(Figure 5.10)

Vacuoles: Fluid-filled sacs surrounded by single membrane

Functions:

1) **Water Regulation (Contractile Vacuoles):**

- Store and excrete water
- Freshwater microorganisms (e.g. paramecium)



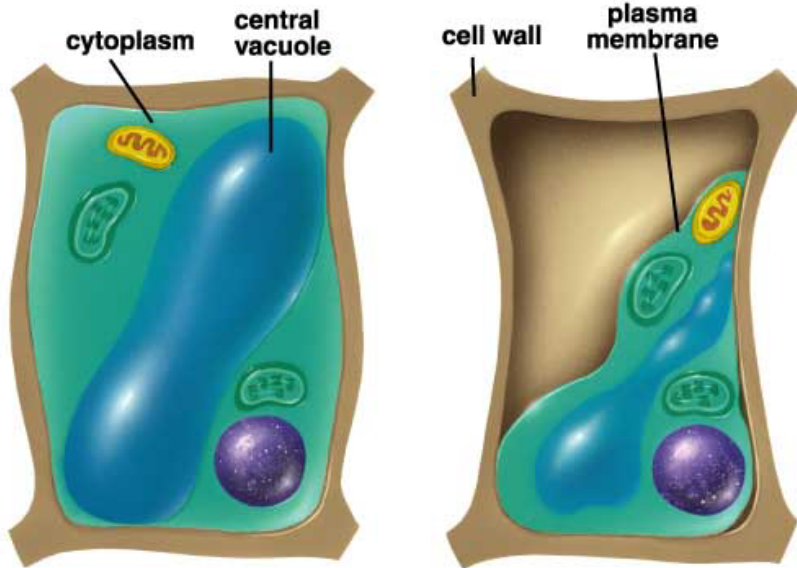
(Figure 5.11)

Vacuoles: Fluid-filled sacs surrounded by single membrane

Functions:

2) **Structural Support and Storage** (Central Vacuoles - Plants):

- Maintains water balance (turgor pressure)
- Dump site for waste
- Storage of sugars and amino acids

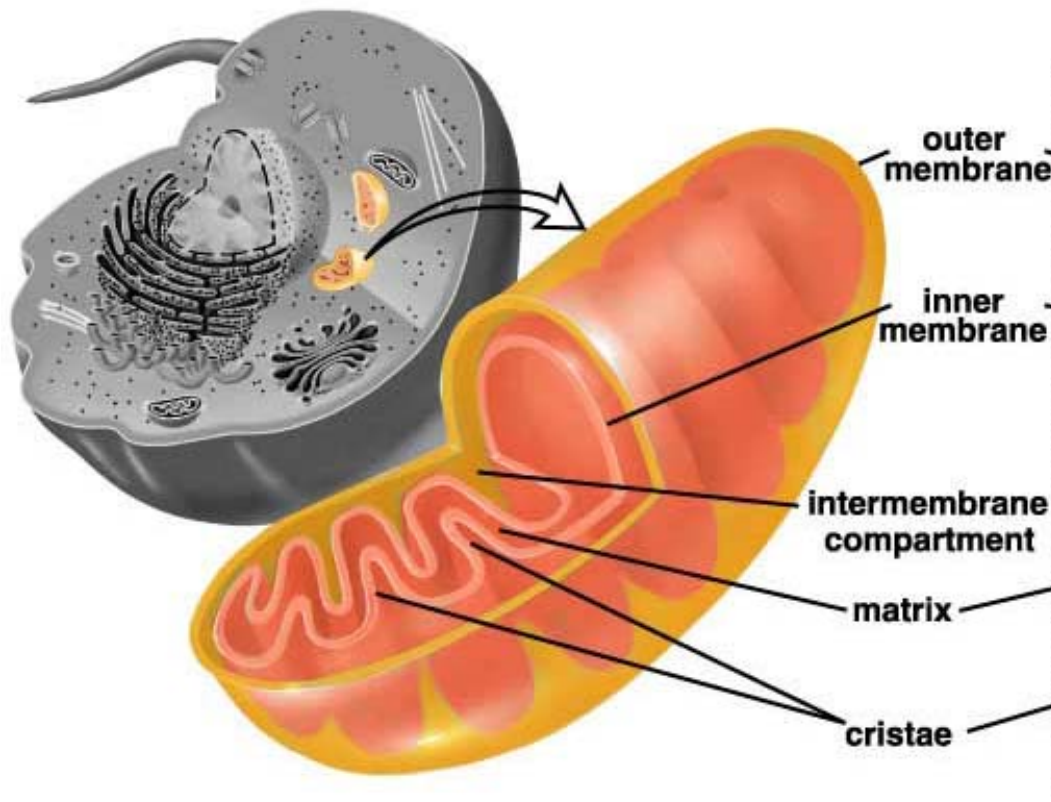


(Figure 5.12)

Mitochondria: Tubular sacs composed of a membrane pair

Function: Converts food products into energy (ATP)

- Rely on oxygen (aerobic respiration)
- Abundant in cells requiring high levels of energy (e.g. muscle)



Structure:

Cristae: Deep folds in the inner membrane

Matrix: Space within the inner membrane

Intermembrane Compartment: Space between membranes

Chloroplasts: Spherical sacs composed of a membrane pair

- Specialized plastids (**Plastid** = storage organelles)

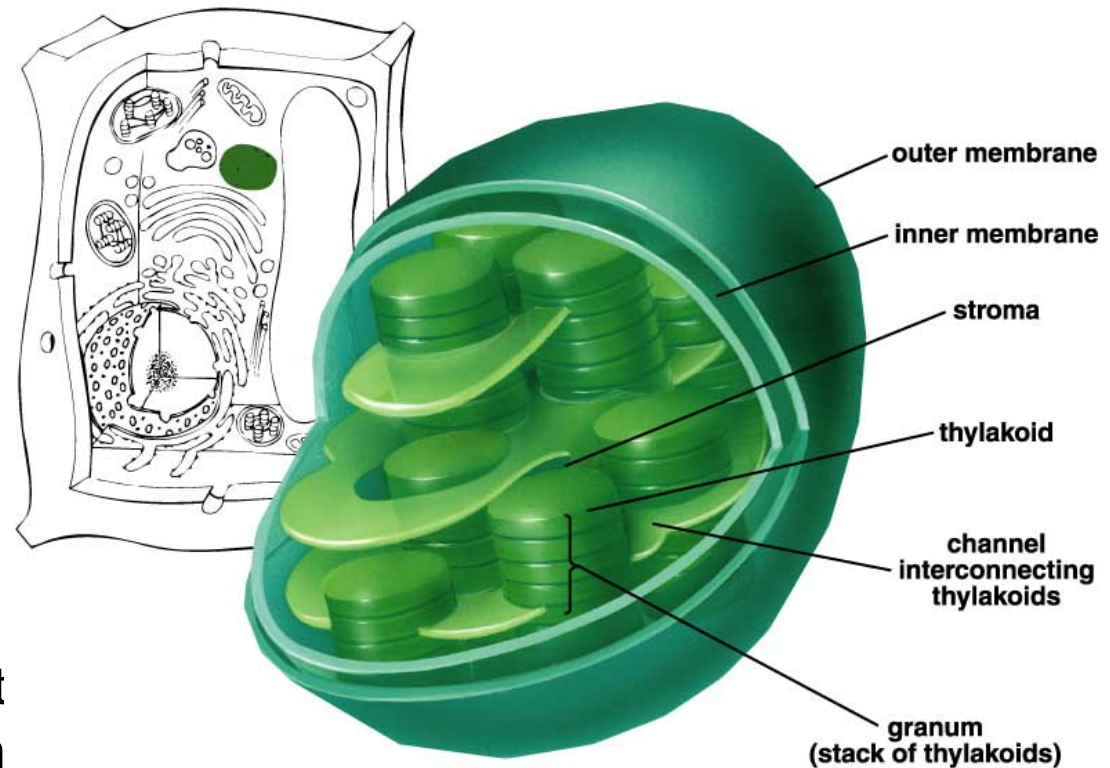
Function: Convert energy (sun) into food products (sugars)

Structure:

Stroma: Fluid in inner membrane

Thylakoids: Hollow sacs that contain chlorophyll

Granum: Stacks of thylakoids



(Figure 5.14)

Cytoskeleton: Internal framework of cell

Types of Protein Fibers:

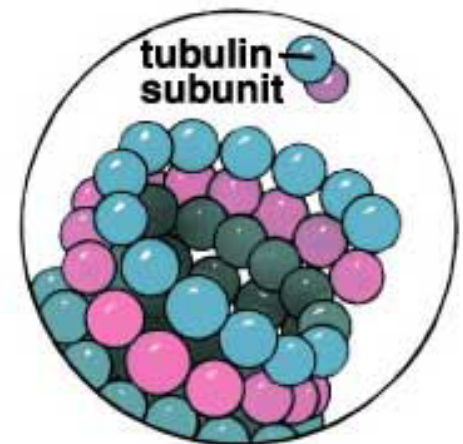
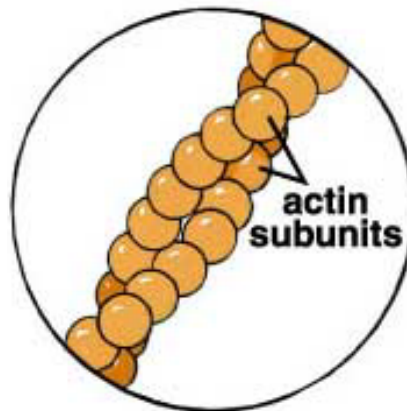
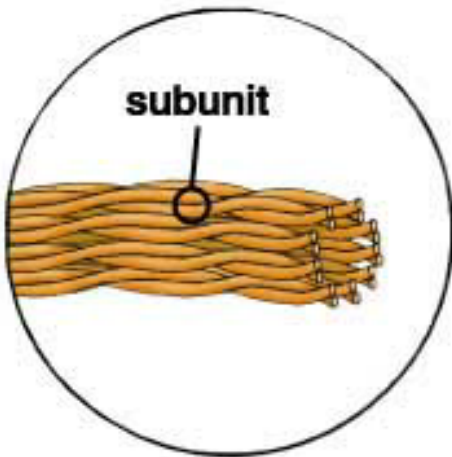
1) **Intermediate Filaments:** 8 proteins woven together

- Join together to form shape of cell

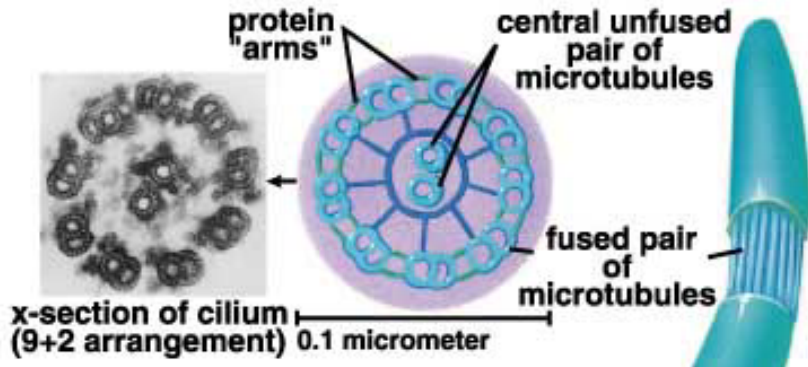
2) **Microfilaments:** Twisted double-strands of protein

3) **Microtubules:** Spiraled double-strands of protein

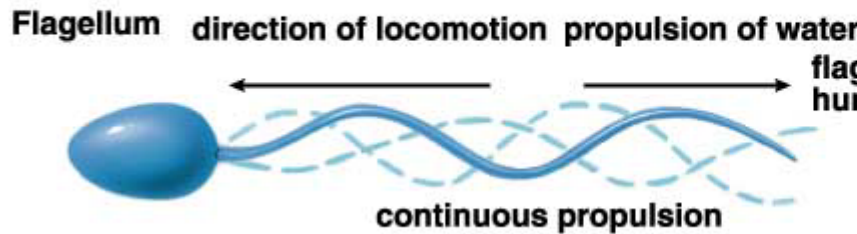
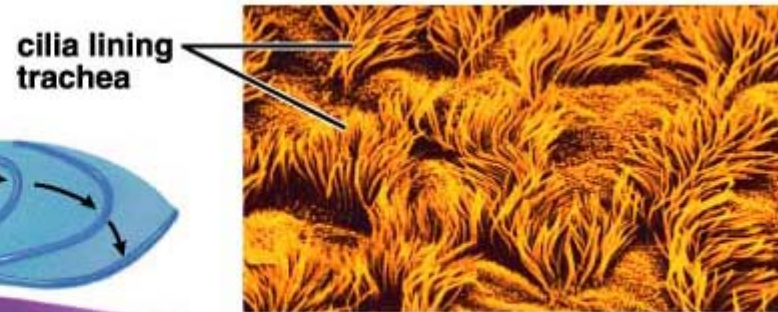
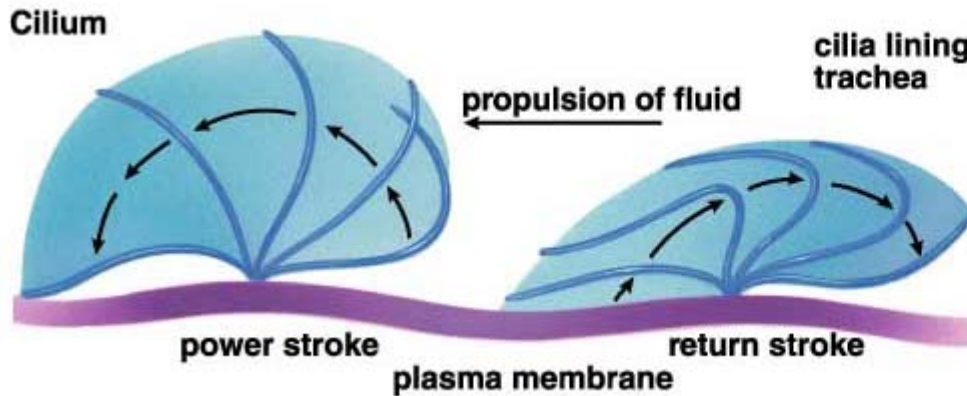
- Allow for cell movement
- Allow for organelle movement
- Allow for cell division



Cilia (“eyelash”) / **Flagella** (“whip”) : Slender extensions of plasma membrane (**Function** = movement)



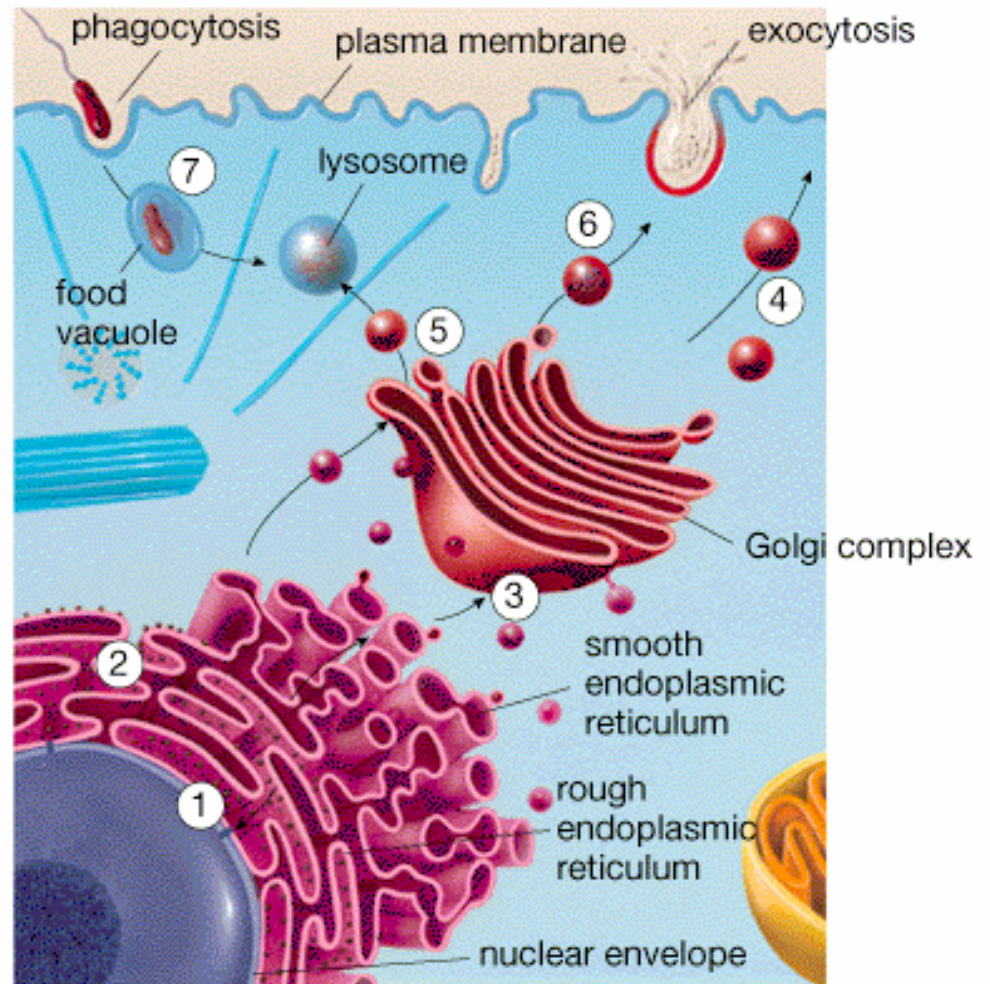
- Composed of microtubules arranged in ring structure
 - ↑ [mitochondria] at base



Eukaryotic Cell Structure:

- 1) **Nucleus**
- 2) **Membrane system**
 - **Plasma membrane**
 - **Endoplasmic reticulum**
 - **Golgi complex**
 - **Lysosomes**

Membrane System in Action:



(Figure 5.10)

Exam on **Wednesday**:

Will Cover:

Chapter 1: An Introduction to Life on Earth

Chapter 2: Atoms, Molecules & Life

Chapter 3: Biological Molecules

Chapter 4: Cell Membrane Structure and Function

Chapter 5: Cell Structure and Function

Will Consist of:

1) Multiple Choice

3) Matching

2) True/False

4) Fill-in-blank

5) Short Answer (Terms/Questions)

Example Questions:

Multiple Choice:

The net movement of molecules from a high concentration to a low concentration is called:

- A) osmosis
- B) exocytosis
- C) active transport
- D) pinocytosis
- E) diffusion

True / False:

Compared to eukaryotic cells, prokaryotic cells are small and simple in structure.

Matching:

Match the following biomolecule type with the appropriate characteristic (e.g. primarily hydrophobic = lipids)

Example Questions:

Fill-in-Blank:

Isotopes refer to atoms of the same element that have different numbers of _____ in the nucleus.

Definitions:

Covalent Bond:

Receptor Proteins:

Short Answer:

List five characteristics of living things: