A TOUR OF THE CELL

Objectives

1. State the three tenets of cell theory.
2. Compare and contrast prokaryotic and eukaryotic cells.
3. Describe the structure, function, and chemistry of the plasma membrane.
4. Differentiate among methods of crossing the plasma membrane.
5. Discuss the make up and roles of various structures within the cell.

Outline

A. Cell Theory
B. Types of cells
    1. Prokaryotes
    2. Eukaryotes
C. Cell Structures
    1. Plasma Membrane
        a. Travel In/Out of Cell
    2. Nucleus
    3. Cytoplasm
    4. Nucleolus
    5. Ribosomes
    6. Endomembrane System
    7. Endoplasmic Reticulum (ER)
        a. Rough Endoplasmic Reticulum (RER)
        b. Smooth Plastic Reticulum (SER)
    8. Golgi Apparatus (Bodies)
    9. Vesicles
    10. Lysosomes
    11. Peroxisomes
    12. Vacuoles
        a. Central Vacuole
        b. Contractile Vacuole
    13. Mitochondria
    14. Chloroplasts
    15. Cytoskeleton
    16. Centrioles
    17. Cilia & Flagella
    18. Cell Wall
D. Cell Junctions

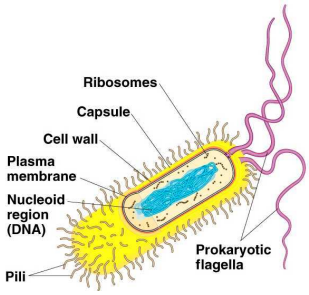
A. Cell Theory

- Smallest functioning unit of life
- All living things are composed of cells
- All cells arise from pre-existing cells

B. Types of cells

1. Prokaryotes

- "pro" = before + "karyos" = nucleus
- Lack a nucleus



  - Single circular chromosome
- Lack organelles
- Cell wall of peptidoglycan
- Divide by binary fission
- Small size (compared to eukaryotes)
  - 1-2 μm in diameter
  - 1-10 μm in length
  - Range: 0.2 μm – 750 μm
- High surface area:volume ratio (compared to eukaryotes)
- Domains Bacteria and Archaea

2. Eukaryotes

- "eu" = true + "karyos" = nucleus

- Nucleus
  - Multiple linear chromosomes

- Membrane bound organelles

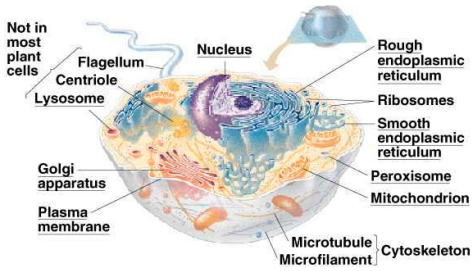
- Cell wall of cellulose or chitin (if present)

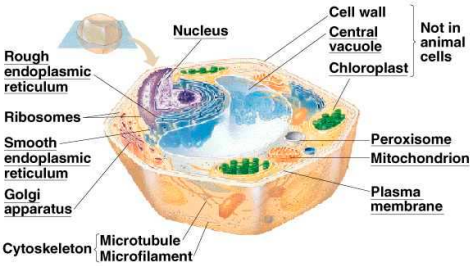
- Divide by mitosis and cytokinesis

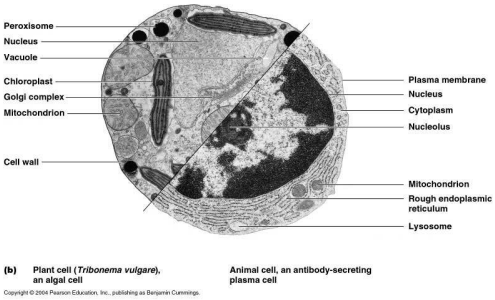
- Large size (compared to prokaryotes)
  - 10-100 μm
  - Range – 5 μm – several meters

- Low surface area:volume ratio
  - 10x smaller than prokaryotes

- Domain Eukarya
  - Protista, Fungi, Plantae and Animalia



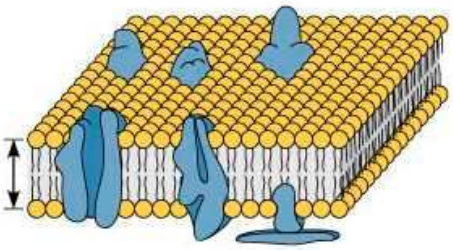




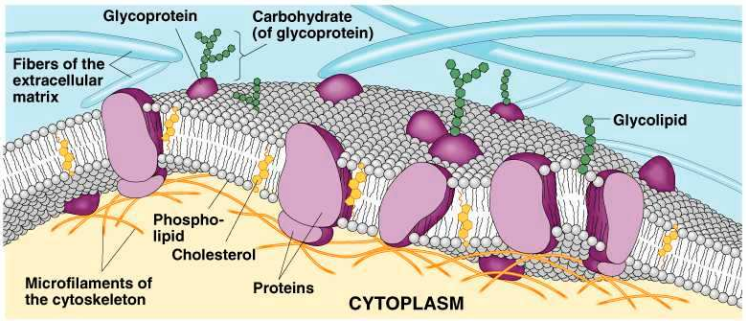
C. Cell Structures

1. Plasma Membrane

- Membrane Structure
  - Fluid mosaic structure



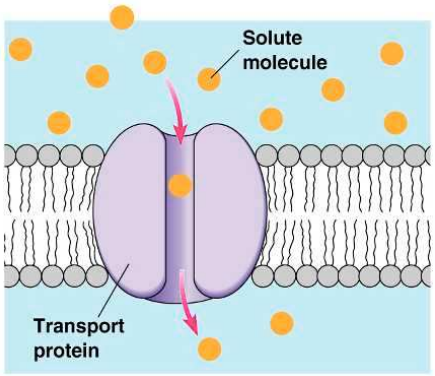
    - Phospholipid bilayer
      - Hydrophilic parts on outside
      - Hydrophobic parts on inside
      - Sterols (cholesterol in humans)
    - Embedded with proteins
      - Permeases
      - Peripheral proteins
  - Carbohydrates
    - Stick out from membrane



- Selectively permeable boundary
- Ultimate area for energy production
- Working surface for enzymes
- Present in all cells

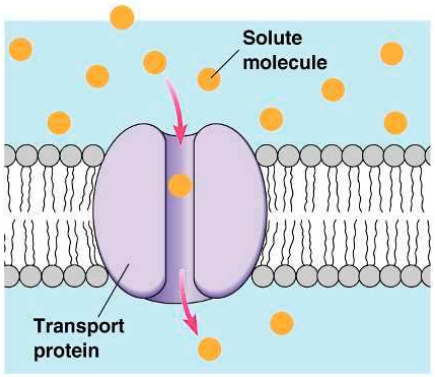
a. Travel In/Out of Cell

- Passive transport
  - Simple Diffusion
    - Small, nonpolar molecules
  - Facilitated Diffusion



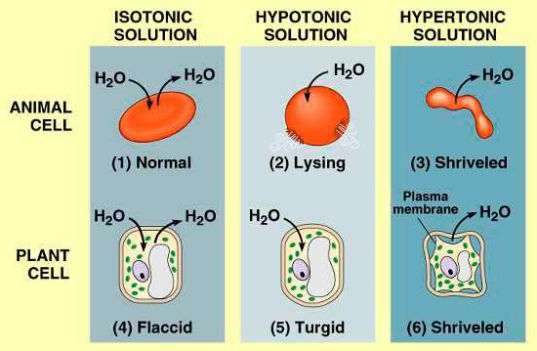
    - Permease required
    - Polar molecules and ions

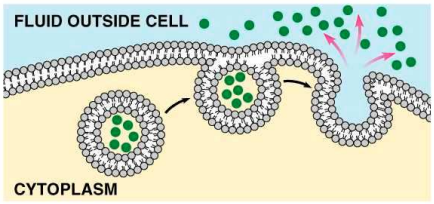
- Active Transport
  - Energy required
    - from ATP or H^+
  - Permease required
  - Transport against [gradient]

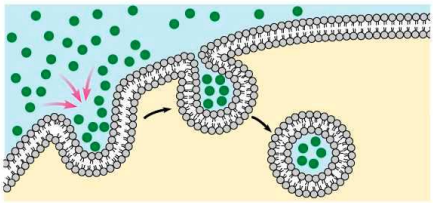


- Osmosis
  - Water moves from:
    - lower to higher [solute]
      - higher of lower [water]

- Changes internal pressure
  - Isotonic
  - Hypertonic
  - Hypotonic

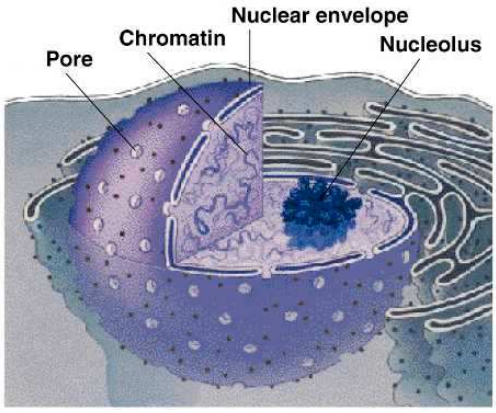






- Exocytosis
- Endocytosis
  - Phagocytosis
  - Pinocytosis

2. Nucleus



- Region of the cell
  - Surrounded by nuclear membrane
    - Double membrane
    - Has large (nuclear) pores
- Houses genetic material
- Defines eukaryotes
- Present in all eukaryotes

3. Cytoplasm

- Region of cell outside nucleus
- Mostly water with salts and proteins
- Medium of many chemical reactions
  - ~1000 different enzymes
- Present in all cells

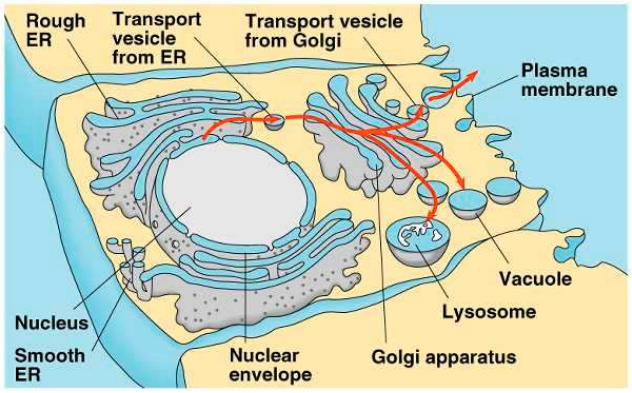
4. Nucleolus

- Inside nucleus
- Made of RNA, DNA and proteins
- Makes ribosomes
- Present in all eukaryotes

5. Ribosomes

- Made of RNA and protein
- Protein synthesis
- Present in all cells

6. Endomembrane System



- Membrane network in cytoplasm
- May be physically connected
- Is functionally connected
- Compartmentalizes cell
- Solves low surface area: volume ratio
- Present in all eukaryotes

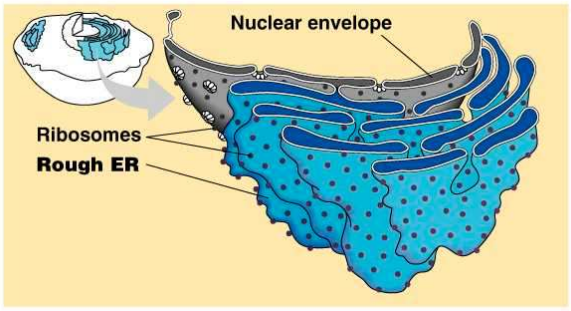
7. Endoplasmic Reticulum (ER)

- Network of membranes
  - Continuous with nuclear membrane

- Synthesis, modification and transport
  - Transfers information

- Present in all eukaryotes

a. Rough Endoplasmic Reticulum (RER)

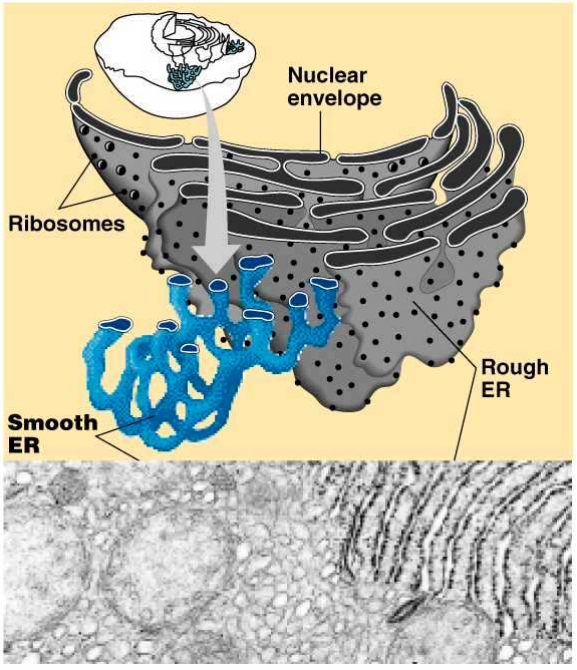


- Associated with ribosomes

- Membrane and secretory protein production

  - Glycosylation

b. Smooth Endoplasmic Reticulum (SER)



- No ribosomes

- Lipid and steroid production

- Detoxification

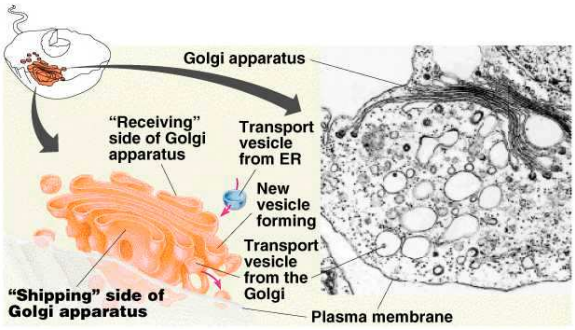
8. Golgi Apparatus (Bodies)

- Stack of membranes

- Modifies, sorts, and ships products from ER

  - Produces lysosomes

- Present in all eukaryotes



9. Vesicles

- Membrane-bound containers

  - Produced by ER, Golgi apparatus, and plasma membrane

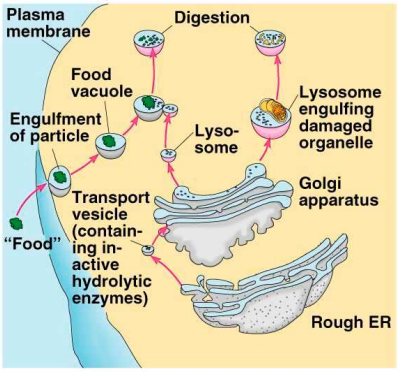
  - Formed by "budding" or endocytosis

- Transports material among organelles

- Can empty contents outside cell

  - Exocytosis

- Present in all eukaryotes



10. Lysosomes

- Temporary vesicle
    - Stores hydrolytic/digestive enzymes
- Breaks down proteins, lipids, etc.
    - Destroys ingested cells and structures
        - Fuses with vesicles
- Breaks open to kill cell
- Present in some protists and animals

11. Peroxisomes

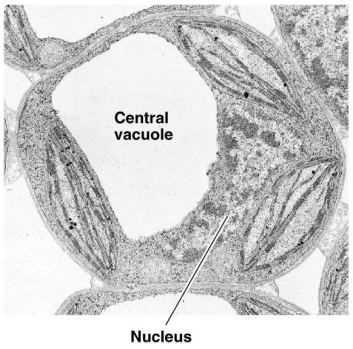
- Permanent “vesicle”
    - Stores oxidizing compounds
    - Produces H_2O_2 to destroy compounds
- Degrades cellular junk
- Present in both plants and animals

12. Vacuoles

- Permanent membrane-bound container
- Storage compartment

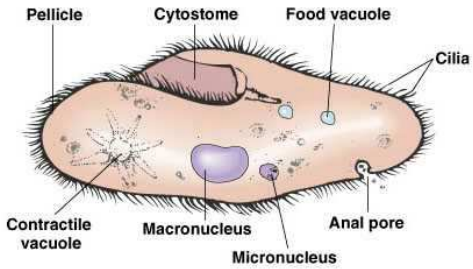
a. Central Vacuole

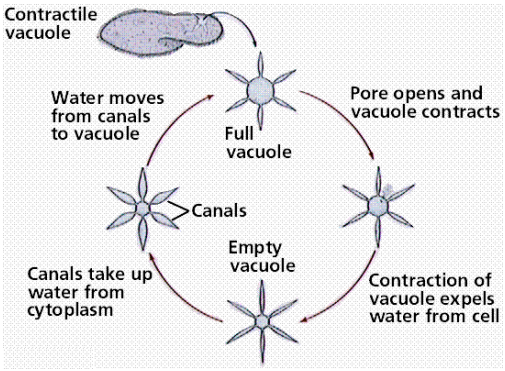
- Stores water and junk
- Gives plant cells rigidity (turgor)
  - Acts as plant skeleton
- Present in some protists and plants



b. Contractile Vacuole

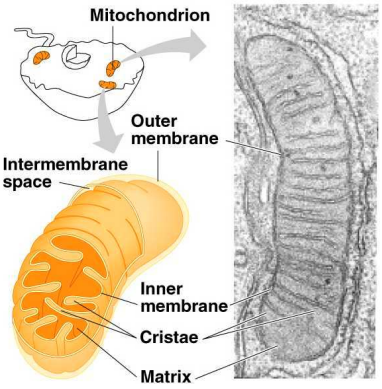
- Collects and ejects excess water and salt





- Present in some protists

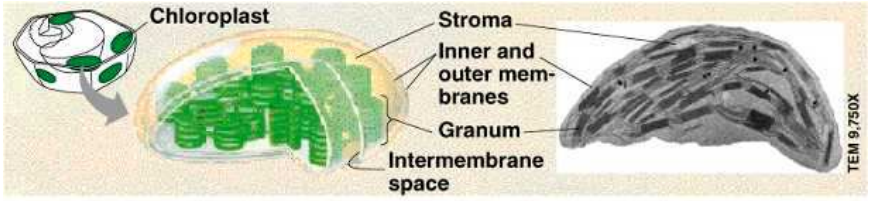
13. Mitochondria



- Double membrane
  - Inner membrane folded into cristae
- Dozens of enzymes in/on cristae
- Aerobic (cellular) respiraton
  - Harvests energy to produce ATP
  - Oxidative phosphorylation
- Present in both plants and animals

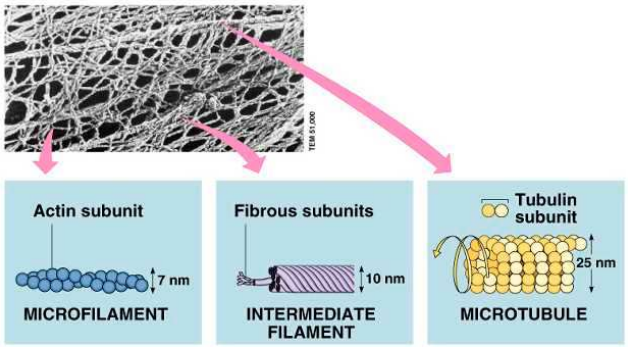
14. Chloroplasts

- Triple membrane
  - Inner membrane forms thylakoids
- Dozens of enzymes in/on thylakoids
- Photosynthesis
  - Harvests light energy to make ATP and sugar
  - Photophosphorylation



- Type of Plastid
- Present in some protists and plants
- Leucoplasts
  - Starch and lipid storage

15. Cytoskeleton

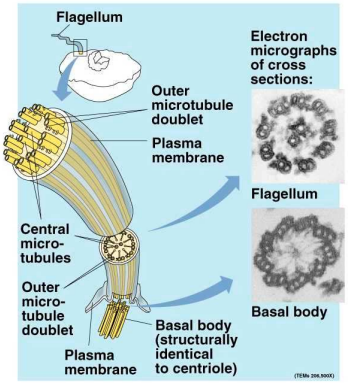


- Bridgework of protein fibers inside cell
  - Microfilaments – thinner
    - Made of actin
  - Microtubules – thicker
    - Made of tubulin
  - Intermediate filaments
- Localizes organelles and enzymes
  - Increases efficiency of reactions
- Flagellar and muscle movements
- Present in all eukaryotes

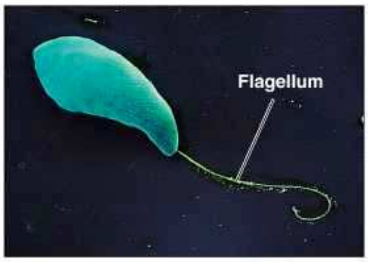
16. Centrioles

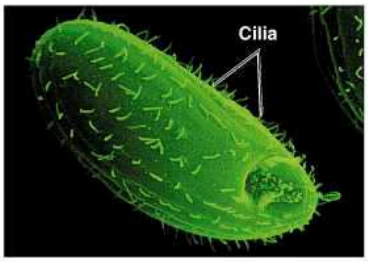
- Located just outside nucleus
- Made of the protein tubulin
  - 9 triplets
- Centrosome
  - Anchors spindle during mitosis
- Basal body
  - Anchors cilia/flagella
- Present in some protists and animals

17. Cilia & Flagella



- Thin appendages that stick outside cell
    - Made of protein
        - 9 pairs + 2 of microtubules
    - Covered by plasma membrane
    - Anchored by basal body (centriole)
        - Cilia shorter, more numerous
        - Flagella longer and fewer
- Movement
- Found in some protists and animals





18. Cell Wall

- Rigid framework outside membrane
- Made of tough material
    - Cellulose – Plants and algae
    - Chitin – Fungi
    - Peptidoglycan – Bacteria
- Protects cell from osmotic rupture
- Maintains shape of cell
- Found in some protists, fungi, and plants

D. Cell Junctions

- Extracellular matrix of glycoprotein
- Connects cells
    - Tight Junction
    - Anchoring Junction
    - Communicating Junction
    - Plasmodesmata
- Helps cells communicate