Unit 1
Matter & Energy for Life

Chapter 2

Interaction of Cell Structure

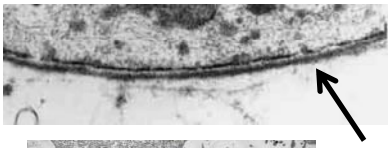
Biology 2201

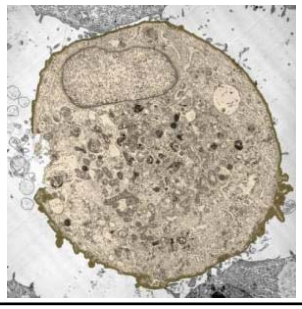
Primary Membrane Function: Homeostasis

- Conditions in the cell must remain more or less constant under many different conditions in order for the cell to carry on its life functions. This constant state resulting from the maintenance of these conditions is called **homeostasis**.

The Cell Membrane Functions

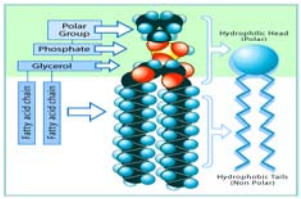
- Transport raw materials into the cell
- Transport manufactured products and wastes out of the cell
- Prevent entry of unwanted matter into the cell
- Prevent the escape of matter needed to perform cellular functions

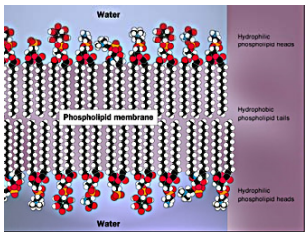




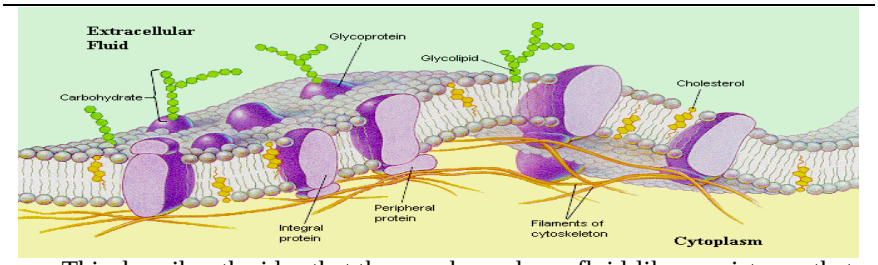
Cell Membrane Structure

- **Lipids**
  - Phospholipids – Composed of a hydrophilic head and two hydrophobic tails.
  - Cholesterol – Regulates the rigidity of the membrane over different temperature ranges.
- **Proteins**
  - Channel or Gate proteins – Serve to allow materials in and out of the cell. These proteins are often specific to certain molecules.
  - Glycoproteins – Proteins that have a carbohydrate chain on them. Often involved in immune response helping cells to identify one another.
- Together these make up the phospholipid bilayer.





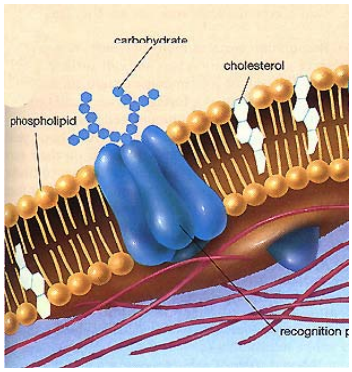
Fluid Mosaic Model



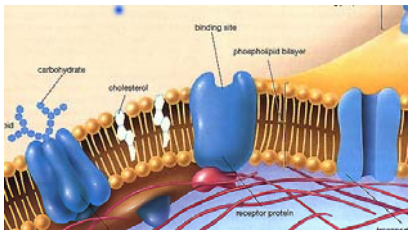
- This describes the idea that the membrane has a fluid-like consistency that allows each phospholipid to move independently throughout the membrane. Lipids can move in laterally or flip-flop.
- All membrane components can move freely as if floating on the surface of the ocean
- The membrane is able to change shape without damaging the cell

Cholesterol in the Membrane

- Allows the animal cell membrane to exist in a wide variety of temperatures
- Warmer temperatures
  - Maintains rigidity of the bilayer – holds it together preventing it from melting
- Colder temperatures
  - Keeps the membrane fluidic, flexible and functional – prevents cell death from a frozen membrane
- Note
  - Plant cells have a different lipid with a similar function



Membrane Proteins



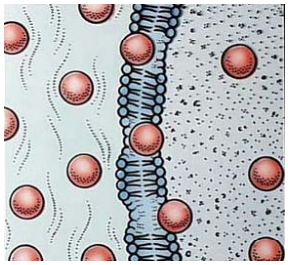
- Have a variety of functions, and cells may have several types on their membrane surface
- Some functions
  - Cell-cell recognition
  - Transport
  - Receptor sites
  - Structural support to cytoskeleton

Maintaining Homeostasis

- The cell membrane is **selectively permeable**, allowing some molecules to pass through, while preventing others
- Water is the solvent both inside and outside the cell, allowing materials to be easily dissolved
- In multicellular organisms, every cell is covered in **extracellular fluid** made up of mostly water and dissolved materials
  - Wastes eliminated by cells (CO_2 or urea)
  - Substances needed by the cells (O_2 or water)

Diffusion and the Cell Membrane

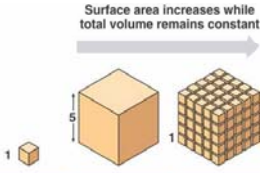
- Passive Transport – Require no cellular energy
- The movement of molecules from a region of higher concentration to a region of lower concentration is called diffusion.
- Occurs along a concentration gradient – high to low
- Reaches a point of equilibrium – no net change in the concentration of a molecule
- Rate of diffusion increases with temperature – increasing Brownian motion (vibrating molecules)



See figure 2.25 on page 53

Limits on Cell Size (Lab activity)

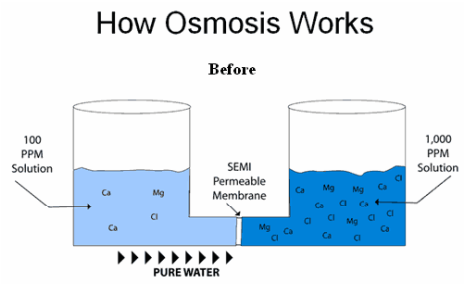
- The rate of diffusion decreases abruptly once a substance crosses the cell membrane
- Having a large surface area, relative the volume, increases the area available for materials to diffuse
- The greater the surface area the larger the amount of raw materials that can enter at only one time.
- As a cell grows its SA-V decreases



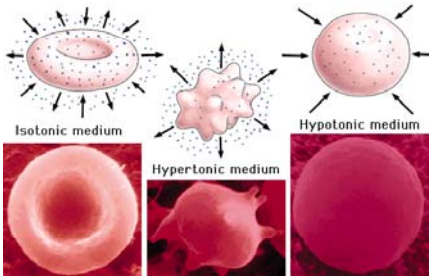
Total surface area (height × width × number of sides × number of boxes)	6	150	750
Total volume (height × width × length × number of boxes)	1	125	125
Surface-to-volume ratio (surface area / volume)	6	1.2	6

Osmosis: The Diffusion of Water

- The diffusion of water across a semi-permeable membrane
- When the membrane does not allow the diffusion of materials, water is still able to cross the membrane from high concentration to low concentration



Cellular Tonicity



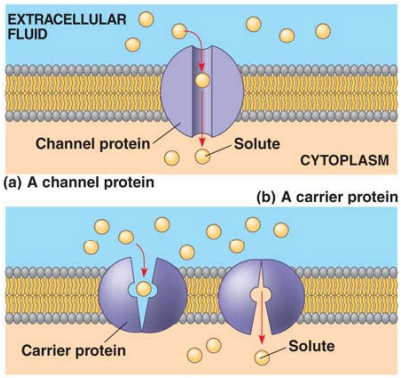
Note: Water moves in or out of the cell down the concentration gradient in an attempt to reach equilibrium

- Isotonic Solution
  - Water Concentration outside the cell is **equal** to the concentration inside the cell
  - **Equal** amounts of solute inside and outside
- Hypotonic Solution
  - Water concentration outside the cell is **Less** than the water concentration inside the cell
  - **More** solute inside the cell
- Hypertonic Solution
  - Water concentration outside the cell is **less** than the water concentration inside the cell
  - **More** solute inside the cell

Facilitated Diffusion

- Sometimes materials are too large to diffuse across the membrane without assistance, or they may not be soluble in lipids, so they cannot dissolve in the lipid bilayer
- These material need **help** from a protein
- **Passive transport**
  - **No cellular energy is required for the carrier protein to function**
- These **carrier proteins** are specific to the materials that they are transporting (moving) across the membrane by size, shape and electrical charge
- Movement of molecules is still going down the concentration gradient, but now the carrier protein is helping to move them

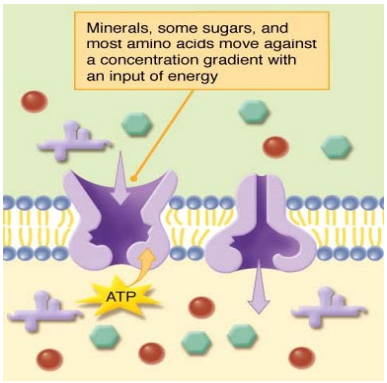
Carrier Protein vs. Channel Protein



- Carrier protein
  - Changes shape to move specific molecules in or out of the cell
  - Ex. Glucose
- Channel proteins
  - Have a tunnel that allows ions of a specific charge to move in or out of the cell
  - Ex. Na^+ or Cl^-

Active Transport

- **The process of moving materials backwards up their concentration gradient**
  - **FROM LOW CONCENTRATION TO HIGH CONCENTRATION**
- ATP is used to activate the transport protein and pump the material out of the cell.
- Often a specific shape is required to be set into the protein before the ATP will release energy to open the pump.
- Similar to pushing an object up a hill



Where To Find Active Transport

- Kidney cells pump glucose and amino acids out of the urine and back into the blood
- Intestinal cells pump nutrients from the gut
- Plant root cells pump nutrients from the soil
- Fish gill cells pump sodium ions out of the body

The Sodium – Potassium Pump

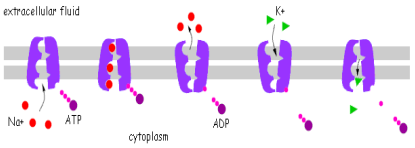
A. Carrier protein has the shape to allow 3 Na^+ (sodium) ions

B. ATP molecule splits, releasing its energy into ADP + phosphate

C. Energy causes the carrier protein to change shape, releasing sodium out of the cell

D. Phosphate is release

E. Shape change causes 2 K^+ ions to be moved out of the cell



Bulk Membrane Transport

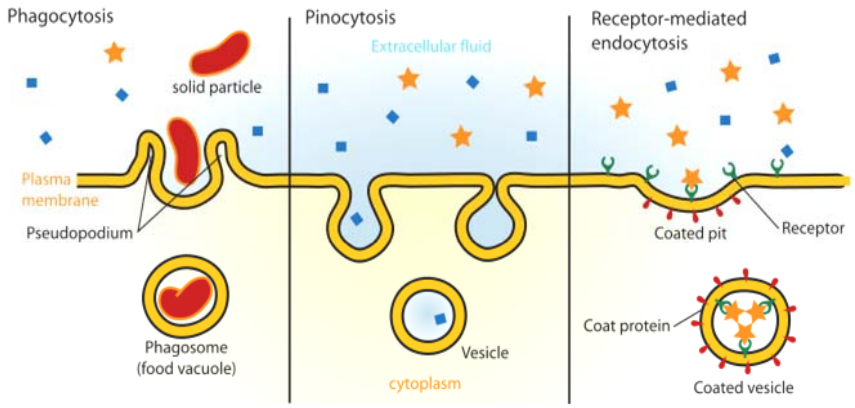
- Sometimes molecules are too large or too polar to cross through the cell membrane
- The cell uses a specialized method of getting these materials in or out of the cell.
- The cell membrane is able to fold in on itself and engulf material into a membrane bubble called a **vesicle**
- Vesicles may be newly formed and separate into or out of the cell, or they may simple fuse with the membrane releasing its contents out of the cell

Endocytosis

- The membrane folds in on itself trapping matter from the extra cellular fluid within it.
- There are three types of endocytosis used by cells depending on what it is engulfing

1. Pinocytosis
   - Cell "drinking"
   - Engulfs extracellular fluid containing dissolved nutrients
2. Phagocytosis
   - Cell "eating"
   - Engulfs extracellular fluid containing bits of matter or bacteria
   - Process used by macrophages in the immune system when they encounter bacteria
3. Receptor-assisted endocytosis
   - Involves intake of specific molecules that attach to special proteins on the cell membrane
   - This **membrane receptors** are specific to molecules that bind to them like a key into a lock

Endocytosis

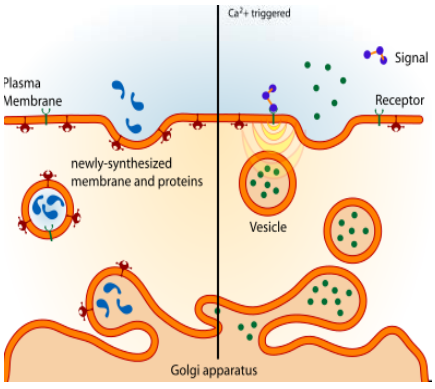


Receptor-Assisted Endocytosis & Cholesterol

- Animal cells bring in cholesterol using this method of endocytosis
- The liver produces cholesterol when levels are low
- Cholesterol is a lipid and cannot dissolve in the extracellular fluid (which is mostly water)
- Each molecule is surrounded in a single layer of phospholipids, each with a protein tag
- This protein tag binds to the receptor side on the cell surface triggering endocytosis to begin
  - See page 63 in your textbook – Figure 2.34

Exocytosis

- Reverse of endocytosis
- A vesicle from the inside of the cell fuses with the cell membrane
- The contents of the vesicle are excreted (expelled) into the extracellular fluid
- Very important to the cells of organs that secrete hormones
  - Ex. The pancreas secretes insulin



Chapter 2 Review & Test

- Review Questions
  - Page 61 - 1, 3, 6, 7, 9, 10, 13, 17
  - Page 64 – 1, 2, 4, 5, 6
- Test
  - Tuesday, October 21, 2008