Notes

Biology 102
Karen Bledsoe, Instructor
http://www.wou.edu/~bledsoek/

Chapter 5

Topic: Cell membrane structure & function

Main concepts:

- The molecules we have been learning about can assemble into structures that make up living organisms.
- Three of the four major classes of biomolecules can be found in the cell membrane: lipids, proteins, carbohydrates.
- **All cells have cell membranes**. Some cells (such as those of plants, fungi, bacteria, and some protists) have a rigid cell wall outside of the cell membrane.
- The primary function of the cell membrane is to control what goes into and what leaves the cell.
- The membrane is made up of a double layer of a particular kind of lipid known as a **phospholipid**, strengthened with molecules of cholesterol.
- Embedded in the fluid lipid layer are globular proteins that can move about in the lipids. This is the **fluid mosaic model** of the cell membrane.
- Membrane proteins serve a number of functions:
  - **Channel proteins**: allow dissolved molecules to diffuse through the membrane. Some of these proteins are structured in a way that allows only certain small molecules or ions through.
  - **Carrier proteins**: These have binding sites that allows them to bind to certain substances and physically move the substance from one side of the membrane to the other.
  - **Receptor proteins**: These proteins have active sites shaped to fit specific signal molecules, such as hormones. Once the protein is activated by the substance, it sets off a series of changes in the cell, such as increased metabolic rate or cell division.
  - **Recognition proteins**: These proteins, called glycoproteins (glyco = sugar) have complex carbohydrates attached to them. These form the identification system that allows your body cells to recognize each other as “self” instead of “invader.”
  - **Protein filaments**: Long strands of protein on the inside surface of the membrane help support and strengthen the cell membrane, forming the “cytoskeleton.”
- Substances move into or out of a cell by passive or active transport.
- Passive transport is caused by the normal kinetic motion of molecules and does not require the input of energy from the cell to make it happen.
  - **Simple diffusion**: Diffusion is the overall movement of molecules from an area of high concentration to an area of low concentration. In the cell, substances that can dissolve in lipids (fats) can diffuse through the lipid layer of the membrane.
  - **Facilitated diffusion**: Not all substances can diffuse through the lipid layer. Channel proteins allow water soluble substances to diffuse into and out of the cell.
  - **Osmosis**: This term refers to a specific kind of diffusion: the diffusion of water through a membrane. Osmosis can sometimes affect the pressure inside the cell. A cell in an **isotonic** solution (equal amounts of dissolved substances on either side of the membrane) has no net movement of water in or out of the cell. A cell in a **hypotonic** solution (less dissolved material outside than inside) may take on too much water, and can swell up and burst. A cell in a **hypertonic** solution (more dissolved material outside than inside) can lose too much water, and shrink.
- Energy-requiring transport requires the cell to spend energy, in the form of the energy-carrying molecule, ATP, to make it happen.
  - **Active transport**: Carrier proteins physically move molecules from one side of the membrane to the other. This usually happens when the cell needs to concentrate a substance inside or outside the membrane.
  - **Endocytosis**: The cell wraps part of its membrane around a substance and pulls it inside. White blood cells do this when they engulf an invader.
  - **Exocytosis**: The cell packages material, such as hormones that is has manufactured, into a small membrane bubble, which fuses with the cell membrane to release the material.

Common misconceptions:

- The biggest difficulty students have with cellular transport is learning to think about the processes at the molecular level. Animations, which can be found online, help students visualize how the processes work.
- Students often confuse osmosis and diffusion, thinking they are the same thing.
- Students may confuse diffusion with dissolving.
- Students often believe that in diffusion, when all the molecules are evenly "spread out," they stop moving.
- The concepts of *tonicity* (isotonic, hypotonic, isotonic) are new and difficult for many students. Many students have trouble remembering what direction water moves in each instance.

Chapter study guide:

- Sketch the fluid mosaic model of the cell membrane and label the parts.
- Define "phospholipid."
- List the different proteins found in the cell membrane and state their functions.
- Describe the motion of dye molecules as they diffuse through water. Remember that diffusion stops, but molecular motion does not.
- Describe what happens to a red blood cell that is dropped in an isotonic solution, a hypotonic solution, and a hypertonic solution. Describe both what happens to the cell itself (swelling up, shrinking, etc.) and what happens at the molecular level.
- Describe the process of active transport. Give an example of when active transport is used.
- Describe the processes of endocytosis and exocytosis and give some examples.
- Why do caribou have different kinds of membrane phospholipids in different parts of their legs?

Useful websites:

- "Structure of the Cell Membrane" http://home.earthlink.net/~shalpine/anim/Life/memb.htm is an interactive demonstration of the structure and function of the cell membrane.
- "Diffusion" http://www.johnkyrk.com/diffusion.html is a simple animation showing a high concentration of molecules in the center of the page. As you watch, they will diffuse through random molecular motion.
- "Osmosis" http://www.wisc-online.com/objects/index_tj.asp?objid=AP11003 is a tutorial that will help you understand the process of osmosis.
- "Transport processes requiring ATP" http://www.wisc-online.com/objects/index_tj.asp?objid=AP11203 shows endocytosis, exocytosis, and active transport.
- "Sodium-Potassium Pump" http://www.brookscole.com/chemistry_d/templates/student_resources/shared_resources/animations/ion_pump/ionpump.html is an animation (with sound) that shows active transport and the use of ATP.