**Chapter 6: Lipids and Membranes**

***6.1: Lipid Structure and Function***

1. Lipids – nonpolar organic

a. hydrocarbons – building block of lipids

(1) carbon and hydrogen held together by nonpolar covalent bonds

(2) hydrophobic 🢣 insoluble in water

2. Nonpolar components which characterize lipids found in organisms

a. Isoprenes   
(1) fat-soluble vitamins 🢣 A, D, E  
(2) cell membranes of Archaea bacteria

b. Fatty acid 🢣 hydrocarbon chain with carboxyl group at one end  
 (fats and oils)

3. Three types of lipids found in cells.

a. Steroids

(1) 4-ring structure with isoprene chain

(2) Examples

(a) cholesterol - important component of cell membranes in many organisms

(b) mammalian sex hormones (made from cholesterol) – testosterone, estrogen, progesterone

b. triglycerides 🢧 Fats and Oils

(1) glycerol + 3 fatty acids

(2) ester linkage 🢣 covalent bond that links fatty acid to glycerol

(3) Some functions of triglycerides

1. long-term energy storage in animals

(b) insulation and padding

(c) water-proofing (oils, waxes)

(d) buoyancy

(4) Different types of triglycerides

(a) saturated lipids—no double bonds, no kinks in the tail structure (link)

* packed tightly together
* solid at room temperature (the longer the hydrocarbon tails, the more stiff the lipid)
* associated with animal fats

(b) unsaturated lipids— one or more double bonds; kinks form around each double bond (link)

* pack together less closely than saturated lipids
* liquid at room temperature
* extracted from plants

c. phospholipids

(1) 3 components

(a) 3-carbon glycerol

(b) 2 fatty acids (2 isoprenes in Archaea)

(c) phosphate group

(2) Phosphate group may have a small organic molecule attached to it.

(3) phospholipids are the foundation of plasma membranes

* amphipathic - having a polar, hydrophilic region in addition to their nonpolar, hydrophobic region.
* Cholesterol is also amphipathic and is found in many plasma membranes

***6.2: Phospholipid Bilayers***

1. Phospholipids in water behave predictably.

a. Hydrophilic phosphate heads interact with water.

b. Hydrophobic hydrocarbon tails are forced together, away from water.

2. lipid bilayer – 2 layers of phospholipids

a. structure

(1) phosphate heads on outside (polar)

(2) hydrocarbon tails to the inside (nonpolar)

b. forms spontaneously in water

3. artificial membranes as experimental systems

a. Artificial membranes enable researchers to determine what can cross a membrane made of particular phospholipids.

b. Information obtained using artificial bilayers

(1) Selective permeability – property of a membrane such that only certain  
 substances are able to cross

(a) Small nonpolar molecules, such as O2 move across quickly.

(b) Very small polar molecules can cross the membrane rapidly (H2O).

(c) Large polarmolecules cannot cross the membrane.

(d) Charged molecules or ions, such as K+ or Cl–, cannot cross.

(2) A membrane composed of saturated phospholipids is less permeable

than one with many unsaturated fatty acids.

(3) cholesterol reduces membrane permeability

(a) reduces fluidity

(b) fills spaces between phospholipids so they pack more tightly.

(4) Fluid nature of membrane allows lateral movement of the phospholipids.

***6.3: How Molecules Move across Lipid Bilayers: Diffusion and Osmosis***

1. In an aqueous solution, atoms and molecules are in constant motion due to their kinetic energy.

a. As they move, particles collide and spread away from each other.

b. This increases entropy and therefore occurs spontaneously.

2. Diffusion — Net movement of molecules and ions from regions of higher concentration to regions of lower concentration (DOWN a concentration gradient)

a. Ions and molecules collide more frequently in areas where they are most concentrated.

b. Net direction of movement due to collisions will be toward areas of lower concentration, where collisions occur less frequently.

c. Dynamic equilibrium ⇨ solute particles are randomly distributed throughout a solution (movement continues but not in a net direction)

1. Because entropy is increased, diffusion is a passive process (requires no energy to make it happen).

e. Factors affecting the rate of diffusion

(1) temperature ⇨ increased kinetic E results in faster rate of diffusion

(2) size of molecules size of molecules ⇨ small atoms/molecules move easily to move than larger ones

(3) steepness of gradient ⇨ the greater the difference in the concentration of a solute between 2 solutions, the faster diffusion occurs

f. Diffusing substances move independently of each other (each down its own concentration gradient).

g. Dialysis ⇨ diffusion of a solute across a membrane

h. Dialysis is the process by which small nonpolar substances cross the phospholipid bilayer of a plasma membrane

1. Example – O2 entering bloodstream from lungs, CO2 leaving bloodstream into lungs

(also, O2 entering cells from bloodstream, CO2 leaving cells into bloodstream)

3. Osmosis — diffusion of water across a membrane

a. passive – water is moving from higher to lower concentration

b. concentration of water depends on concentration of solute

c. solution = solute + solvent

(1) 10% sucrose solution

⮚ 10% sucrose

⮚ 90% water

(2) 30% sucrose solution

⮚ 30% sucrose

⮚ 70% water

(3) In which direction will osmosis occur?

b. Osmosis is influenced by the tonicity of solutions on either side.

Tonicity –the relative concentration of solutes in solutions on either side of a membrane

(1) Terms (referring to solute concentration)

(a) Hypotonic– having less solute than

(b) Hypertonic– having more solute than

(c) Isotonic– having the same solute than concentration as

(d) net movement of water: hypotonic 🢧 hypertonic

(2) effects of osmosis on cell shape/size

(a) cells WITH cell walls (example: plants)

isotonic solutions 🢧 no change

hypotonic solutions 🢧 cells swell but do not burst (turgidity)

hypertonic solutions 🢧 cells shrink, pulling away from the cell wall (plasmolysis)

(b) cells without walls (example: animal cells)

isotonic solutions 🢧 no change

hypotonic solutions 🢧 cells swell and may burst (lysis)

hypertonic solutions 🢧 cells shrivel up (crenation)

***6.4: Membrane Proteins***

1. properties of membrane proteins

a.amphipathic - proteins that have both nonpolar and polar amino acids can be anchored in the membrane alongside phospholipids.

b.secondary and tertiary protein structure can form a channel or pore.

2. Fluid-Mosaic Model

a. descriptive of plasma membrane

b. a mosaic (mixture) of phospholipids and different types of

proteins that move amongst each other in a fluid manner

c.types of membrane proteins

(1)integral membrane proteins span the membrane.

(2)peripheral membrane proteins only on one side of the membrane

3.The role of membrane proteins in selective permeability

a.Integral (aka transport) membrane proteins are specific.

(1) each transports only 1 or 2 particular substances

(2) transports in a certain direction

b.Integral proteins regulate the movement of substances that do not freely cross the phospholipid bilayer.

(1) ionic compounds

(2) polar molecules

1. 2 types of transport through membrane proteins

a. Facilitated diffusion – movement of a substance through a membrane protein from a higher to a lower concentration

(1) passive process

no energy required

follows the concentration gradient

(2) Facilitated diffusion occurs through 2 categories of integral (transport) proteins.

(a) channel proteins – pores in plasma membrane that allow passage of ions / polar molecules

* Ion channels - The movement of ions is influenced by the electrical gradient (toward opposite charge) as well as concentration gradient (toward lower concentration)

This is called an electrochemical gradient.

* Aquaporins are integral membrane protein in some cells that transport water 10X faster than normal
* Most channel proteins are gated channels which open in response to specific situations, such as the binding of a specific molecule or a change in charge.

(b) carrier protein🢣 pick up a molecule and transport it to other side of membrane   
(vs. channel proteins that are simply passageways)

(example: diffusion of glucose)

b. Active Transport – the movement of a substance through a membrane protein from an area of lower concentration to a higher concentration

(1) requirements

(a) pump 🢧 membrane protein

(b)energy 🢧 usually provided by phosphorylation from ATP

(2)Used by cells to establish electrochemical gradients that represent potential energy

(3)example: sodium-potassium pump

(a) 2 K+ transported IN

(b) 3 Na+ transported OUT

