**Chapter 3 Notes**

Carbon

* Framework of biological molecules consists primarily of carbon bonded to
  + Carbon
  + O, N, S, P or H
* Can form up to 4 covalent bonds
* Hydrocarbons – molecule consisting only of carbon and hydrogen
  + Nonpolar
  + Functional groups add chemical properties

Isomers

* Molecules with the same molecular or empirical formula
  + Structural isomers
  + Stereoisomers – differ in how groups attached
    - * Mirror image molecules
      * D-sugars and L-amino acids

Macromolecules

* Polymer – built by linking monomers
* Monomer – small, similar chemical subunits
* 4 Major Groups:
  + Carbohydrates
  + Lipids
  + Proteins
  + Nucleic Acids
* Dehydration synthesis
  + Formation of large molecules by the removal of water
  + Monomers are joined to form polymers
* Hydrolysis
  + Breakdown of large molecules by the addition of water
  + Polymers are broken down to monomers

Carbohydrates

* Molecules with a 1:2:1 ratio of carbon, hydrogen, oxygen
* Empirical formula (CH2O)*n*
* C—H covalent bonds hold A LOT of **energy**
  + Carbohydrates are good energy storage molecules
  + Examples: sugars, starch, glucose
* Monosaccharides
  + Simplest carbohydrate
  + 6 carbon sugars play important roles
  + Example: Glucose C6H12O6
  + Fructose is a structural isomer of glucose
  + Galactose is a stereoisomer of glucose
  + Enzymes that act on different sugars can distinguish structural and stereoisomers of this basic six-carbon skeleton
* Disaccharides
  + 2 monosaccharides linked together by dehydration synthesis
  + Used for sugar transport or energy storage
  + Examples: sucrose, lactose, maltose
* Polysaccharides
  + Long chains of monosaccharides
  + Linked through dehydration synthesis
  + Polysaccharides serve as energy storage
  + Plants use starch
  + Animals use glycogen
  + Polysaccharides serve as Structural support
  + Plants use cellulose
  + Arthropods and fungi use chitin

Nucleic Acids

* Polymer – nucleic acids
* Monomers – nucleotides
  + sugar + phosphate + nitrogenous base
  + sugar is deoxyribose in DNA or ribose in RNA
  + Nitrogenous bases include
    - Purines: adenine and guanine
    - Pyrimidines: thymine, cytosine, uracil
  + Nucleotides connected by phosphodiester bonds
* Deoxyribonucleic Acid (DNA)
  + Encodes information for amino acid sequence of proteins
  + Sequence of bases
  + Double helix – 2 polynucleotide strands connected by hydrogen bonds
  + Base-pairing rules
    - A with T (or U in RNA)
    - C with G
* Ribonucleic Acid (RNA)
  + RNA similar to DNA except
  + Contains ribose instead of deoxyribose
  + Contains uracil instead of thymine
  + Single polynucleotide strand
  + RNA uses information in DNA to specify sequence of amino acids in proteins
* Other nucleotides
  + ATP adenosine triphosphate
    - Primary energy currency of the cell

Proteins

* Protein functions include:
  + Enzyme catalysis
  + Defense
  + Transport
  + Support
  + Motion
  + Regulation
  + Storage
* Proteins are polymers
  + Composed of 1 or more long, unbranched chains
  + Each chain is a polypeptide
  + Amino acids are monomers
* Amino acid structure
  + Central carbon atom
  + Amino group
  + Carboxyl group
  + Single hydrogen
  + Variable R group
  + Joined by dehydration synthesis
    - Peptide bond
* The shape of a protein determines its function
  + 4 Levels of Structure:
    - Primary structure – sequence of amino acids
    - Secondary structure – interaction of groups in the peptide backbone
      * a helix
      * b sheet
    - Tertiary structure – final folded shape of a globular protein
      * Stabilized by a number of forces
      * Final level of structure for proteins consisting of only a single polypeptide chain
    - Quaternary structure – arrangement of individual chains (subunits) in a protein with 2 or more polypeptide chains
* Domains
  + Functional units within a larger structure
  + Most proteins made of multiple domains that perform different parts of the protein’s function
* Chaperones
  + Once thought newly made proteins folded spontaneously
  + Chaperone proteins help protein fold correctly
  + Deficiencies in chaperone proteins implicated in certain diseases
    - * Cystic fibrosis is a hereditary disorder
        + In some individuals, protein appears to have correct amino acid sequence but fails to fold
* Denaturation
* Protein loses structure and function
* Due to environmental conditions
  + pH
  + Temperature
  + Ionic concentration of solution
* Dissociation
  + subunits may be dissociated
  + without losing their individual tertiary structure

Lipids

* Loosely defined group of molecules with one main chemical characteristic
  + They are insoluble in water
* High proportion of nonpolar C—H bonds causes the molecule to be hydrophobic
* Fats, oils, waxes, and even some vitamins
* Excellent for energy storage
* Fats
* Triglycerides
  + Composed of 1 glycerol and 3 fatty acids
* Fatty acids
  + Need not be identical
  + Chain length varies
  + Saturated – no double bonds between carbon atoms
    - Higher melting point, animal origin
    - solid at room temp
  + Unsaturated – 1 or more double bonds
    - Low melting point, plant origin
    - Liquid at room temp
  + Trans fats produced industrially
* Phospholipids
* Composed of
  + Glycerol
  + 2 fatty acids – nonpolar “tails”
  + A phosphate group – polar “head”
  + Form all biological membranes
  + Micelles – lipid molecules orient with polar (hydrophilic) head toward water and nonpolar (hydrophobic) tails away from water
  + Phospholipid bilayer – more complicated structure where 2 layers form
    - Hydrophilic heads point outward
    - Hydrophobic tails point inward toward each other