LECTURE OUTLINE

I. LEVELS OF CHEMICAL ORGANIZATION

A. Atoms

1. Nucleus—central core of atom
    a. Proton—positively charged particle in nucleus
    b. Neutron—noncharged particle in nucleus
    c. Atomic mass—number of protons in the nucleus; determines the type of atom
2. Energy levels—region surrounding atomic nucleus that contains electrons
    a. Electron—negatively charged particle
    b. May contain up to eight electrons in each level
    c. Energy increases with distance from nucleus

B. Elements, molecules, and compounds

1. Element—a pure substance; made up of only one kind of atom
2. Molecule—a group of atoms bound together in a group

3. Compound—substances whose molecules have more than one kind of atom

II. CHEMICAL BONDING

A. Chemical bonds form to make atoms more stable

1. Outermost energy level of each atom is full
2. Atoms may share electrons, or donate or borrow them to become stable

B. Ionic bonds

1. Ions form when an atom gains or loses electrons in its outer energy level to become stable
    a. Positive ion—has lost electrons; indicated by superscript positive sign(s), as in Na^+ or Ca^{++}
    b. Negative ion—has gained electrons; indicated by superscript negative sign(s), as in Cl^-
2. Ionic bonds form when positive and negative ions attract other because of electrical attraction
3. Electrolyte—molecule that dissociates (breaks apart) in water to form individual ions; an ionic compound

C. Covalent bonds

1. Covalent bonds form when atoms share their outer energy to fill up and thus become stable
2. Covalent bonds do not ordinarily easily dissociate in water

III. INORGANIC CHEMISTRY

A. Organic molecules contain carbon-carbon covalent bonds and/or carbon-hydrogen covalent bonds; inorganic molecules do not

B. Examples of inorganic molecules: water and some acids, bases, and salts

C. Water

1. Water is a solvent (liquid into which solutes are dissolved), forming aqueous solutions in the body

2. Water is involved in chemical reactions

a. Dehydration synthesis—chemical reaction in which water is removed from small molecules so they can be strung together to form a larger molecule

b. Hydrolysis—chemical reaction in which water is added to the subunits of a large molecule to break it apart into smaller molecules

c. Chemical reactions always involve energy transfers, as when energy is used to build ATP molecules

d. Chemical equations show how reactants interact to form products; arrows separate the reactants from the products

D. Acids, bases, and salts

1. Water molecules dissociate to form equal amounts of H+ (hydrogen ion) and OH– (hydroxide ion)

2. Acid—substance that shifts the H+/OH– balance in favor of H+; opposite of base

3. Base—substance that shifts the H+/OH– balance against H+; also known as an alkaline; opposite of acid

4. pH—mathematical expression of relative H+ concentration in an aqueous solution

a. 7 is neutral (neither acid nor base)

b. pH values above 7 are basic; pH values below 7 are acidic

5. Neutralization occurs when acids and bases mix and form salts

6. Buffers are chemical systems that absorb excess acids or bases and thus maintain a relatively stable pH

IV. ORGANIC CHEMISTRY

A. Carbohydrates—sugars and complex carbohydrates

1. Contain carbon (C), hydrogen (H), and oxygen (O)

2. Made up of six-carbon subunits called monosaccharides or single sugars (e.g., glucose)

3. Disaccharide—double sugar made up of two monosaccharide units (e.g., sucrose, lactose)

4. Polysaccharide—complex carbohydrate made up of many monosaccharide units (e.g., glycogen, made up of many glucose units)

5. Function of carbohydrates is to store energy for later use

B. Lipids—fats and oils

1. Triglycerides

a. Made up of one glycerol unit and three fatty acids

b. Store energy for later use

2. Phospholipids

a. Similar to triglyceride structure, except with only two fatty acids, and with a phosphorus-containing group attached to glycerol

b. The head attracts water and the double tail does not, thus forming stable double layers (bilayer) in water

c. Form membranes of cells

3. Cholesterol

a. Molecules have a steroid structure made up of multiple rings

b. Cholesterol stabilizes the phospholipids' tails in cellular membranes and is also converted into steroid hormones by the body

C. Proteins

1. Very large molecules made up of amino acids held together in long, folded chains by peptide bonds

2. Structural proteins

a. Form structures of the body

b. Collagen is a fibrous protein that holds many tissues together

c. Keratin forms tough, waterproof fibers in the outer layer of the skin

3. Functional proteins

a. Participate in chemical processes

b. Examples: hormones, cell membrane channels and receptors, enzymes

c. Enzymes

(1) Catalysts—help chemical reactions occur

(2) Lock-and-key model—each enzyme fits a particular molecule that it acts on as a key fits into a lock

4. Proteins can combine with other organic molecules to form glycoproteins or lipoproteins

D. Nucleic acids

1. Made up of nucleotide units

a. Sugar (ribose or deoxyribose)

b. Phosphate

c. Nitrogen base (adenine, thymine or uracil, guanine, cytosine)

2. DNA (deoxyribonucleic acid)

a. Used as the cell's "master code" for assembling proteins

b. Uses deoxyribose as the sugar and A, T, (not U), C, and G as bases

c. Forms a double-helix shape

3. RNA (ribonucleic acid)

a. Used as a temporary "working copy" of a gene (portion of the DNA code)

b. Uses ribose as the sugar and A, U, (not T), C, and G as bases

4. By directing the formation of structural and functional proteins, nucleic acids ultimately direct overall body structure and function