

Water And The Fitness Of The Environment.

Chapter 3

Objectives

Chapter 3 & 4

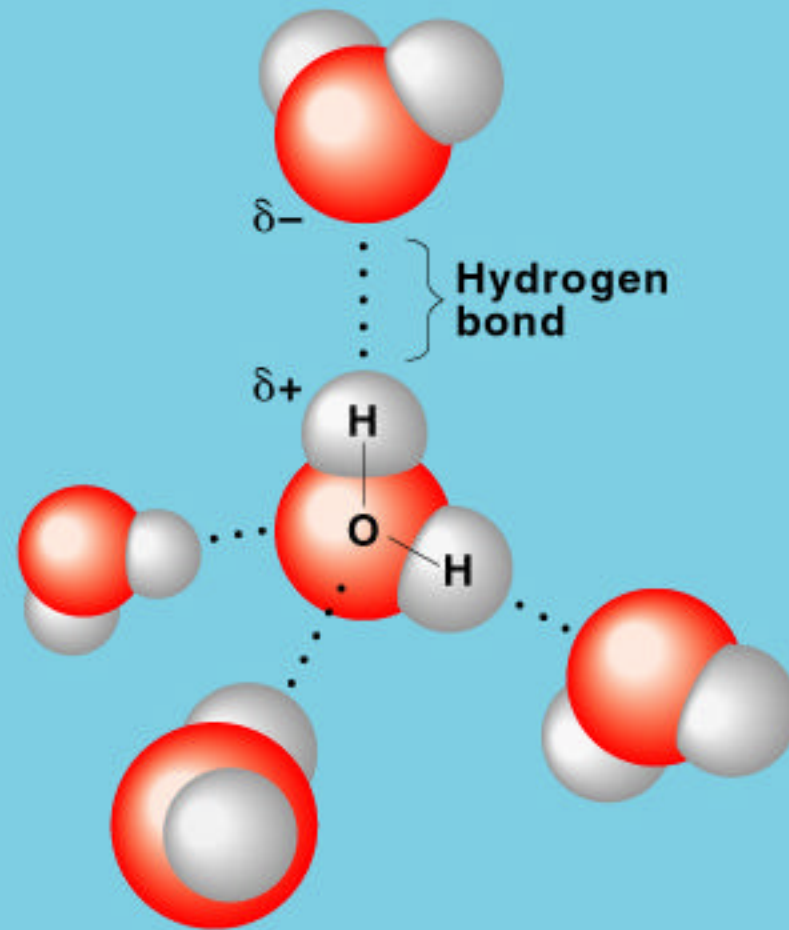
- Be familiar with the properties of water
- Understand the relationship of kinetic energy and heat
- Understand the concept of pH and be able to calculate the pH of a solution
- Be able to explain the importance of Carbon
- Understand what an isomer is and be able to apply your understanding
- Be familiar with the various functional groups

WATER'S POLARITY AND IT'S EFFECTS.

- The polarity of water molecules results in hydrogen bonding
- Organisms depend on the cohesion of water molecules
- Water moderates temperatures on Earth
- Oceans and lakes don't freeze solid because ice floats
- Water is the solvent of life

The Polarity Of Water Molecules Results In Hydrogen Bonding

- ☼ Water is a polar molecule. Its polar bonds and asymmetrical “V” shape give water molecules opposite charges on opposite sides.
- ☼ Hydrogen bonding orders water into a higher level of structural organization.
- ☼ Water has extraordinary properties that emerge as a consequence of its polarity and hydrogen-bonding.



©1999 Addison Wesley Longman, Inc.

ORGANISMS DEPEND ON THE COHESION OF WATER MOLECULES.

- ☉ Cohesion: Phenomenon of a substance being held together by hydrogen bonds.
 - Adhesion: Clinging of one substance to another substance
 - examples: water transport, capillary action
- ☉ Surface tension: Measure of how difficult it is to stretch or break the surface of a liquid.
 - Examples: water strider, overfill

WATER MODERATES TEMPERATURES ON EARTH.

- ⦿ Kinetic energy: energy of motion; all atoms exhibit kinetic energy
- ⦿ Heat: a measure of all kinetic energy in a system
- ⦿ Temperature: measure of the average kinetic energy of molecules ($^{\circ}\text{C}$)

Units of Heat

- ☼ Calorie (cal): amount of heat energy needed to raise 1 g of water by 1 °C
- ☼ Kilocalorie (kcal): amount of heat energy needed to raise 1 kg of water by 1 °C
 - food measurements as Calories
- ☼ Joule (J): smaller than calorie.
 - $1\text{ J} = 0.239\text{ cal}$ or $1\text{ cal} = 4.184\text{ J}$
- ☼ Specific heat: Resistance to temperature change when absorbing or losing heat

Water Has High Specific Heat

- The specific heat of water is higher than most molecules
 - So What!
 - Enables living organisms to better resist changes in their body temperature
- Heat of Vaporization: amount of heat that must be absorbed for 1 g of a substance to be converted from liquid to gaseous state
- Evaporative cooling: as liquid evaporates, the surface of the liquid that remains behind cools down
 - sweat

Oceans And Lakes Don't Freeze Solid Because Ice Floats

- Because of hydrogen bonding, water is less dense as a solid than it is as a liquid. Consequently, ice floats.
- So!
 - Expansion of water contributes to the fitness of the environment for life.
 - If ice sank then the remaining liquid would freeze until the whole thing was solid
 - only a small amount would thaw when warmed

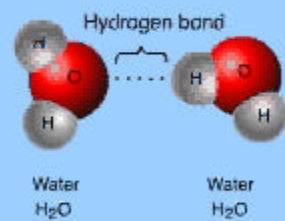
Water Is The Solvent Of Life

- Solution: a homogenous mixture of two or more substances
 - Solvent: substance that dissolves another
 - Solute: substance that is dissolved
 - Aqueous solution: where water is the solvent
- Hydrophylic and Hydrophobic substances
 - Hydrophilic (water loving): polar or ionic substances
 - Hydrophobic (water fearing): nonpolar or non-ionic substances
- Solute concentration in aqueous solutions expressed as molarity (M)

The Dissociation Of Water



- $1\text{M H}_2\text{O} \leftrightarrow 10^{-7}\text{ M H}^+ \text{ and } 10^{-7}\text{ M OH}^-$
- Acid: a substance that results in an increase in $[\text{H}^+]$, generally adds H^+
- Base: a substance that results in an increase in $[\text{OH}^-]$, may directly or indirectly modify $[\text{OH}^-]$

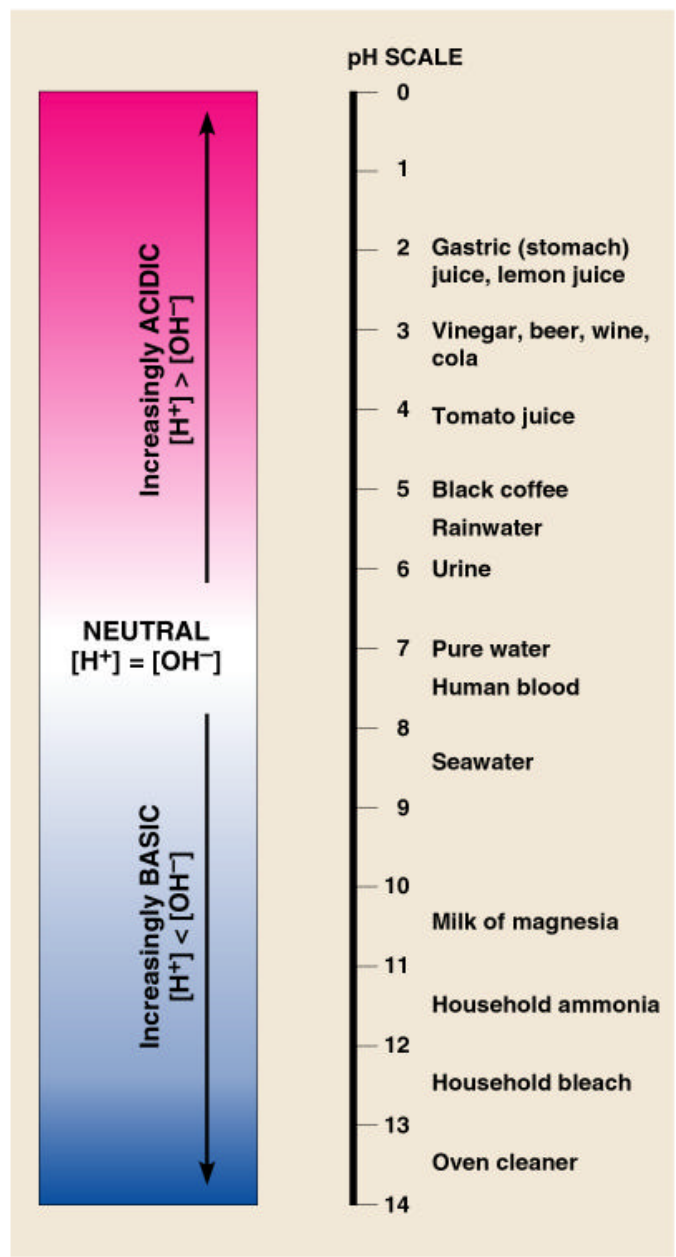


© 1999 Addison Wesley Longman, Inc.

pH

$$\text{pH} = -\log [\text{H}^+]$$

- pH scale ranges from 0 to 14 (fig 3.9)
 - acidic range is <7
 - alkaline (basic) range is >7
 - neutral is $=7$
- Buffer: any substance that minimizes pH change by adding or removing H^+
- Acid precipitation threatens the fitness of the environment



Carbon and the Molecular Diversity of Life

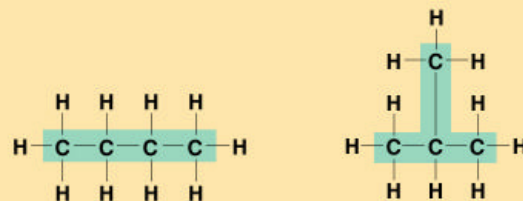
Chapter 4

- ⦿ All life on this planet is carbon based
- ⦿ Organic Chemistry is the study of Carbon compounds
- ⦿ Carbon is versatile forming up to 4 bonds (tetrahedron)

Isomers

- Isomers: variation in the structure of organic molecules with the same molecular formula

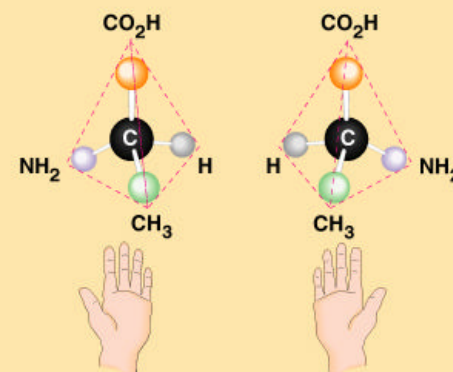
- Structural Isomers: differ in the covalent arrangement of their atoms
- Geometric Isomers: differ in their spatial arrangement
- Enantiomers: structures that are mirror images of each other



(a) Structural isomers: variation in covalent partners, as shown in the example of butane and isobutane.



(b) Geometric isomers: variation in arrangement about a double bond. (In these diagrams, "X" represents an atom or group of atoms attached to a double-bonded carbon.)



(c) Enantiomers: variation in spatial arrangement around an asymmetric carbon, resulting in molecules that are mirror images, like left and right hands. Enantiomers cannot be superimposed on each other.

Functional Groups

Groups of atoms frequently attached to the skeletons of organic molecules

• Hydroxyl group -OH

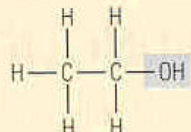
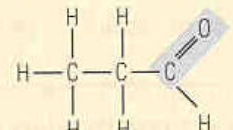
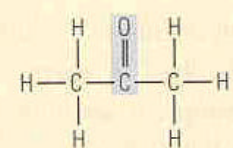
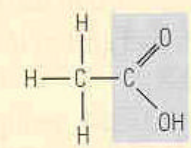
- Polar
- Alcohols

• Carbonyl >CO

- aldehyde: at end of carbon chain
- ketone: nested inside carbon chain

• Carboxyl -COOH

- form H^+

NAME OF COMPOUNDS	EXAMPLE
Alcohols	 <p>Ethanol (the drug of alcoholic beverages)</p>
Aldehydes	 <p>Propanal</p>
Ketones	 <p>Acetone</p>
Carboxylic acids	 <p>Acetic acid* (the acid of vinegar)</p>

Functional Groups

- Amino Group $-NH_2$
 - Amines
 - Act as base
- Sulfhydryl $-SH$
 - Thiols
- Phosphate $-PO_4^{2-}$
 - Usually very reactive
 - ATP

