

## General Biology

Course No: BNG2003  
Credits: 3.00

### 2b. Water and the Fitness of the Environment

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- **The Molecule That Supports All of Life**
  - Water is The Biological Medium here on Earth
  - All living organisms require water more than any other substance

- Three-quarters of the Earth's surface is submerged in water
- The abundance of water is the main reason the Earth is habitable



- **Four emergent properties of water** contribute to Earth's fitness for life

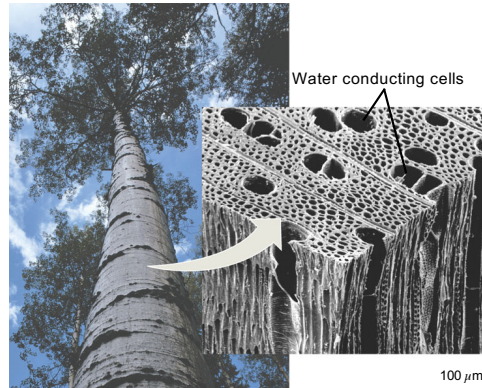
#### **Cohesion**

- Water molecules exhibit cohesion
- Cohesion
  - Is the **bonding** of a high percentage of the molecules to neighboring molecules
  - Is due to **hydrogen bonding**

- **Cohesion** helps to pull water up through the microscopic vessels of plants (where is the pulling energy force coming from ?)

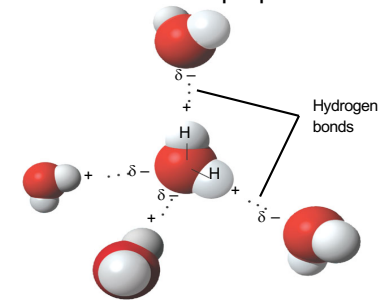
**Bio-Engineering:**

Transport of Photosynthesis products, minerals, etc.



The **Polarity of water** molecules results in hydrogen bonding

- The water molecule is a polar molecule
- The polarity of water molecules
  - Allows them to form **hydrogen bonds** with each other (see also dissolving of salts)
  - Contributes to the various properties water exhibits



- **Surface tension**
  - is a measure of how hard it is to break the surface of a liquid
  - is related to cohesion



**Moderation of Temperature**

- Water moderates air temperature
  - By absorbing heat from air that is warmer and releasing the stored heat to air that is cooler

**Heat and Temperature**

- Kinetic energy
  - Is the energy of motion
- Heat
  - Is a measure of the total amount of kinetic energy due to molecular motion
- Temperature
  - Measures the intensity of heat

### Water's High Specific Heat

- The specific heat of a substance
  - Is the amount of heat that must be absorbed or lost for 1 gram of that substance to change its temperature by 1°C
- **Water has a high specific heat**, which allows it to minimize temperature fluctuations to within limits that permit life
  - Heat is absorbed when hydrogen bonds break
  - Heat is released when hydrogen bonds form (see also dissolving of salts)

### Evaporative Cooling

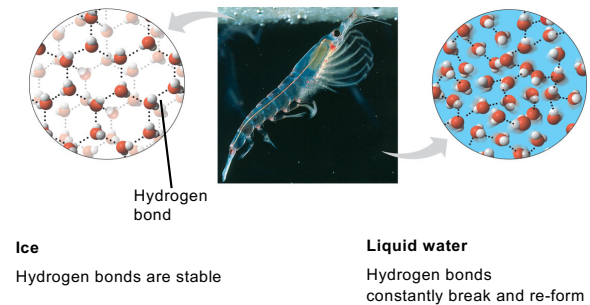
- Evaporation
  - is the transformation of a substance from a liquid to a gas
- Heat of vaporization
  - is the quantity of heat a liquid must absorb for 1 gram of it to be converted from a liquid to a gas
- **Evaporative cooling**
  - is due to water's high heat of vaporization
  - allows water to cool a surface

### Insulation of Bodies of Water by Floating Ice

- Solid water, or **ice**
  - is less dense than liquid water
  - floats in liquid water
- **Since ice floats in water**
  - life can exist under the frozen surfaces of lakes and polar seas

### The hydrogen bonds in ice

- Are more “ordered” than in liquid water, making ice less dense

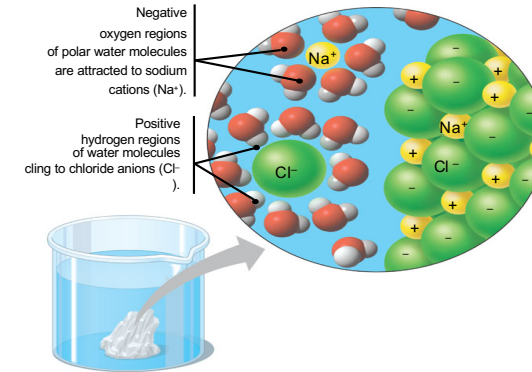


## The Solvent of Life

- Water is a versatile solvent due to its polarity
- It can form aqueous solutions

## Dissolving salt in water

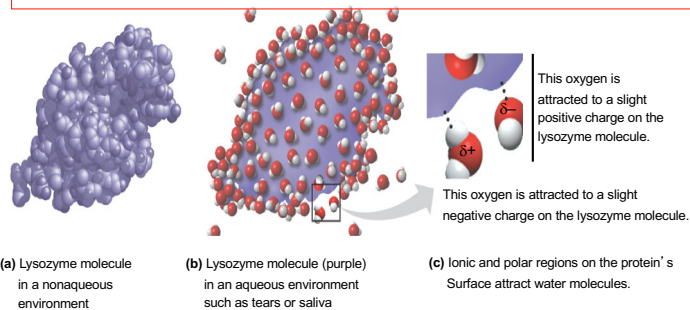
- The different regions of the polar water molecule can interact with ionic compounds called solutes and dissolve them



- Water can also interact with polar molecules such as proteins

Van der Waals interactions etc ---> protein structure ---> protein function ---> diseases

e.g.: AD, PD, HD, Prion



## Hydrophilic and Hydrophobic Substances

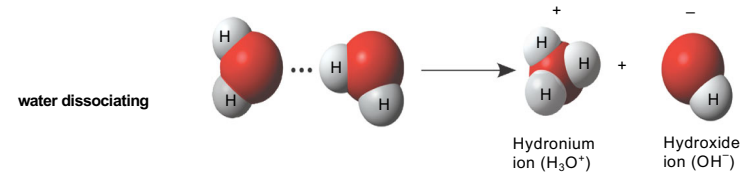
- A hydrophilic substance
  - has an affinity for water
- A hydrophobic substance
  - does not have an affinity for water

## Solute Concentration in Aqueous Solutions

- Since most biochemical reactions occur in water
  - It is important to learn to calculate the concentration of solutes in an aqueous solution
- A mole
  - Represents an exact number of molecules of a substance in a given mass
- Molarity
  - Is the number of moles of solute per liter of solution

## pH Dissociation of water molecules leads to acidic and basic conditions that affect living organisms

- Water can dissociate
  - into hydronium ions and hydroxide ions
- Changes in the concentration of these ions
  - can have a great affect on living organisms



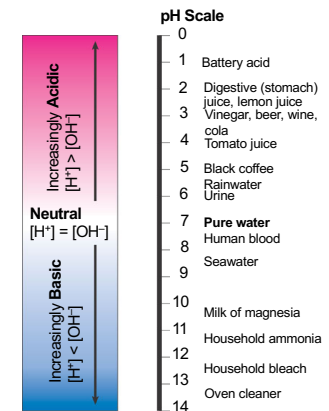
## Effects of Changes in pH

### Acids and Bases

- An acid
  - is any substance that increases the hydrogen ion concentration of a solution
- A base
  - is any substance that reduces the hydrogen ion concentration of a solution

## The pH Scale

- The pH scale and pH values of various aqueous solutions
- The pH of a solution
  - is determined by the relative concentration of hydrogen ions
  - is low in an acid
  - is high in a base



## Buffers

- The internal pH of most living cells
  - must remain close to pH 7
- Buffers
  - are substances that minimize changes in the concentrations of hydrogen and hydroxide ions in a solution
  - consist of an acid-base pair that reversibly combines with hydrogen ions

Which physiological buffer system do you know (in human being)?

## Ecology: The Threat of Acid Precipitation

- Acid precipitation refers to rain, snow, or fog with a pH lower than pH 5.6 and is caused primarily by the mixing of different pollutants with water in the air
- Acid precipitation can damage life in Earth's ecosystems

