Biology

Topic:

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❖ Water is importance to Life

• Water is the single most important molecule of earth.

– All living organisms require water

– The chemical reactions of your body occur in cells consisting of 70–95% water

• Water has unique properties that make it a life- supporting substance

❖ The structure & prosperities of H2O

• Atoms differ in their **electronegativity**, or their affinity for electrons in a covalent bond

• The unequal sharing of electrons in a molecule such as water makes the molecule polar

• Water is a solvent (مذيب) that can dissolve many substances

تجذب

– Molecules that attract water are hydrophilic

– Molecules that cannot attract water are hydrophobic

▲ Figure 3.4 Walking on water. The high surface tension

❖ Properties of water

• Water shows cohesion(التماسك (and (التلاصق) adhesion

• When water molecules adhere to polar surfaces it is called **adhesion**

• When water molecules cling together with hydrogen bonds it is called **cohesion**

• Water cohesion allows this insect to walk, stand, or run on water (Picture)

❖ Properties of Water contribute to earth's suitability for life

1. COHESION; cohesiveness of water molecules

• Hydrogen bonds make liquid H2O cohesive;

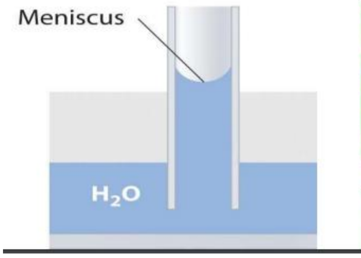
➔ Cohesion is the attraction between molecules of the same kind.

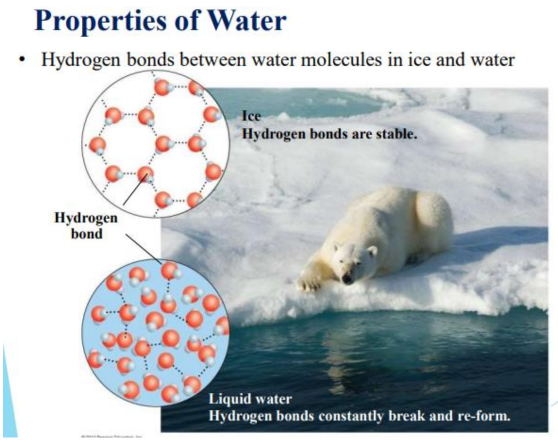
2. Surface tension

results from the cohesion of water molecules (H bonded to one another and to the water below)

e.g., overfilling a drinking glass; water stands above the rim (الحافة(

- The stronger the force between molecules in a liquid, the stronger the surface tension.





3. Adhesion: clinging of one substance to another (adhesion of water to cell walls by H bonds) resists the downward pull of gravity.

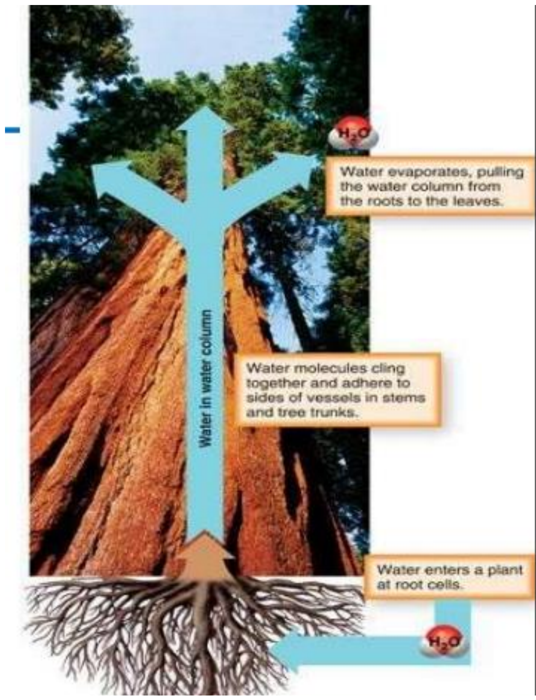
• Adhesion of water to a glass surface of a capillary tube (or tree vessels) leads to ascending water to the top .

❖ Properties of water

• Water has a high heat capacity, protecting organisms from temperature changes.

• Water has a high heat of vaporization.

• These properties of water keep temperatures compatible with those of living organisms.



❖ Moderation of Temperature

• Water moderates temperature changes

➔ By absorbing heat from air that is warmer and releasing the stored heat to air that is cooler

➔ Water stores heat… it heats up slowly

•Since organisms have a high water content, they don't experience rapid changes in temperature
(including: Ectotherms: cold-blooded animal; that is, any animal whose regulation of body temperature depends on external sources, such as sunlight

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❖ Acids and Bases

• An **acid** is a substance that releases H+ when dissolved in water.
• Acidic solutions have a high H+ concentration.

Hydrochloric acid HCl $\longrightarrow$ H+ + Cl

• A **base** is a substance that releases OH- when dissolved in water.
• Basic solutions have a low H+ concentration.

Sodium hydroxide NaOH $\longrightarrow$ Na+ + OH-

❖ Water Ionizes

• When water dissociates, it releases an equal number of ions.
➔ Hydrogen ions (H+)
➔ Hydroxide ions (OH-)

H – O – H $\rightleftharpoons$ H+ + OH-

• The covalent bond within a water molecule breaks spontaneously

$$H_2O \leftrightarrow OH^- + H^+$$

Water Hydroxide Hydrogen

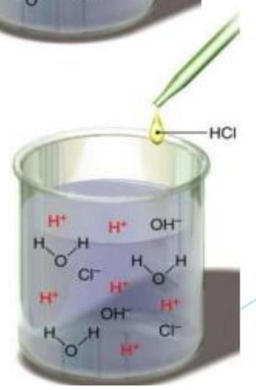
• This produces two ions in a process called Ionization
➔ because of the great strength of covalent bonds, this does not occur too often

❖ pH and the pH scale

• The pH is a mathematical way of indicating the number of H+ ions in a solution.

• The pH scale is used to express acidity or basicity (alkalinity).

• Pure water has a pH of 7
 – There are equal amounts of [H+] relative to [OH-]



• Acid – any substance that dissociates in water and increases the [H+]
 – acidic solutions have pH values below 7

• Base – any substance that combines with [H+] when dissolved in water
 - basic solutions have pH values above 7

• Strong acids and bases dissociate completely in water (HCl, NaOH).

- Single arrows indicate complete dissociation -NaOH→ Na+ + OH-

• Weak acids and bases dissociate only partially and reversibly.

- Examples: NH3 (ammonia) and H2CO3 (carbonic acid).

- Double arrows indicate a reversible reaction.

- At equilibrium, fixed ratio of reactants and products.
• H2CO3 ⇋ HCO3- + H+

- The pH scale & pH values of some aqueous solutions

• The measure how acidic (how much H+) is on the pH scale from 0 (most acidic) to 14 (most basic)

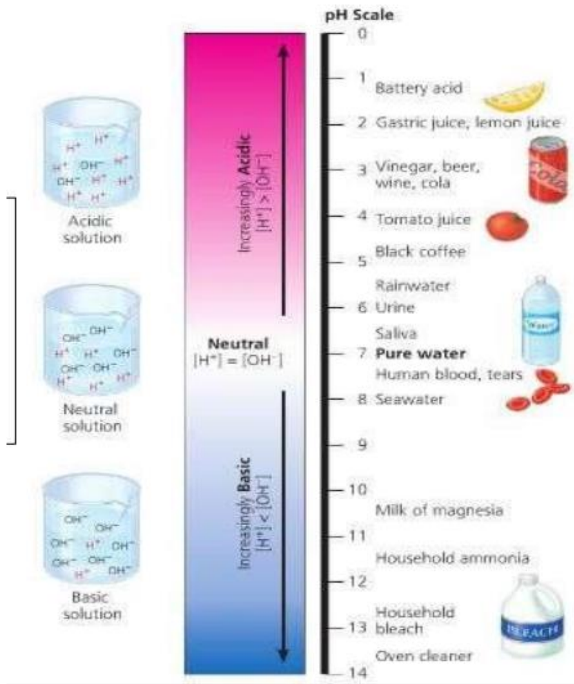
• The pH of most cells is kept close to 7 (neutral) by buffers that resist pH change

• A **buffer** is a weak acid or base that reacts with strong acids or base to resist (prevent) sudden changes in pH

• Buffer – a chemical substance that takes up or releases hydrogen ions

– buffers don't remove the acid or the base affecting pH but minimize their effect on it

– most buffers are pairs of substances, one an acid and one a base



❖ Buffers and pH

• Within the body, the pH is kept in a narrow range to maintain health.

• A buffer is a chemical or combination of chemicals that keeps a pH within a given range.

• Buffers resist changes in pH by taking up extra H+ or OH from solution.

• E.g. on buffer:
- carbonic acid (H2CO3)
- bicarbonate anion (HCO3-)

❖ Water is the solvent of life

محلول
• A solution is a liquid consisting of a uniform mixture of two or more substances.

– The dissolving agent is the solvent. المذيب

– The substance that is dissolved is the solute. المذاب

– An aqueous solution is one in which water is the solvent. محلول مائي

A crystal of salt (NaCl) dissolving in water