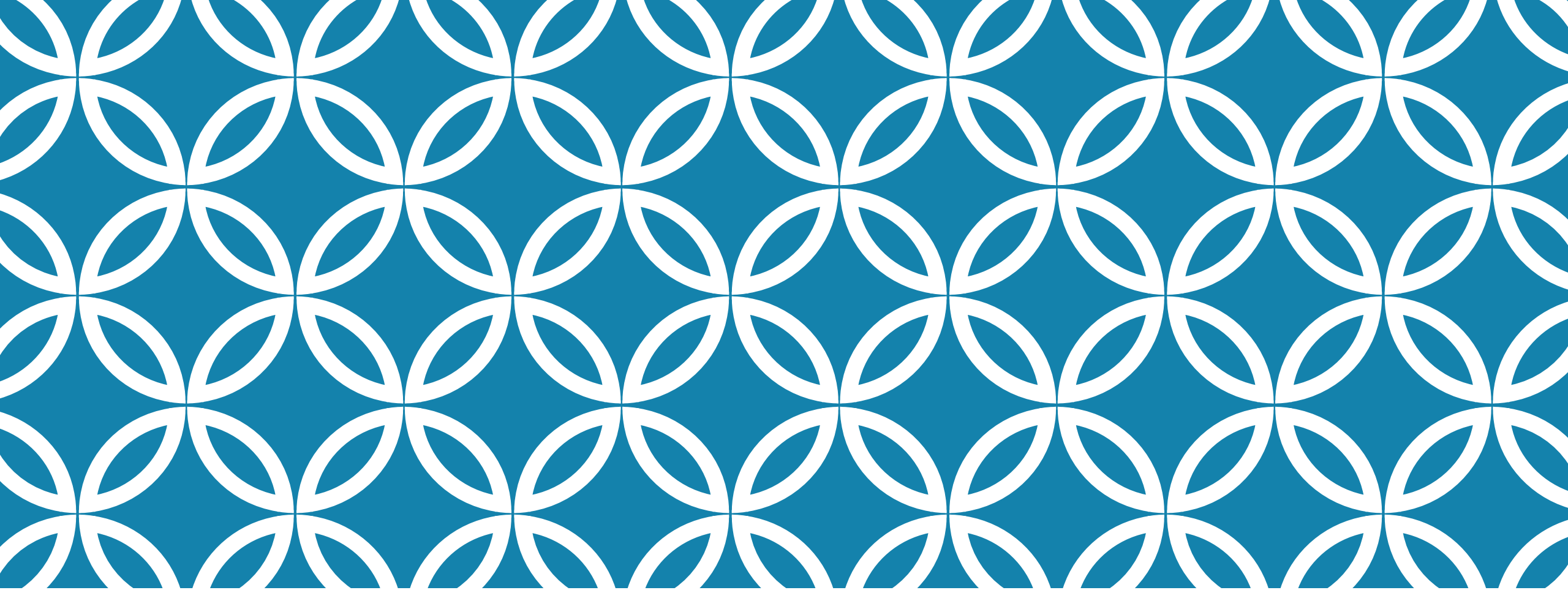


BASIC CHEMISTRY

Revision

WHAT IS A MOLECULE?

Molecule: group of two or more atoms held together by covalent bonds

- element molecules: only of one type of atoms (e.g. N_2, H_2)
- compounds: two or more elements

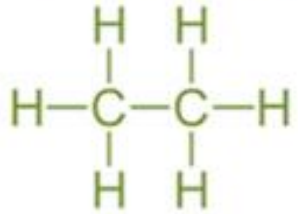
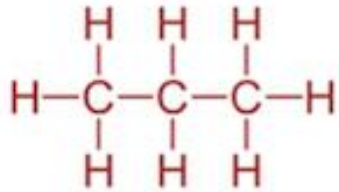
IMPORTANT ELEMENTS IN BIOLOGICAL MOLECULES

element name	symbol	number of bonds
carbon	C	4
hydrogen	H	1
oxygen	O	2
nitrogen	N	3

SIMPLE STRUCTURE FORMULAS

Simple structure formulas

- show atoms and chemical bonds within molecules

Molecular Formula	Structural Formula
Ethane C_2H_6	
Ethanol C_2H_6O	
Propane C_3H_8	

KEY TERMS

Metabolism

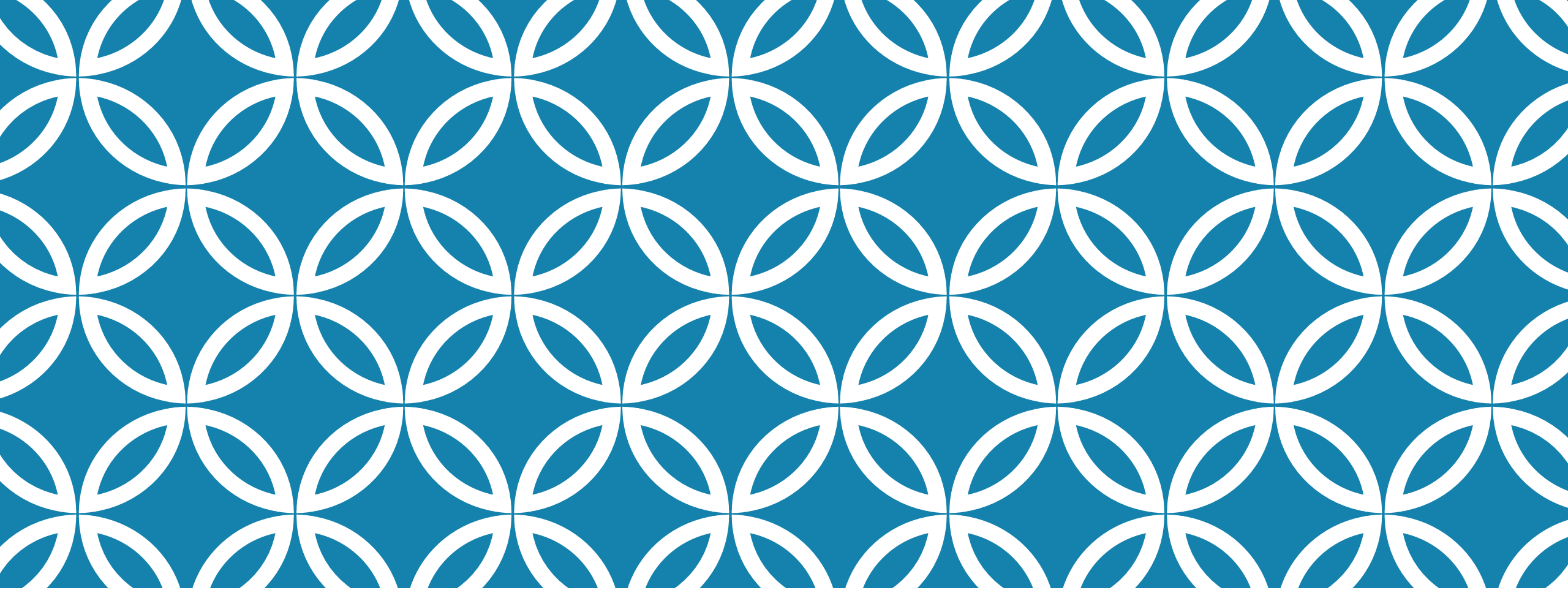
Anabolism

Catabolism

Summarize and find definition

Research (book, inet)

Ask next lesson (only precise questions)



WATER | H_2O

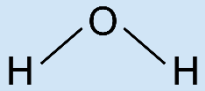
LEARNING OBJECTIVES

Understandings, Applications and Skills (This is what you maybe assessed on)

	Statement	Guidance
2.2.U1	Water molecules are polar and hydrogen bonds form between them.	
2.2.U2	Hydrogen bonding and dipolarity explain the cohesive, adhesive, thermal and solvent properties of water.	Students should know at least one example of a benefit to living organisms of each property of water. Transparency of water and maximum density at 4°C do not need to be included.
2.2.U3	Substances can be hydrophilic or hydrophobic.	
2.2.A1	Comparison of the thermal properties of water with those of methane.	Comparison of the thermal properties of water and methane assists in the understanding of the significance of hydrogen bonding in water.
2.2.A2	Use of water as a coolant in sweat.	
2.2.A3	Modes of transport of glucose, amino acids, cholesterol, fats, oxygen and sodium chloride in blood in relation to their solubility in water.	

WATER (H_2O)

- H2O = Hydrogen + Oxygen
- Needed by living beings e.g. humans, animals, plants

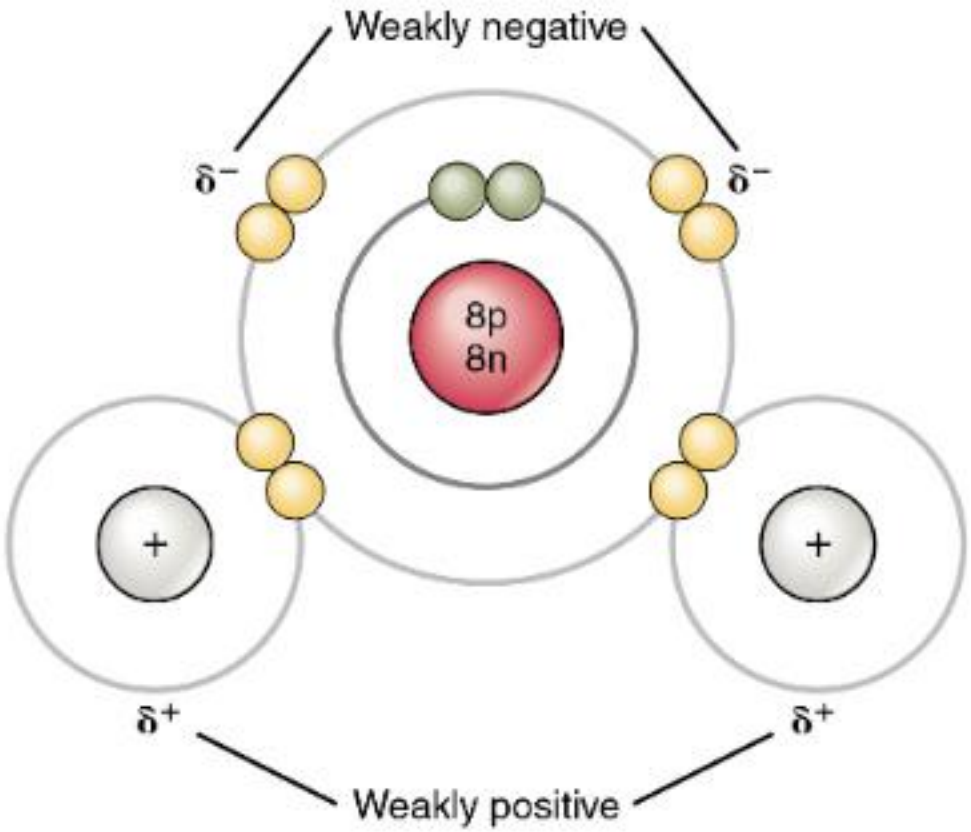
Liquid	• Room temperature • Can evaporate
solid	• Below 0°C • can turn into ice
gas	• Above 100°C • 

UNDERSTANDING

- Water molecules are polar and hydrogen bonds form between them
- Hydrogen bonding and dipolarity explain the adhesive, cohesive, thermal and solvent properties of water
- Substances can be hydrophilic or hydrophobic

WATER IS EVERYWHERE

- ¾ of Earth‘s surfaces are covered by water
- Habitat for freshwater and sea water organisms
- 70% of animal cell mass
- 95% of plant cell mass



(a) Planetary model of a water molecule

PROPERTIES OF WATER

Polarity (Polarität) / Dipolarity (Dipolarität)

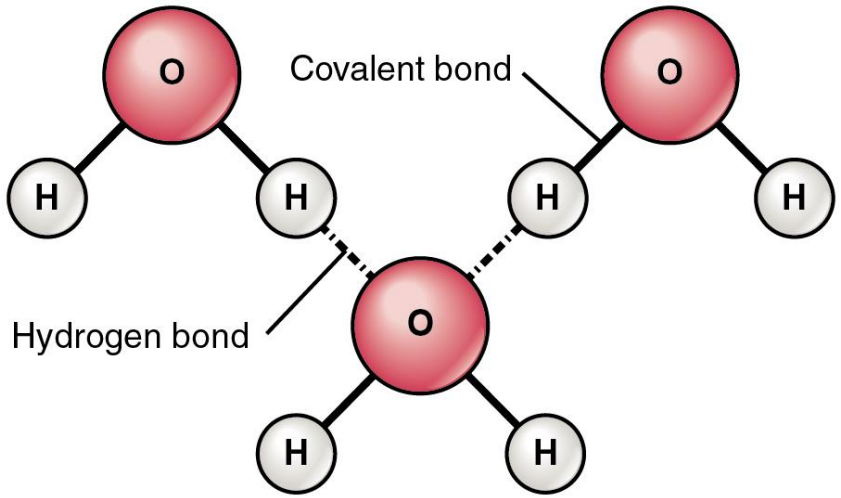
Water is polar because of an uneven distribution of electrons between oxygen and hydrogen

Hydrogen bonds (Wasserstoffbrückenbindungen)

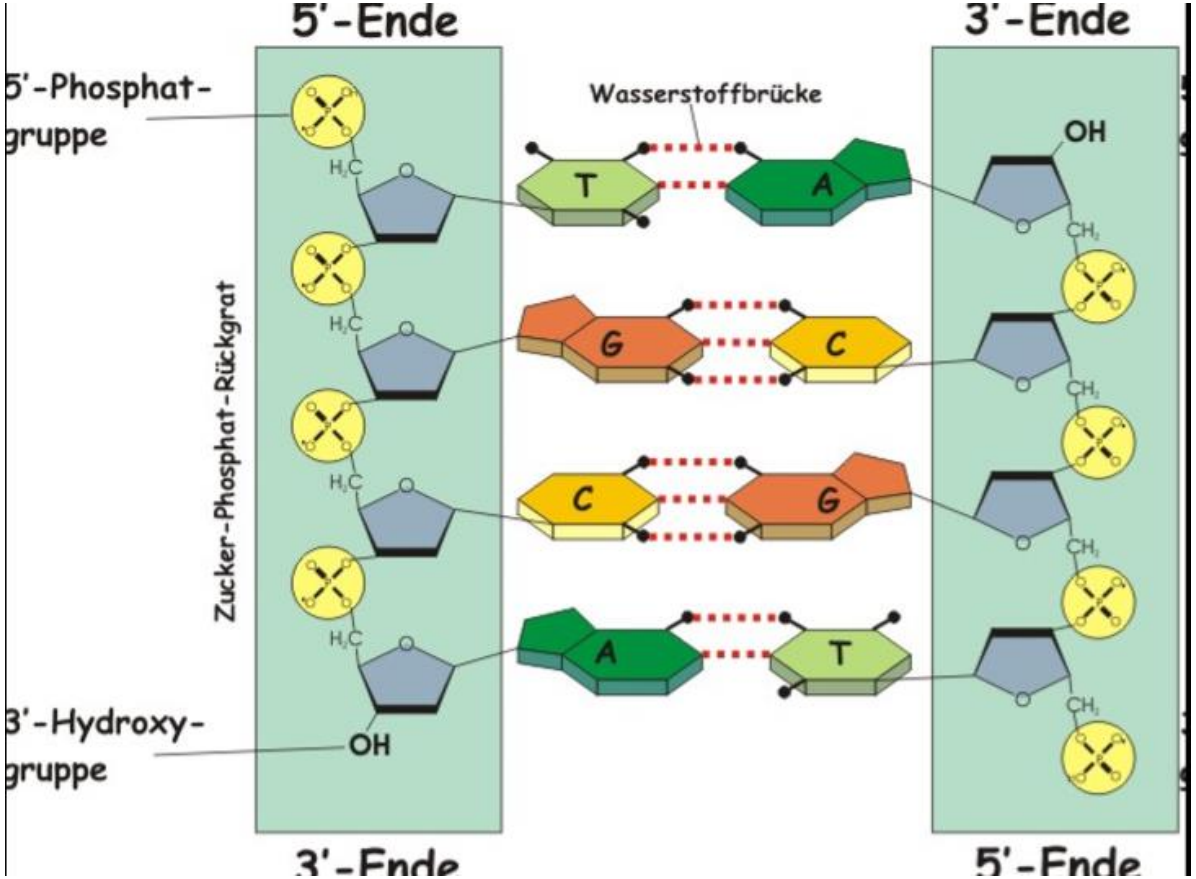
form between water molecules

weak bonds

break and reform easily

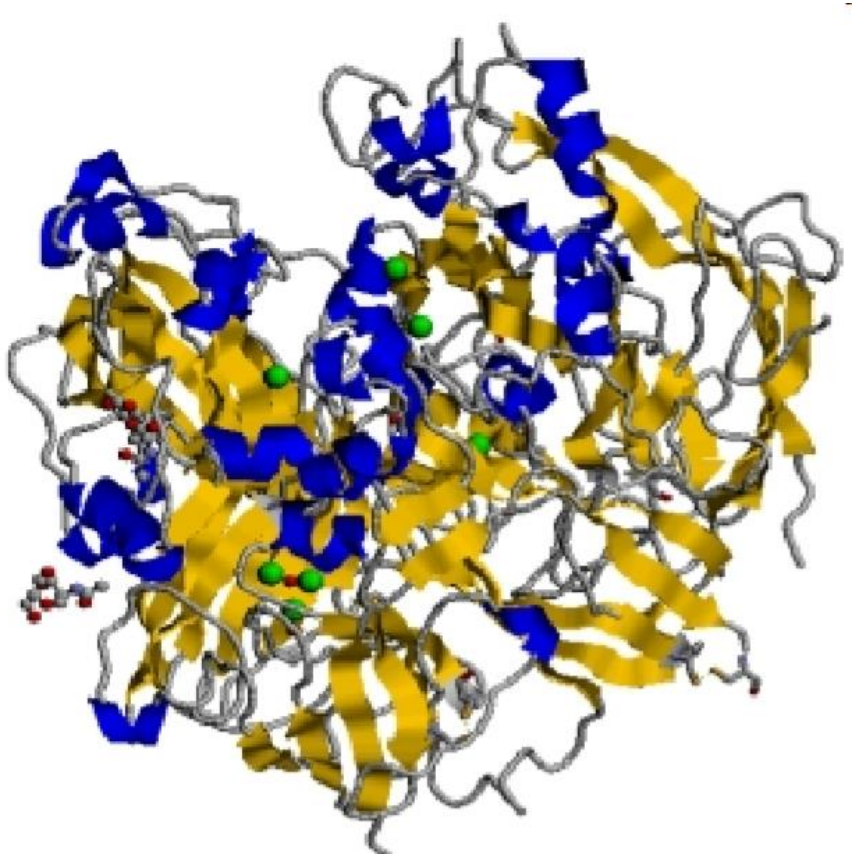


OTHER EXAMPLES FOR HYDROGEN BONDS



in DNA

OTHER EXAMPLES FOR HYDROGEN BONDS



in proteins

PROPERTIES OF WATER

Cohesion

Adhesion

Thermal properties

Solvent properties

COHESIVE PROPERTY OF WATER

Binding together of two molecules of the same type (e.g. two water molecules)

water molecules cohere = stick to each other because of hydrogen bonds.

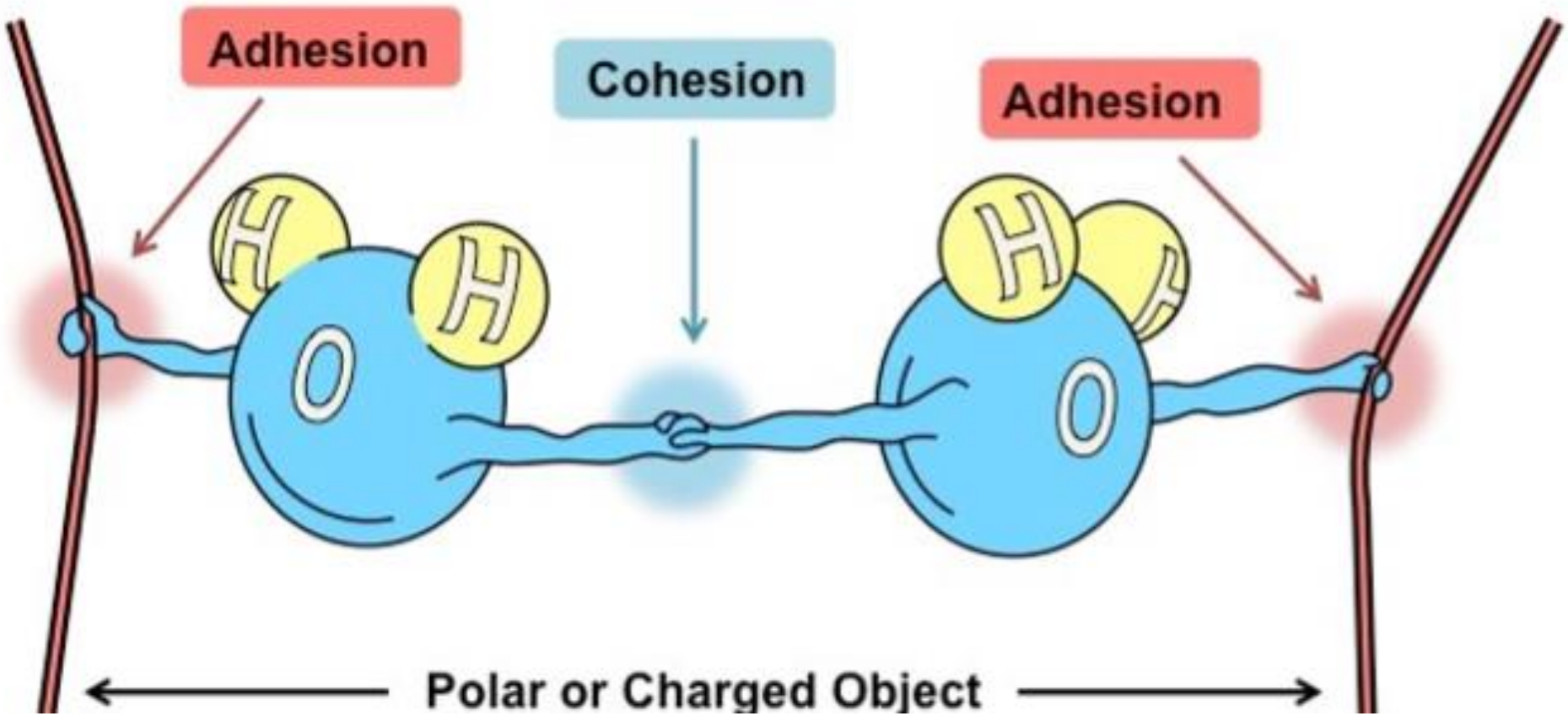
Example: Water transport in plants →water sucked through xylem vessels at low pressure. Water molecules not broken by suction force

ADHESIVE PROPERTY OF WATER

Hydrogen bonds can form between water and other polar molecules, causing water to stick to them.

Example: In leaves water adheres to cellulose molecules in cell walls. If water evaporates from cell wall and is lost from leaf → adhesive forces cause water to be drawn out of the nearest xylem vessel. → keeps the walls moist.

COHESION VS ADHESION



THERMAL PROPERTY OF WATER

A) High specific heat capacity

- **Hydrogen bonds restrict the motion of water.**
- **Increases in water temperature require hydrogen bonds to be broken.**
- **therefore → energy needed → lot of energy needed to raise water temperature, lose a lot of energy to cool down**

Example: Water's temperature remains relatively stable in comparison to air or land → thermally stable habitat for aquatic organisms.

THERMALPROPERTY OF WATER

B) High latent heat of vaporization

- **When a molecule evaporates → separates from other molecules in a liquid → becomes vapor molecule**
- **Heat needed to do that = latent heat of vaporization**
- **evaporation has cooling effect**
- **Huge amounts of heat needed → hydrogen bonds have to be broken**

Example: Water is a coolant, sweating is an example.

THERMALPROPERTY OF WATER

C) High boiling point

- **Boiling point = highest temperature that it can reach in a liquid state**
- **Water has got a high boiling point because of high latent heat of vaporization**
- **Therefore → water = liquid over broad range of temperatures**

Example: 0 – 100°C = temperature range found in most habitats on Earth.

SOLVENT PROPERTY OF WATER

Water forms shells around charged and polar molecules → prevents them from clumping together

Water forms hydrogen bonds with polar molecules

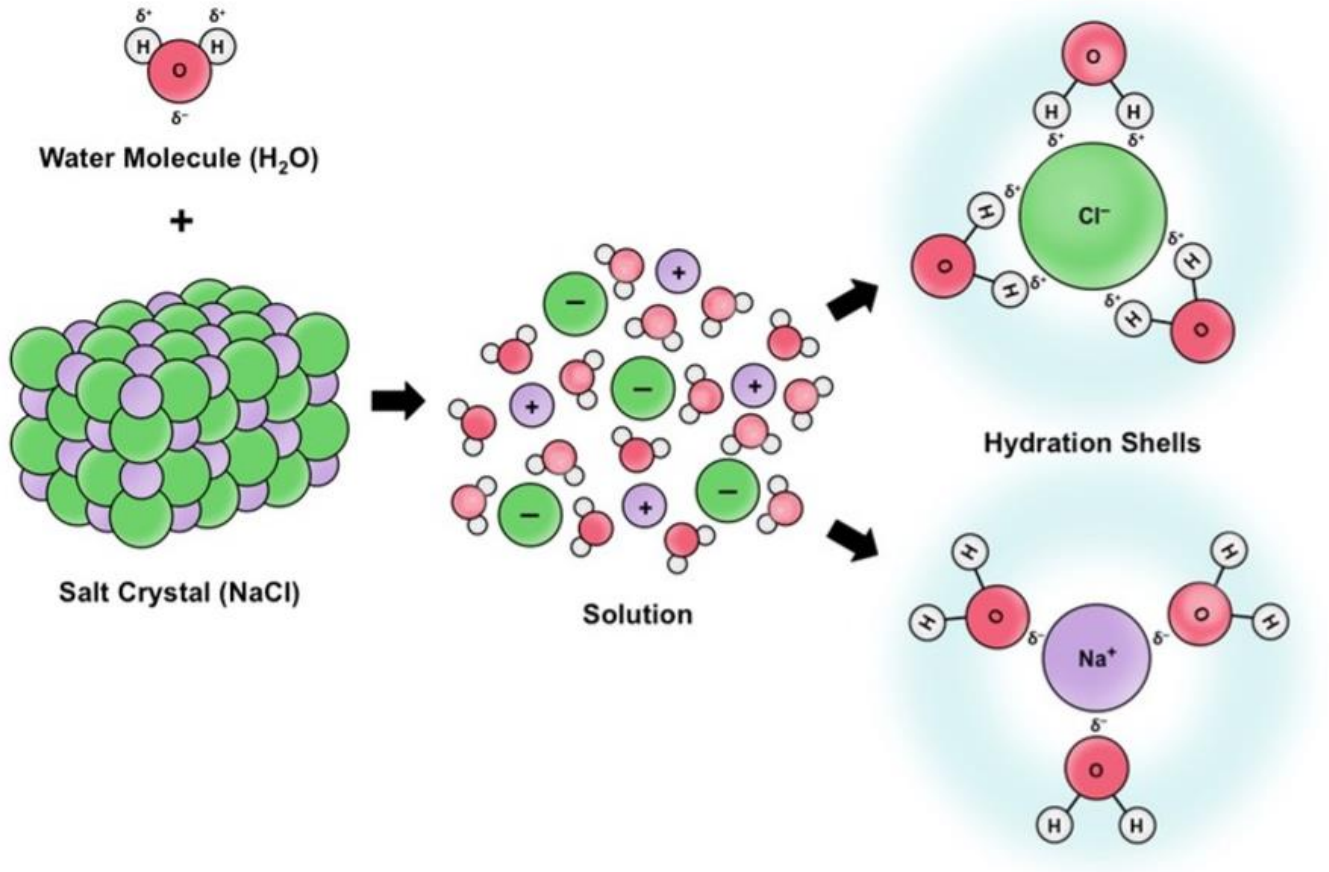
Partially negative oxygen pole is attracted to positively charged ions

Partially positive hydrogen pole is attracted to negatively charged ions

→so both dissolve

Example: Cytoplasm is a complex mixture of dissolved substances in which the chemical reactions of metabolism occur.

SOLVENT PROPERTY OF WATER



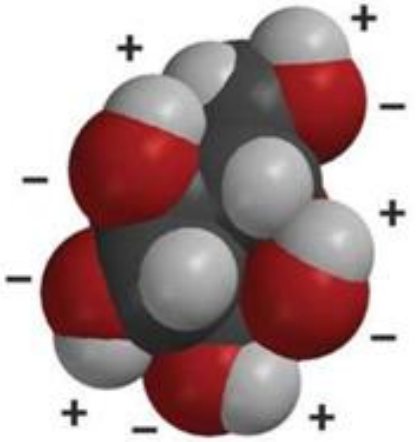
HYDROPHILIC AND HYDROPHOBIC

Hydrophilic = 'water-loving'

substance = chemically attracted to water

Examples:

- *substances that dissolve in water like glucose*
- *Substances with positive or negative charges (e.g. sodium + chloride)*
- *substances water adheres to like cellulose*



A space filling molecular diagram of glucose

Hydrophobic = 'water-fearing'

Insoluble in water but dissolve in other solvents like propanone (acetone)

Examples:

- *Non-polar,*
- *No charge*
- *All lipids including fats and oils*

BIOLOGICAL SIGNIFICANCE OF WATER PROPERTIES

Property	Attributes	Significance
Thermal	Extensive hydrogen bonding means water can absorb a lot of heat before changing state	Water is an excellent coolant (e.g. sweat) Water is a good medium for metabolic reactions (absorbs heat from exothermic reactions)
Cohesive	Dipolarity means water will stick to other water molecules (via H-bonds)	Water has a high surface tension, allowing small organisms to move on its surface (e.g. Basilisk lizard)
Adhesive	Dipolarity means water will stick to surfaces that are polar or charged	Water can move via capillary action against gravity (e.g. water can move up the xylem via transpiration)
Solvent	Dipolarity means water can dissolve molecules that are polar or charged	Water is a good transport medium (e.g. the blood system can transport soluble materials in its plasma)
Density	Water is less dense as a solid than as a liquid (maximum density ~ 4°C)	Ice floats on water (prevents oceans from freezing as ice layer prevents exposure to cold temperatures)
Transparency	Water is transparent to visible spectrum	Aquatic plants can undergo photosynthesis