Water Study Guide

A1.1.1 - Water as medium of life. *Students should appreciate that the first cells originated in water and that water remains the medium in which most processes of life occur.*

- State that the first cells originated in water.
- List reasons why water is a substance on which life depends

  Water is a solvent: dissolves other polar molecules. Helps transport molecules in body, is a medium for chem react. In body/life

  Water is metabolite: a product/reaction

  Water is temp. buffer

  Water is in cells

A1.1.2— Hydrogen bonds as a consequence of the polar covalent bonds within water molecules. *Students should understand that polarity of covalent bonding within water molecules is due to unequal sharing of electrons and that hydrogen bonding due to this polarity occurs between water molecules. Students should be able to represent two or more water molecules and hydrogen bonds between them with the notation shown to indicate polarity.*

- Describe the structure of an atom.

  Protons +, neutrons, electrons -
- Outline the formation of ionic and covalent bonds between atoms.

  Ionic: attraction between + - ion, not shared =

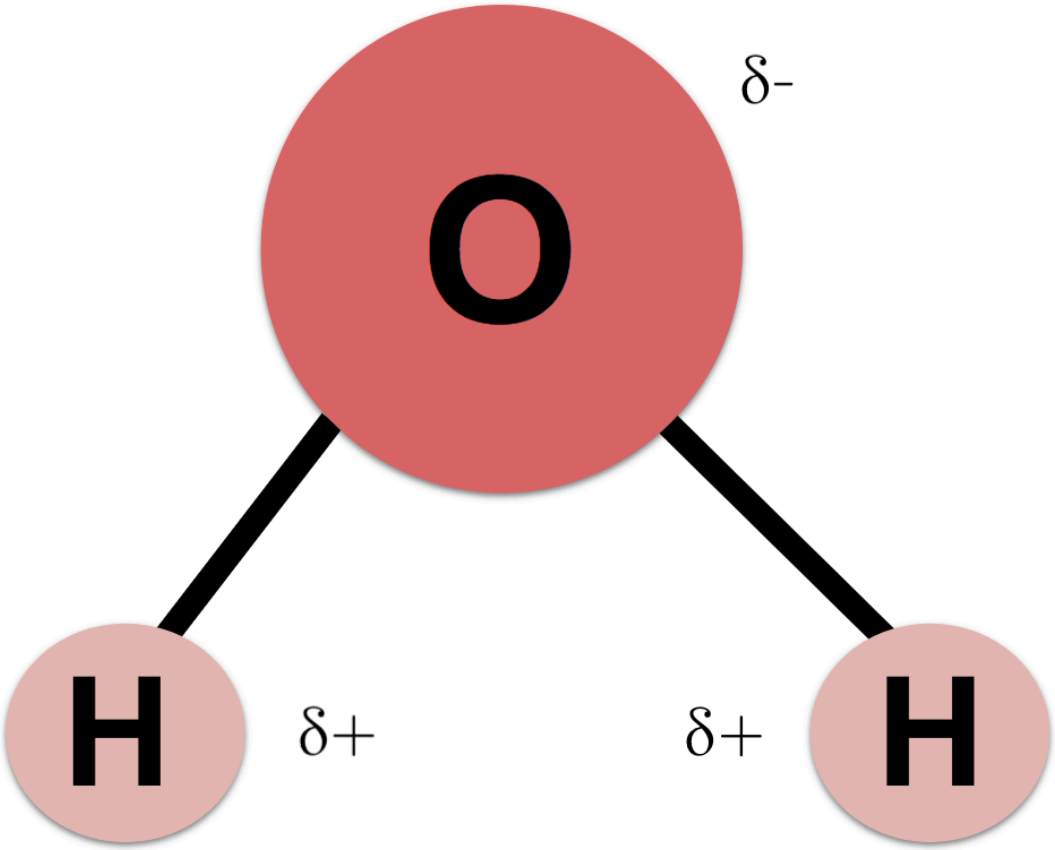
  Covalent: 1+ pair of electrons
- Explain the sharing of electrons between atoms in a polar covalent bond.

  Polar covalent: share electrons unequally
- State the location of the polar covalent bond within a water molecule.

  Bond of oxygen to hydrogen
- Explain the partial charges of the oxygen and hydrogen atoms within a water molecule.

  Oxygen -

  Hydrogen +
- Draw a water molecule, including notation to depict the partial charges of the atoms.



- Outline the cause of the formation of hydrogen bonds between water molecules.

  Hydrogen to oxygen repeated

  Not a real bond, just an attraction

- Outline the consequences of the collective strength of hydrogen bonds between water molecules.

  Hydrogen bond = surface tension (cohesion)

A1.1.3— Cohesion of water molecules due to hydrogen bonding and consequences for organisms. *Include transport of water under tension in xylem and the use of water surfaces as habitats due to the effect known as surface tension.*

- Define cohesion.

  Water molecules attracted to water molecules

- Describe how water moves through the xylem of a vascular plant.

Cohesion + adhesion help move water up

- Outline the cause of surface tension.

  Hydrogen bonds so strong, not attracted to other

- State a benefit to living things that results from surface tension.

  Bugs being able to walk on water and not drown

  seeds can spread away from parent

A1.1.4— Adhesion of water to materials that are polar or charged and impacts for organisms. *Include capillary action in soil and in plant cell walls.*

- Define adhesion.

  Water attracted with some other molecule

- Define polar.

  Unequal sharing of electrons

- Define ion.

  atom/group that has an electric charge

- Compare cation and anion.

  Cation: ion with positive charge

  Anion: ion with negative charge

- Explain why water is attracted to molecules that are polar or charged.

  H+ and O- attracted to opposite in other polar/charged

- Outline the cause of capillary action.

  Cohesion + adhesion = help water move up

- Describe capillary action in plant tissue.

  Cohesion + adhesion = help water move up and spread around plant

- Outline the cause and effect of capillary action in soil.

  cohesion + adhesion keeps water stuck within pores of soil

A1.1.5— Solvent properties of water linked to its role as a medium for metabolism and for transport in plants and animals. *Emphasize that a wide variety of hydrophilic molecules dissolve in water and that most enzymes catalyze reactions in aqueous solution. Students should also understand that the functions of some molecules in cells depend on them being hydrophobic and insoluble.*

- Identify solvent and solutes of a solution.

solvent: the liquid that dissolves solutes

solutes: the object that dissolves in the liquid

- Define solvation.

the action of a solute dissolving in a solvent

- Explain why water is able to dissolve charged and polar molecules.

due to the slightly charges from water molecules it attracts to other w polar

- Outline the solvation of hydrophilic and hydrophobic substances.

solvation hydrophilic: does mix with water molecules since different charges

solvation hydrophobic: doesn't mix with water bc they're non polar

- State an example of the function of a molecule depending on it being hydrophobic and insoluble.

lipids are an example that don't mix with water since they're non polar

- State an example of the function of a molecule depending on it being hydrophilic and soluble.

salts since they need to dissolve in water, for the body it helps dissolve minerals within the body to transport

- Outline the role of water as a medium for metabolism.

dissolves salts, fatty acids, sugar, amino acids, and proteins like enzymes

- Describe the role of water as a medium for transport in vascular plants.

transports mineral ions from roots to leaves

- Describe the role of water as a medium for transport in animal blood.

helps transport: salt ions amino acids proteins glucose waste products from metabolism

A1.1.6— Physical properties of water and the consequences for animals in aquatic habitats. *Include buoyancy, viscosity, thermal conductivity and specific heat capacity. Contrast the physical properties of water with those of air and illustrate the consequences using examples of animals that live in water and in air or on land, such as the black-throated loon (Gavia arctica) and the ringed seal (Pusa hispida).*

- Define physical property.

viscosity: how dense a liquid is to flow

buoyancy: the pressure that forces an object to float

thermal conductivity: ability to hold and move heat in an object

specific heat capacity: how much energy it takes for something to heat up

- List physical properties of water that are consequential for animals in aquatic habitats.

need viscosity to keep blood flowing within cold waters

need buoyancy to stay afloat without using too much energy

need thermal conductivity in order for animals to keep heat within body and not die of hyperthermia

need specific heat capacity so water stays an a stable temperature

- Outline the cause and effect of buoyancy.

if water is denser object will float

- Outline the cause and effect of viscosity.

amount of friction in molecules in liquid as they flow over each other making a liquid thick or not

(thick is more viscous, thin is less viscous)

- Compare viscosity of air to water to blood.

air is less viscous, water is more vicious than air, blood is more vicious than air and water

- Define thermal conductivity.

ability to hold and move heat within an object

- Compare less conductive to more conductive materials.

less conductive absorbs heat SLOWLY and feel less hot to the touch

more conductive absorbs heat QUICKLY and is hot to the touch

- Outline a consequence to life of the thermal conductivity of air and water.

heat is moving slowly within animal in water so it doesn't die of hyperthermia

- Define specific heat capacity.

how much energy it takes for heating up an object

- Describe why water has a high specific heat capacity.

it takes a lot of energy in order to break the millions of hydrogen bonds

- State two benefits to life of the high specific heat capacity of water.

water is at a stable temperature not too hot or too cold for animals who have adapted there, homeostasis within a person's body to keep it from not overheating or freezing

- Outline a benefit to life of water's high specific heat capacity.

temperature buffer

- Compare the physical properties of water to those of air.

water higher: buoyant force, viscosity, thermal conductivity, specific heat capacity

air lower: buoyant force, viscosity, thermal conductivity, specific heat capacity

- Describe how the black-throated loon (*Gavia arctica*) and/or the ringed seal (*Pusa hispida*) interact with the physical properties of water in their habitat.

black throated loon: buoyancy, keeps afloat in water w out using sm energy, air not vicious so can fly easily, thermal conductivity is low so doesn't lose that much body heat, specific heat capacity means temperature in air changes

ringed seal: buoyancy, keeps afloat in water w out using sm energy, water is viscous so seal adapted, thermal conductivity, so seal has fat to keep warm, specific heat is high temperature in water doesn't change so much

A1.1.7— Extraplanetary origin of water on Earth and reasons for its retention. *The abundance of water over billions of years of Earth's history has allowed life to evolve. Limit hypotheses for the origin of water on Earth to asteroids and reasons for retention to gravity and temperatures low enough to condense water.*

- Explain the hypothesis that asteroids are responsible for the origin of water on Earth.

asteroids held water in them then they crash onto earth

- State two reasons why water was retained on early Earth.

earth in goldilocks zone and gravity of earth kept it

A1.1.8— Relationship between the search for extraterrestrial life and the presence of water. *Include the idea of the "Goldilocks zone".*

- Explain why the presence of water is considered fundamental to the search for extraterrestrial life.

where water is life should follow

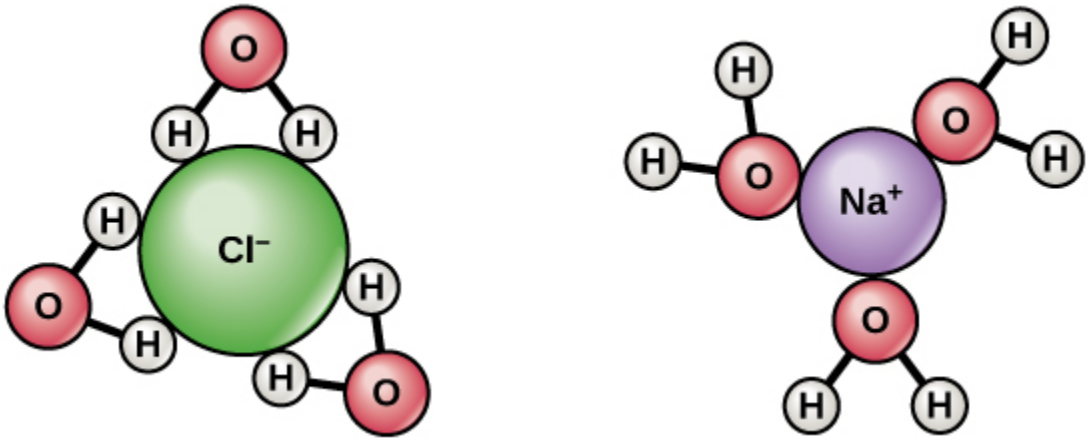
- Define "Goldilocks zone" in relation to the search for extraterrestrial life.

the zone where water can live on planet since it's just far away from the star's heat

D2.3.1— Solvation with water as the solvent. *Include hydrogen bond formation between solute and water molecules, and attractions between both positively and negatively charged ions and polar water molecules.*

Water has a unique force of attraction called Hydrogen bonding thanks to its high polarity and the fact that it contains an O–H bond

Since salts are charged ions, water easily dissolves them. They undergo hydration which is:



Water surrounds the negative ions with the positive sides and vice versa, keeping the salt dissolved

Sugars are also polar, which allows water to dissolve those too since polar dissolves polar things

This all helps organisms use water as a medium of solvation and transport of biomolecules since a lot of things are polar (sugars, polar amino acids, nucleic acids, etc.)