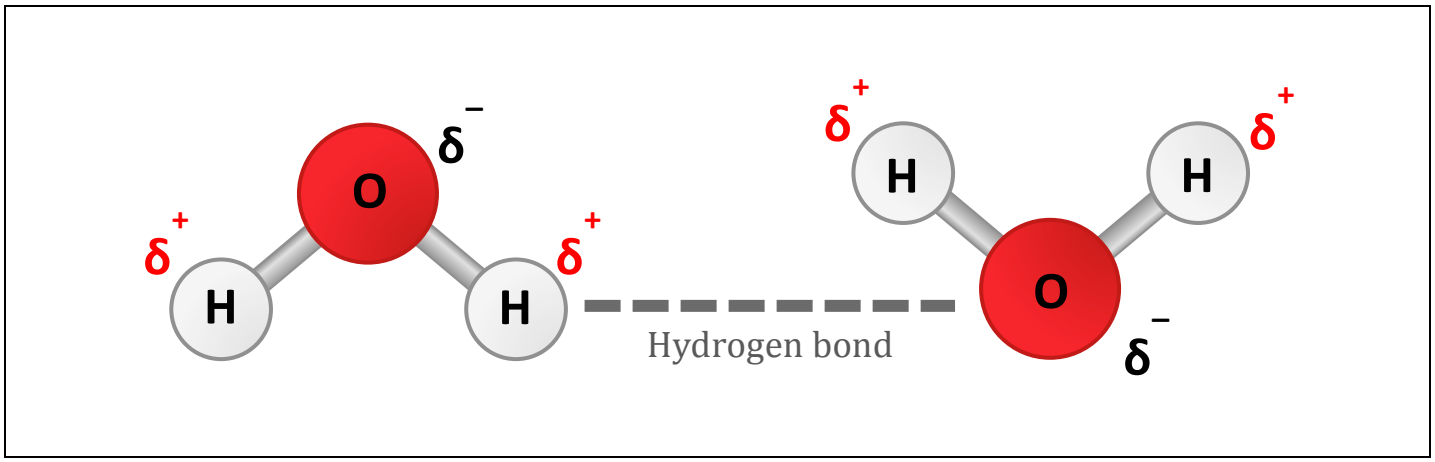
2.2 Water

Water Structure

Explain the polarity of water

- Water is made up of two hydrogen atoms covalently bonded to an oxygen atom
- The oxygen atom has a high electronegativity and attracts the shared electrons more strongly
- This results in polarity (the O atom is slightly negative, while the H atoms are slightly positive)
- Due to this polarity, water can form hydrogen bonds between the O of one molecule and the H of another

Draw a diagram of two water molecules, showing the intermolecular bonding between them



Water Properties

Distinguish between cohesion and adhesion with relation to water

Cohesion: Cohesion is when two identical molecules 'stick' together (via intermolecular bonding)

Water molecules are cohesive (they can 'stick' together via hydrogen bonding)

Adhesion: Adhesion is when two different molecules 'stick' together (via intermolecular bonding)

Water molecules are adhesive with polar or charged substances

Describe the biological significance of the cohesive and adhesive properties of water

- The cohesive properties of water results in water having a high surface tension (due to extensive H bonding)
- This is biologically significant as it allows small insects to move along the surface of water (e.g. water striders)
- The adhesive properties of water result in capillary action when in contact with charged or polar surfaces
- This is biologically significant as it allows for a transpiration stream in plants (flow of water against gravity)

Explain the thermal properties of water

- Water molecules can form extensive hydrogen bonding between molecules, which require energy to break
- This means it takes a lot of thermal energy (heat) to change the temperature (or state) of water
- Hence, water has a high specific heat capacity (and a high heat of vaporisation / fusion)

Describe the biological significance of the thermal properties of water

- Because water has a high specific heat capacity, it functions as an excellent biological coolant
- Sweating results in evaporative cooling, as ambient heat is absorbed to evaporate water (break H bonds)
- This cools the air surrounding the skin and also directly draws heat from the skin

Compare water (H_2O) and methane (CH_4)

Similarities:

- They have a similar size and molecular weight (water = 18 daltons, methane = 16 daltons)
- They have comparable valence structures (tetrahedral orbitals– although water is bent due to unbonded pairs)

Differences:

- Water has a significantly higher boiling point and melting point
- Water has a higher specific heat capacity (plus a higher heat of vaporisation / fusion)
- This is because water is polar and can form hydrogen bonds (methane is non-polar and doesn't form H bonds)

Distinguish between hydrophilic and hydrophobic

Hydrophilic substances are soluble in water (hydrophilic = water 'loving')

Hydrophobic substances are insoluble in water (hydrophobic = water 'hating')

Describe (with examples) how the solubility of molecules affects their mode of transport within the blood

- Ionic compounds (e.g. salt) dissociate in water and are transported within blood plasma in a dissolved state
- Glucose and other monosaccharides are water soluble and hence are transported freely within blood plasma
- Amino acids are zwitterions and can be freely transported within blood plasma in an ionised state
- Oxygen is soluble in water, but only in low amounts (most oxygen is complexed to haemoglobin in red blood cells)
- Lipids (fats and cholesterol) are non-polar and insoluble in water (they are transported in blood as lipoproteins)