Recap

We learnt about the nucleotide derivative ATP and how it's formed from ribose, adenine and three phosphate groups. You now understand how ATP hydrolysis leads to energy release and how ATP is synthesised by the enzyme ATP synthase.

1.7 Water

The Biological Importance of Water

- **Water makes up about 80% of a cell's contents**. Water has both intracellular (inside cells) and extracellular (outside cells) functions.
- **Water has some key functions**. The AQA specification asks you to know 5 main functions, which we will explore below.

Structure of Water

- **The chemical formula for water is H2O**. Water is made up of one atom of oxygen (O) and two atoms of hydrogen (H) and held together by **covalent bonds**.

Key Aims

1. *Biological Importance of Water.*
2. *Structure of Water.*
3. *Properties of Water.*

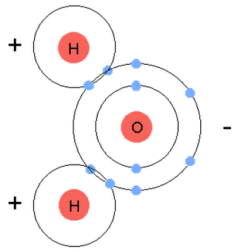

Fig 1. Chemical Structure of Water.

- **Water is a polar molecule**. The electrons that are shared in the covalent bond between oxygen and hydrogen are unevenly distributed. Oxygen attracts the electrons more, giving **oxygen a partial negative charge**, which then gives the **hydrogen atoms a partial positive charge**.

AQA Specification

Water is a major component of cells. It has several important properties in biology..

- **Hydrogen bonds form between water molecules**. Because water is a polar molecule, hydrogen bonds form between water molecules. The partially positive hydrogens of one water molecule are electrically attracted to the partially negative oxygen atom of another water

Study Mind **Tip**

A polar molecule is a molecule that has electrochemical properties and an electrical charge. A non-polar molecule is a molecule with no electrical charge (electrically neutral).

molecule. Many of the special properties of water are a consequence of its ability to form hydrogen bonds.

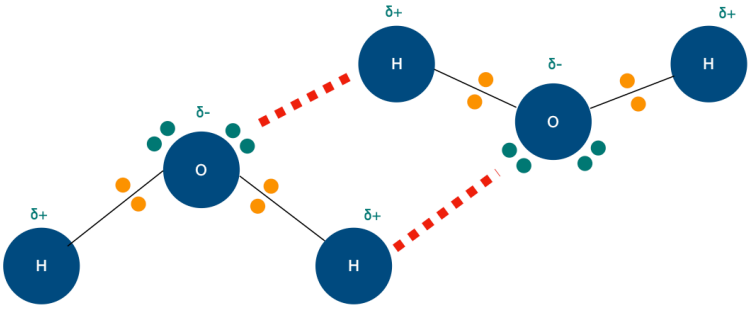

Fig 2. Hydrogen Bonds Between Polar Water Molecules.

AQA Specification

Water is a metabolite in many metabolic reactions, including condensation and hydrolysis reactions.

- **Metabolic reactions keep living organisms alive**.
  - A **metabolic reaction** is a biochemical reaction that takes place in living organisms in order to keep them alive.
  - A **metabolite** is a molecule that takes part in a metabolic reaction.

- **Water is a very important metabolite**. It is often a reactant necessary to start a metabolic reaction and is also often a byproduct of metabolic reactions.

- **Water is a key metabolite in condensation and hydrolysis reactions**. As we have seen numerous times so far already (e.g. condensation to make polymers such as polysaccharides and polypeptides).

Water as a Solvent

AQA Specification

Water is an important solvent in which metabolic reactions occur.

- **Many important biological molecules are either polar molecules or ionic molecules**. This means these molecules have some degree of electrical charge to them. In order for these molecules to function, they need to be dissolved in a polar solvent. Polar molecules cannot dissolve in non-polar solvents.

- **Water is a key solvent for many biological molecules**. Water's polarity makes it a very good polar solvent for many biological

Study Mind Tip

Go the extra mile in the exam. There's no harm in writing 5 points if the question has 3 marks (unless they specify that they want 3 functions of water). Also expand on your points - if you mention that water is a key metabolite in condensation reactions, then it is useful to list some examples of condensation reactions to impress the examiner.

molecules. For example, in ionic calcium chloride, the positive Ca2+ will be attracted to the negative pole of a water molecule, and Cl- will be attracted to the positive pole. Many metabolic reactions occur in water.

Latent Heat Capacity of Water

- **Most organisms require a specific temperature range in order for them to survive**. Drastic changes in temperature can often be lethal, especially to very small organisms.

- **Water has a high latent heat capacity**. The strength of the hydrogen bonds in water means that water has a high latent heat capacity. In order to vaporise water, these **hydrogen bonds** need to be broken, which requires quite a lot of energy.

- **Water vaporisation can be used for cooling down**. Water uses up a lot of heat when it evaporates, which is useful for many organisms because they can use water vaporisation as a thermoregulatory mechanism. When organisms sweat or transpire (sweating in plants), the vaporised water molecules carry away heat from the body.

- **The organism can cool itself without losing too much water**. However, because of the high latent heat capacity of water, the organism can cool itself down without losing too much water.

AQA Specification

Water has a relatively large latent heat of vaporisation, providing a cooling effect with little loss of water through evaporation.

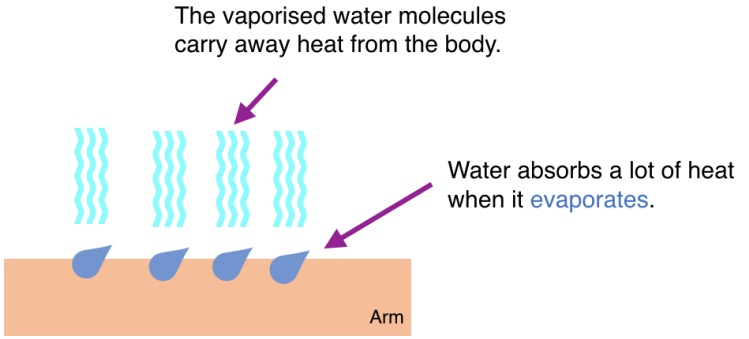

Fig 3. Water Vaporisation Can Be Used for Cooling Down. Water absorbs a lot of heat when it evaporates. When an organism sweats, the vaporised water molecules carry heat away from the surface of the body.

AQA Specification

Water has strong cohesion between water molecules; this supports columns of water in the transport cells of plants, and produces surface tension where water meets air.

Cohesion

Cohesion is defined as the attraction between the same type of molecule.

- **Water molecules have strong cohesion**. Water molecules are attracted to each other because of hydrogen bonds and are thus very cohesive.

- **Cohesion enables water to flow and transport**. This strong cohesive property of water is what allows water to flow, which is very important for transporting substances in many organisms. For example, in the xylem of plants, cohesion enables water to move up in columns against the force of gravity.

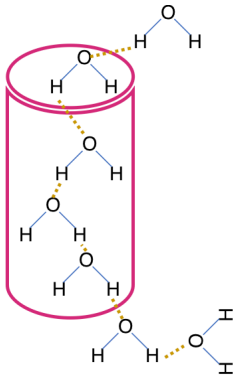

Fig 4. Cohesion of Water in the Xylem Of Plants. Cohesion enables water to move up in columns against the gravity.

AQA Specification

Water has a relatively high heat capacity, allowing it to buffer changes in temperature.

- **Cohesion produces surface tension where water meets air**. Small organisms use this to walk on water.

Specific Heat Capacity of Water

Specific heat capacity of water is the amount of heat energy (J) needed to raise the temperature of 1kg of water by 1 kelvin.

Knowledge Recall

1. *Does water have a low or high latent heat capacity and what is this due to?*
2. *Do water molecules have weak or strong cohesion?*
3. *Define specific heat capacity?*
4. *Does water have a low of high specific heat capacity?*

- **Water has a high specific heat capacity**. This means that a lot of energy is needed to change the temperature of water, so water has a reasonably constant temperature.
- **The ocean is a thermally stable habitat**. There is little temperature fluctuation in large volumes of water (e.g. oceans and lakes). This means that aquatic creatures can live in a stable environment.

- **Evaporation of water uses a lot of heat**. Evaporation requires a lot of heat energy to raise the temperature of water (e.g. during sweating). This helps cool an organism.