Teaching notes: Water

These teaching notes relate to section 3.1.7 of our AS and A-level Biology specifications. This resource describes key teaching points in the accompanying PowerPoint presentation.

Key points

- Water is a major component of cells.
- Water is a metabolite in many reactions (for example, condensation and hydrolysis reactions – section 3.1.1).
- Water is the solvent in which metabolic reactions occur (increases rate of collisions between reactant molecules).
- Water acts as a buffer against temperature changes.
- The evaporation of water has a cooling effect.
- Many of the properties of water relate to the ability of water molecules to 'stick together'.

PowerPoint presentation

Introduction (slide 1)

Ask students what they already know about the behaviour of water.

Water in biology (slide 2)

Water is the most common compound in organisms.

The table shows approximate values for a human and for a cell of *Escherichia coli*.

Questions for students:

- Q: Would you expect the water content of humans to be constant? If not, why not?

  A: For example, it will depend on how much water drunk recently, how much lost on sweating, less water first thing in the morning since water lost overnight in exhaled breath/sweating.

- Q: The cells of *E. coli* from which the data were obtained were rapidly dividing. What is the evidence from the table that this is the case?

  A: Relatively high content of DNA.

First bullet point

Students will learn about hydrolysis and condensation reactions (section 3.1.1).

Second bullet point

Question for students:

Q: What is the advantage of metabolic reactions taking place in solution?

A: Increases random movement of molecules and so increases rate of successful collisions between reactants (link to enzyme action, section 3.1.4.2).

This pond skater can walk on water (slide 3)

A pond skater is able to walk on water. We will find out why, when we look at the properties of water.

Water molecules are polar (slide 4)

This slide introduces the concept that water molecules are **polar** because the oxygen atom in each molecule pulls more strongly on the shared electrons than do the hydrogen atoms.

It also shows how a **hydrogen bond** forms between the differently charged components of each molecule – a δ^+ hydrogen of one molecule and the δ^- oxygen of another molecule.

Students who are also studying chemistry should be familiar with these concepts. You might need to reassure students taking biology as a contrasting subject that:

- they will **not** be expected to reproduce this diagram in a written examination
- the concept of weak hydrogen bonds crops up several times in the co-teachable Year 1/AS content (for example, complementary base pairing in DNA structure in section 3.1.5).

Hydrogen bonds (slide 5)

This slide shows how hydrogen bonds hold water molecules together and introduces the concept of **cohesion**. You might need to reassure students taking biology as a contrasting subject that:

- they will **not** be expected to reproduce this diagram in a written examination
- they will use their understanding of cohesion when learning about the cohesion-tension theory of water transport in plants (section 3.3.4.2).

Cohesion between water molecules (slide 6)

Even without an understanding of the underlying chemistry of the previous two slides, students should understand the concept of water molecules being held together by a force called **cohesion**. This idea can be reinforced by linking to 'sucking' a drink through a straw. We create a partial vacuum in our mouths and the column of water-based drink is pushed upwards by atmospheric pressure. Cohesion between water molecules prevents the column breaking.

Students will come across this idea later when studying the cohesion-tension theory of water movement in plants (section 3.3.4.2).

Water as solvent 1 (slide 7)

If not previously introduced, the concepts of hydrophilic and hydrophobic substances can be introduced here. The importance of these concepts will become apparent when studying transport across biological membranes (section 3.2.3) and absorption of products of digestion (section 3.3.3).

Water as solvent 2 (slide 8)

This slide provides pictorial representations of:

- polar ions (a)
- part of a polar group at the end of a larger molecule (b)
- part of a non-polar molecule (c).

The latter does not dissolve in water because it is not polar.

Cohesion of water molecules explains why (slide 9)

The values given here are **not** ones that students would be expected to give in a written examination. You might like to use them to compare the values from other compounds.

The important points here are that:

- by acting as a temperature buffer, the temperature of bodies of water, such as ponds, lakes or seas, do not vary as much as the air temperatures above them. This idea can be linked to the effect of temperature on enzyme-controlled reactions and the special significance for organisms not able to control their own temperature.
- by removing a large amount of heat when evaporating even a small amount of water, organisms are cooled. Although temperature regulation is not in the AS/A-level specifications, students can be reminded of the comprehensive coverage of this topic at GCSE (for example, the *evaporation* of sweat or the *evaporation* of water vapour from the tongue of a panting dog).

Questions for students

1. Give **two** properties of water that are important in biology. Explain the importance of each property you identify.

[4 marks]

2. The evaporation of water from the leaves of a plant results in columns of water being pulled up through its narrow xylem vessels.

2.1. Explain why this column of water does **not** break.

[3 marks]

2.2. Explain **one** other effect on the plant caused by the evaporation of water from its leaves.

[2 marks]

3.1 Explain the meaning of the terms hydrophilic and hydrophobic.

[2 marks]

3.2 Give **one** example of a hydrophilic substance and **one** example of a hydrophobic substance.

[2 marks]

4. Organisms that live on land usually experience greater ranges of environmental temperature than do organisms that live in water. Explain why.

[2 marks]

5. Most substances contract when they cool. Water is unusual. As it freezes, it expands, becoming lighter.

5.1. Suggest why water becomes lighter as it expands.

[2 marks]

5.2. Suggest **one** biological advantage of this property of water.

[2 marks]

6. Scientists looking for extra-terrestrial life are looking for planets with evidence of free water. Explain why water is considered so important for life to occur.

[6 marks]

The guide mark scheme for these student questions is available in e-AQA through Secure Key Materials.