The polarity of water molecules results in hydrogen bonding.

"Water is so common that it is easy to overlook the fact that it is an exceptional substance with many extraordinary qualities. Following the theme of emergent properties, we can trace water's unique behavior to the structure and interactions of its molecules." (p. 46)

"The properties of water arise from attractions between these **polar molecules**. The attraction is electrical; the slightly positive hydrogen of one molecule is attracted to the slightly negative oxygen of a nearby molecule. The two molecules are thus held together by a hydrogen bond (Figure 3.2). Although the arrangement of molecules in a sample of liquid water is constantly changing, at any given moment, many of the molecules are linked by multiple hydrogen bonds." (p.47)

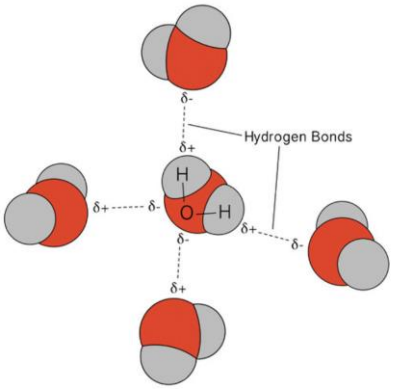


Figure 3.2 Hydrogen bonds between water molecules. The charged regions of a polar water molecule are attracted to oppositely charged parts of neighboring molecules. Each molecule can hydrogen–bond to multiple partners, and these associations are constantly changing. At any instant in liquid water at 37ºC (human body temperature), about 15% of the molecules are bonded to four partners in short–lived clusters.

Bozeman Biology, Water's Life Supporting Properties : http://www.youtube.com/watch?v=ZScEgE55XTM

Four emergent properties of water contribute to Earth's fitness for life

"We will examine four of water's properties that contribute to the suitability of Earth as an environment for life. These are water's cohesive behavior, its ability to moderate temperature, its expansion upon freezing, and its versatility as a solvent." (p. 47)

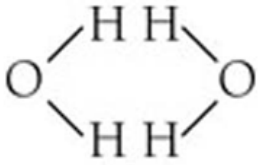
Concept Check 3.1

1. What is electronegativity, and how does it affect interactions between water molecules?
   [See page 39 and Figure 2.13.]

Electronegativity is the tendency of an atom to attract a shared electrons

2. Why is it unlikely that two neighboring water molecules would be arranged like this?

Each hydrogen atom in the molecule has a partial positive charge (δ^+). This would cause the H atoms to repel each other. Instead, the hydrogen prefers to orient itself to the O atom. This is because the O atom has a partial negative charge (δ^-).



What If?

What would be the effect on the properties of the water molecule if oxygen and hydrogen had equal electronegativities?

There would be an even sharing of the paired electrons. Water would behave like a nonpolar molecule.

Advanced Biology: Chapter 3, *"Water & the Fitness of the Environment"*

Complete the table below. Explain how the polarity of water molecules results in the life-supporting property of water.

Life-supporting property of water	***Description of the property***	***How the property aids organisms***	***Adaptations that take advantage of water's life-supporting property***
Adhesion/Cohesion → Surface tension	• Cohesion is the attraction between water molecules due to hydrogen bonds • Adhesion is the attraction between water molecules and other molecules which helps create surface tension • Surface tension is a measure of how difficult it is to stretch of break a liquid	• Cohesion due to hydrogen bonds contributes to the transport of water and dissolved nutrients against gravity • Water moving up from the roots of plants to the leaves as a result of capillary action is because of adhesion. • Insects can walk on water because of cohesion and surface tension.	
High specific heat	• Specific heat of a substance is defined as the amount of heat that must be absorbed or lost for 1 g of a substance to change its temperature by 1°C	• Water is used by warm-blooded animals to more evenly disperse heat in their bodies and resist temperature changes. • A large body of water can absorb and store a huge amount of heat while warming only a few degrees • High specific heat tends to stabilize ocean temperatures	
High heat of vaporization	• The quantity of heat a liquid must absorb for 1 gram of it to be converted from the liquid to the gaseous state • Water has a high heat of vaporization. As liquid water heats up, hydrogen bonding makes it difficult to separate the liquid water molecules from each other.	• In many living organisms, the evaporation of sweat allows organisms to cool to maintain homeostasis of body temperature. • Evaporation of water from leaves of a plant helps keep the tissues from becoming too warm in sunlight • Helps moderate earth's climate and contributes to the temperature stability in lakes and pool	

Advanced Biology: Chapter 3, *"Water & the Fitness of the Environment"*

Life-supporting property of water	*Description of the property*	*How the property aids organisms*	*Adaptations that take advantage of water's life-supporting property*
Lower density as a solid	• Water is one of the few substances that are less dense as a solid than as a liquid • Water's lower density in its solid form is due to the orientation of hydrogen bonds as it freezes: the water molecules are pushed farther apart compared to liquid water.	• The lower density of ice compared to liquid water allows it to float on water – If ice sank lakes and ponds would eventually freeze solid • In lakes and ponds, ice will form on the surface of water creating an insulating barrier that protects the animals and plant life in the pond from freezing.	
Versatile solvent	• Water is a polar molecule. Due to the electronegativity difference between hydrogen and oxygen, electrons spend more time around the oxygen. As a result, water molecules surround charged molecules, shield them from one another	• Water dissolves compounds such a salt [NaCl] and sugars allowing them to be transported. • Many different kinds of polar compounds are dissolved in water of biological fluids such a blood, the sap of plants and the liquid within all cells.	