Section Summary

Atoms, which consist of protons, neutrons, and electrons, are the smallest units of an element that retain all of the properties of that element. Electrons can be donated or shared between atoms to create bonds, including ionic, covalent, and hydrogen bonds. Chemical bonds differ in their strengths and lead to the formation of molecules. Hydrogen bonds give water the unique properties that sustain life.

Exercises

1. In the below reaction what is the reactant?

   $2H_2O_2$ (hydrogen peroxide) → $2H_2O$ (water) + O_2 (oxygen)

2. Positive ions are formed by losing electrons and are called:
   a. anions
   b. polar molecules
   c. water
   d. cations

3. Which type of bond represents a strong chemical bond where electrons are shared unequally?
   a. hydrogen bond
   b. ionic bond
   c. polar covalent bond
   d. nonpolar covalent bond

4. Compare and contrast ionic and covalent bonds.

5. Hydrogen bonds are weak bonds yet they play an important role in holding the two strands of DNA together. Hypothesize why it would be important that a weak bond is used in this example vs. a strong bond.

Answer

1. Hydrogen peroxide
2. (d)
3. (c)
4. Ionic and covalent bonds both allow for atoms to become more stable and result in the synthesis of molecules and/or chemical compounds. Ionic bonds are chemical bonds that form between ions of opposite charges whereas covalent bonds are a result of atoms sharing pairs of electrons.
5. Hydrogen bonds form weak bonds between different molecules. Before a cell can reproduce it must make a copy of its DNA. If strong bonds were used to hold the two strands together, instead of the weaker hydrogen bonds, the cell would need to invest a lot more energy into reproduction order to first break these bonds.

Glossary

anion: a negative ion formed by gaining electrons

cation: a positive ion formed by losing electrons

chemical bond: an interaction between two or more of the same or different elements that result in the formation of molecules

chemical formula: shows how many and which atoms make up a molecule

compound: are made up of different types of atoms held together by chemical bonds

chemical reactions: occur when two or more atoms bond together to form molecules or when bonded atoms break apart

covalent bond: a type of strong bond between two or more of the same or different elements; forms when electrons are shared between elements

electronegativity: an atom's ability to attract a shared pair of electrons more closely to its own nucleus

electron transfer: the movement of electrons from one element to another

hydrogen bond: a weak bond between partially positively charged hydrogen atoms and partially negatively charged elements or molecules

ion: an atom or compound that does not contain equal numbers of protons and electrons, and therefore has a net charge

ionic bond: a chemical bond that forms between ions of opposite charges

nonpolar covalent bond: a type of covalent bond that forms between atoms when electrons are shared equally between atoms, resulting in no regions with partial charges as in polar covalent bonds

polar covalent bond: a type of covalent bond in which electrons are pulled toward one atom and away from another, resulting in slightly positive and slightly negative charged regions of the molecule

products: the substances that are formed at the end of a chemical reaction (usually on the right side of a chemical equation

reactants: the substances used at the beginning of a chemical reaction (usually on the left side of a chemical equation)

2.3 Water

Learning objectives

By the end of this section, you will be able to:

- *Describe the properties of water that are critical to maintaining life*
- *Explain why water is an excellent solvent*
- *Provide examples of how water is cohesive and adhesive*
- *Be able to define and explain all bolded terms*

Do you ever wonder why scientists spend time looking for water on other planets? The reason is simple; water is essential to life. Even minute traces of water on another planet can indicate that life could or did exist on that planet. Water is one of the more abundant molecules in living cells and the most critical to life as we know it. Approximately 60–70 percent of your body is made up of water. Without it, life simply would not exist.

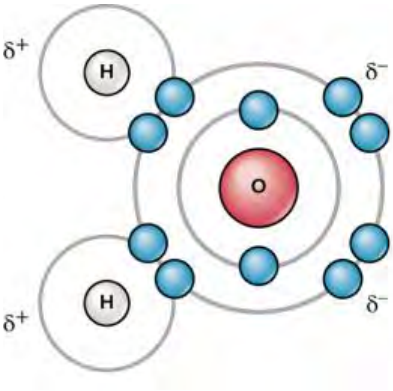

Figure 2.22 The water molecule depicts a polar covalent bond. (credit: modified from Parker et al./Microbiology OpenStax)

The hydrogen and oxygen atoms within water molecules form polar covalent bonds. The shared electrons spend more time associated with the oxygen atom than they do with hydrogen atoms. There is no overall charge to a water molecule, but there is a slight positive charge on each hydrogen atom and a slight negative charge on the oxygen atom (Figure 2.22). Because of these charges, the slightly positive hydrogen atoms repel each other and form a unique shape. Each water molecule attracts other water molecules because of the positive and negative charges in the different parts of the water molecule (Figure 2.23).

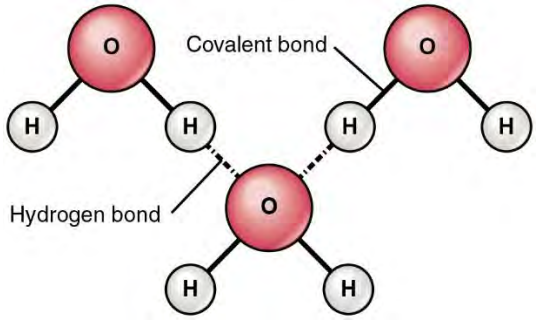

Figure 2.23 Hydrogen bonds form between slightly positive (δ+) and slightly negative (δ–) charges of polar covalent molecules, such as water. (credit: Betts et al. / Anatomy and Physiology OpenStax)