

## Chapter 2

### The Chemical Basis of Life I: Atoms, Molecules, and Water

#### Instructional Strategies and Activities

- If you like to include physically dynamic activities, you can have students act out chemical bonds and reactions. Print out sheets with large font characters, including plusses and minuses to represent protons and electrons and letters to represent elements. Have volunteers tape the paper with the symbols to their chests. Then have the students work out a short play to illustrate the specified bond or reaction.
- To illustrate the different types of chemical bonds, you could compare covalent bonds to links in a chain, ionic bonds to magnets, and hydrogen bonds to static cling.
- In order to help students understand the importance of the properties of water for living organisms, you could have them debate which property of water is most important to life. You could assign one property to a group of students and then have each group argue why theirs is most important.
- To illustrate adhesion and cohesion it often helps to relate these phenomena to everyday life. For example, ask students to think about how Jet Dry™ works or why waxing results in water beading on the hood of a car.
- Instructors might want to have students think about why the transition from water to ice is so detrimental to most organisms. This could be the perfect time to address the Walt Disney urban myth! Why are we unable to freeze a human body (cryonics) and later revive the individual with our current level of technology? You may wish to follow this up with a question about how certain organisms can withstand extremely low temperatures, such as tardigrades which have survived exposure to  $-272^{\circ}\text{C}$ .
- Antioxidants prevent cellular damage from free radicals. Ask students for the names and sources of the antioxidants they know. Also mention that antioxidants have commercial value, especially in retarding rancidity of fats and oils. It also might bear mentioning that coffee and dark chocolate have recently been found to contain large amounts of antioxidants!

#### Student Misconceptions

- Students may wonder why the symbols on the periodic table do not match the names of the elements. Sometimes the symbols are derived from the element's Latin name, while students are familiar with the English version.

Some examples include:

<u>Symbol</u>	<u>Latin Name</u>	<u>English Name</u>
Au	Aurum	Gold
Na	Natrium	Sodium
K	Kalium	Potassium

- Often students equate pH with a scale of acidity, and draw the erroneous conclusion that higher numbers on the pH scale mean greater acidity. Make sure that students understand that the pH scale is a quantitative measure of both acidity and alkalinity of solutions by measuring the hydrogen ion concentration. This might be a good time to review scientific notation with your students. By seeing that  $10^{-11}$  is a smaller number (thus fewer hydrogen ions) than  $10^{-2}$ , a student may understand what the 11 and 2 represent on the pH scale.
- You may also wish to stress the logarithmic nature of the pH scale. Students have a hard time understanding that a one point change on the pH scale indicates a tenfold change in hydrogen ion concentration.

### **Beyond the Book**

- If the nucleus of an atom was the size of a marble, then the body of the whole atom would be approximately the size of a football field, with slight variations based on the number of subatomic particles.
- Not only are radioisotopes used for biological research and medical procedures, they are also utilized for industrial purposes. Radioisotopes can function as energy sources for spacecraft and pacemakers, as well as functioning like large x-ray machines to search for structural flaws in large-scale equipment.
- Sodium is a metal that is very reactive with water. In fact, the hydrogen produced when sodium interacts with water can ignite from the heat released by the reaction. However, when combined with chlorine (a toxic gas), it forms a mineral that is almost 80% of the constituents of saltwater.
- Although hydrogen, nitrogen, carbon and oxygen make up nearly 95% of the atoms in living organisms, some of these elements are not so common on Earth. Carbon only makes up 0.025% of the Earth's crust by weight, while hydrogen is only 0.44%. However, hydrogen is the most abundant element in the galaxy, and nitrogen is the sixth most abundant cosmic element.

## Additional Web Resources

- WebElements™ Periodic Table – Students can click on an element to be taken to a webpage with information on the element. This site also provides a scholar version geared towards university-level students.  
<http://www.webelements.com/>
- pH Scale – Animated pH scale that provides a visual illustration of the molecules in a neutral solution and a sliding scale of pH.  
<http://www.johnkyrk.com/pH.html>
- Cn3D – Free software from NCBI for viewing molecular structure in 3D, and includes verbal summary of structural features.  
<http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml>
- World Index of Molecular Visualization Resources – A website devoted to collecting links to available molecular visualization and modeling sites. Links are sorted by author, title or subject.  
[www.molvisindex.org](http://www.molvisindex.org)
- USGS Water Science for Schools – A USGS site that includes the properties of water, common measuring techniques and the Earth's water cycles.  
<http://ga.water.usgs.gov/edu/mwater.html>

## Etymology of Key Terms

amphi-	two; both (from the Greek <i>amphi-</i> on both sides)
ana-	up; back (from the Greek <i>an-</i> up)
cat-	down (from the Greek <i>kata-</i> down)
colligative	depending upon the number of molecules not the specific type (from the Latin <i>colligatus-</i> tying together)
hydro-	of, or pertaining to, water (from the Greek <i>hydor-</i> water)
ion	an electrically charged atom or group of atoms (from the Greek <i>ion-</i> going)
electro-	pertaining to or involving electricity (from the Greek <i>electron-</i> amber)
equi-	equal (from the <i>Latin aequus-</i> equal)
-gen	that which produces (from the Greek <i>genes-</i> born or produced)

libri	balance (from the Latin <i>libra</i> - balance)
lys (lysis)	dissolution; breaking (from the Greek <i>lysis</i> - dissolution)
neutro-	neutral; having no charge or affiliation (from the Latin <i>neuter</i> -neither)
-pathic	feeling; suffering (from the Greek <i>pathos</i> - suffering or feeling)
proto-	first (from the Greek <i>protos</i> - first)
radio-	dealing with radiant energy; emitting rays (from the Latin <i>radius</i> -ray)
solute	substance dissolved in a solution (from the Latin <i>solutus</i> , past participle of <i>solvere</i> - to loosen)
solvent	a substance that dissolves another to form a solution (from the Latin <i>solvent</i> , the stem of <i>solvens</i> , which is the present participle of <i>solvere</i> - to loosen)