Lesson 6: Water: Structure & Properties

I. Time: 50 minutes

II. Materials:

III. Objectives:
   After successful completion of the lesson, students will be able to:
   a. Describe and draw the atomic and molecular structure of water
   b. List and describe the properties of water
   c. Define cohesion and adhesion
   d. Explain the dependence of living systems on the properties of water
   e. Make and present a model of a hydrogen bond in water

Maryland State Objectives:
   a. Expectation 1.5: The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.
      i. Indicator 1.5.5 The student will create and/or interpret graphics. (scale drawings, photographs, digital images, field of view, etc.)
   b. Expectation 3.1: The student will be able to explain the correlation between the structure and function of biologically important molecules and their relationship to cell processes.
      i. Indicator 3.1.1: The student will be able to describe the unique characteristics of chemical substances and macromolecules utilized by living systems.
      ii. Indicator 3.1.2: The student will be able to discuss factors involved in the regulation of chemical activity as part of a homeostatic mechanism.
   b. Expectation 3.2: The student will demonstrate an understanding that all organisms are composed of cells which can function independently or as part of multicellular organisms.
      i. Indicator 3.2.2 The student will conclude that cells exist within a narrow range of environmental conditions and changes to that environment, either naturally occurring or induced, may cause changes in the metabolic activity of the cell or organism.
   c. Expectation 3.5: The student will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.
      i. Indicator 3.5.1: The student will analyze the relationships between biotic diversity and abiotic factors in environments and the resulting influence on ecosystems.

IV. Lesson:
   a. Opening: (5 minutes)
      i. Have student make some observations of what happens when different substances are mixed with water on a T-chart. Have beakers of sand, oil, salt, sugar, drink, mix, and a reactive alkali metal (such as sodium, potassium, or lithium). Write the name of these substances on the left of the T-Chart and put observations on the right. One at a time, poor these substances into water. Have students observe the results.
      ii. Use the demonstration to start a conversation on the properties of water. Ask the students if they can explain why some reacted and others did not. Yesterday the focus was on the reactive nature of water as a chemical. Tell students that the focus of water today will be its “stickiness” or ability to bond with other substances. Sometimes this ability of water will chemically break down things or just make them wet.
      iii. Ask the students to summarize what was learned about chemicals during the past two lessons. Ask them if they can describe the properties of water. Tell them that they will learn about the properties of water in detail today and have a lab on them during the next lesson.
   b. Development:
      i. Pass out the handout “Water: Structure & Properties”.
      ii. Using a computer, bring up the PowerPoint file “Water: Structure & Properties”
      iii. Have the students work in pairs or small groups to answer questions 1-3. You may wish to review the answers with the class. (5 minutes)
iv. Show the presentation and have students follow along on their handouts and fill in the missing words on the blanks. (15 minutes)
   1. Slide 1 – Tell students that we will be looking at specific structure and properties of water. Ask the students what they know about the properties of water.
   2. Slide 2 – Ask the students what a compound is. Emphasize the terms compound and molecule.
   3. Slide 3 – Ask the students what a covalent bond is before revealing the answer. Ask them how this is different than an ionic bond.
   4. Slide 4 – Tell the students that atoms don’t “want” complete shells but having complete shells is more stable and is what naturally tends to happen.
   5. Slide 5 – It may help to draw a molecule of water on the board to demonstrate these charges. Students do, however, have a diagram to look at later.
   6. Slide 6 – Ask students how water might react with non-ionic compounds.
   7. Slide 7 – Emphasize that hydrogen bonding is strictly talking about positive charges on hydrogen atoms and is not simply a polar charge.
   8. Slide 8 – If students didn’t guess earlier, cohesion is one answer to the previous question about water bonding to a non-ionic substance.
   9. Slide 9 – Adhesion is another answer to that question. Ask students to give other examples of water adhesion in biology.
  10. Slide 10 – Ask the students what would happen to the earth if ice was more dense than water.
  11. Slide 11 – Ask students to think about how high specific heat is demonstrated in the earth’s oceans as seasons change.

v. Have students work in pairs on question 13. Once they have finished, have each student present their drawings to a classmate. You may want to select a few good ones and have them presented to the rest of the class. (15 minutes)

c. Closing:
   i. Engage a class discussion on the properties of water. Have students summarize the main points and the take 5 minutes to think about how these properties relate to functions within living systems. You may want to have the students write these down on a sheet of paper and then later present them to the class. (10 minutes)

V. Suggested Assessments:
   a. Have students draw two water molecules and then cut them out and paste them on a new sheet of paper so that the molecules are aligned to show a hydrogen bond. Also have them label each atom and show partial charges.
   b. Student completion of “Water: Structure & Properties” handouts will assess the above objectives.

VI. Related Links/Resources:
   a. The United States Geological Survey website features a lot of information and activities in regard to water. The webpage on water properties at [http://ga.water.usgs.gov/edu/waterproperties.html](http://ga.water.usgs.gov/edu/waterproperties.html) gives good information and simple diagrams to explain hydrogen bonding in water and may be a useful resource for student activities.