# Chapter 2: Chemistry comes to Life

## Learning Objectives

After reading the textbook and studying the material in this chapter, the student should be able to:
Describe the characteristics of the subatomic particles (protons, neutrons, and electrons) and explain the structure of an isotope.
Differentiate between covalent, ionic, and hydrogen bonds in terms of strength and the actions of the electrons.
List the unique properties of water that make it valuable to biological systems.
Predict what happens when an acid or a base is added to water.
Define *pH*, explain the range of the pH scale, and tell which values indicate acid and which values indicate base.
Describe the structure of a polymer, including its formation through dehydration synthesis and its breakdown through hydrolysis.
Describe the structure and biological purpose of carbohydrates, lipids, proteins, and nucleotides and give an example of each.
Describe ATP as the energy currency of the cell.

## Chapter 2 Group Activities

### Group Activity 1: Interpreting Nutrition Labels

**Estimated Time to Complete:** 15 to 20 minutes

**Learning Objective:**

Describe the structure and biological purpose of carbohydrates, lipids, proteins, and nucleotides and give an example of each.

**Introduction:** In this chapter, students have learned about biological molecules such as carbohydrates, proteins, and lipids and their importance to the human body. This activity allows students to relate this information to nutritional labels. Students will be provided with two nutritional labels and be asked to compare the labels and analyze each product for its nutritional content.

**Materials:**

Provide each group of students with a copy of two nutritional labels (without the name of the product listed). One should be from a "healthy" food and the other from a junk food. They should both have detailed fat information (total, saturated, mono, and polyunsaturated) and carbohydrate information (sugar, fiber, and complex carbohydrates).

**Procedure:**

Break class into groups of 3 to 5 students and provide each group with a copy of the two nutritional labels. Ask students to begin comparing the two products to ultimately come to a conclusion concerning which product would be a healthier choice and why.
Have the students make a list of the criteria they used to evaluate each product.

Go over the results as a class. Ask each group to reveal what information ultimately led it to its conclusions. This might include things such as calorie content, total fat content, saturated fat content, amount of sugar, amount of fiber, and so forth.
Ask students what it means if the product contains *trans* fats.

Make sure to correct any misconceptions about the labels and explain that the topic of nutrition will be revisited in a later chapter.

**Assessment Suggestions:** Ask students to analyze the nutrition label on a food product of their choice.

## Group Activity 2: Debating the Pros and Cons of Food Irradiation

**Estimated Time to Complete:** 20 to 40 minutes, based on whether students have completed a pre-assignment (which will decrease class time needed) and how much detail you would like to go into.

**Learning Objective:**

Describe the characteristics of the subatomic particles (protons, neutrons, and electrons) and explain the structure of an isotope.

**Introduction:** In this activity, students will complete a preparatory assignment that simply involves reading a website from either the FDA or CDC on food irradiation. Afterward students will participate in a group discussion to clarify any misconceptions and to debate the pros and cons of food irradiation.

**Materials:**

None

**Procedure:**

Ask students to read an article on food irradiation in preparation for this activity. The following are excellent articles on the topic:
www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm
www.fsis.usda.gov/Fact_Sheets/Irradiation_and_Food_Safety/index.asp

Break the class into groups of 3 to 5 students to discuss the process of irradiation. Either let the students discuss freely or distribute a handout with some specific questions to direct their discussion (especially if time limitations are a factor). To test whether they truly understand the process, ask questions such as: How does the process of food irradiation work? How long have studies been done on the safety of irradiated food? Does the food become radioactive after the treatment? Are there any special concerns related to food that has been irradiated? What sorts of foods (and other products) can be irradiated? What benefits come from irradiation? What items other than food are irradiated?

As a class, review the answers to specific questions you have posed and clarify any misconceptions.

Allow the groups to resume their discussion with the final goal of evaluating the safety of food irradiation. If given the choice, would students be more likely to choose an untreated or an irradiated product? If they might be likely to choose an irradiated product, would they still be likely to do so if the cost was increased due to the expense of the irradiation process?

You might also ask groups to debate their positions.

**Assessment Suggestions:** Ask students to reflect on this discussion and prepare a brief writing assignment describing the process of irradiation and then make an argument for or against the use of this process.

## Group Activity 3: Practicing with Chemical Bonds

**Estimated Time to Complete:** 15 to 20 minutes

**Learning Objective:**

Differentiate between covalent, ionic, and hydrogen bonds in terms of strength and the actions of the electrons.

**Introduction:** This activity can be completed in class as a group activity or sent home for students as practice.

**Materials:**

Copies of the attached handout

**Procedure:**

Decide whether this will be an in-class or at-home activity.

If it is to be completed in class, break students into groups and allow them to go through the problems.

If you are completing the activity in class, consider having different groups complete different problems. Then ask two groups to get together and explain to each other the problems they solved.

Once each group has attempted the problems, review the answers as a class.

**Assessment Suggestions:** You can collect the worksheet or ask students to follow up by doing additional bonding problems.

## Case Study

Juan has just learned that his mother has been diagnosed with breast cancer. Preliminary tests suggest that the best course of treatment would be surgery followed by radiation therapy. Juan's mother is unfamiliar with radiation treatments and recalls hearing that exposure to radiation can actually cause cancer. Based on Juan's knowledge of chemistry, he will need to explain how the radiation therapy might help in his mother's treatment plan.

Can exposure to radiation cause cancer?

How would radiation treatment be useful in the treatment of cancer?

What harmful side effects might occur?

What type of radiation would be used in the treatment?

## Practicing with Chemical Bonds Worksheet

For **each** of the atoms shown (Cl, F, Ne, Cr, H, and K), review the electron shell diagram and answer the following questions on a separate piece of paper. You may find it helpful to cut out each of the atoms so that you can compare them side by side. Since there are six atoms on the page, you will go through this question set six times—once for each atom.

Is this atom capable of bonding? If the answer is no, skip the remaining questions for this atom. If the answer is yes, continue with the questions.

Could this atom bond with another atom of the exact same type? (For example, if you are looking at the chlorine atom, this question is asking if chlorine could bond to another chlorine atom.) If the answer is yes, what type of bond would it be?

Compare the atom to each of the other atoms on the page. List every other atom that this atom could bond with. For example, if you are working with chlorine, you would want to compare it to F, Ne, Cr, H, and K. Make sure to indicate whether the bond would be ionic or covalent for each of your choices. If you indicate that a bond is covalent, make sure to be specific and state whether it would be a polar or nonpolar covalent bond.