CARBON COMPOUNDS

SSS: SC.B.1.4.1, SC.F.1.4.8, SC.G.1.4.1

INTRODUCTION

Carbon is the central element of life. Carbon to life is like flour to baking, a necessary ingredient. Carbon is an element with several isotopes, a non-metal that occurs as diamonds, graphite crystals, CO_2, and an element that bonds covalently to as many as four other atoms. Carbon forms the backbone of organic compounds from which hydrogen, oxygen and other elements are attached.

STUDENT LEARNING OBJECTIVES

1. Students will be able to sketch the four basic functional groups of carbon compounds and describe their functions.
2. Students will be able to distinguish between proteins, carbohydrates, and lipids, and identify examples of each.
3. Students will be able to identify groups of carbon compounds on food labels, and compare/contrast nutrition facts of different types of food products.

MATERIALS

Teaching Aids

Lecture Presentation: **Carbon Compounds** (PowerPoint)

CO2 Demonstration:

1) Flask (500 ml)
2) Graduated cylinder (100 ml)
3) 1 Teaspoon
4) Medium-size balloon
5) Baking soda
6) Vinegar

Food Labels:

1) Peanut Butter (JIFF)
2) Peanut Butter (All Natural)
3) Strawberry Jelly (Publix)

Handouts

- Carbon Compounds WS1 – Functional Groups
- Carbon Compounds WS2 – Proteins, Carbohydrates, and Lipids
- Carbon Compounds WS3 – Food Labels

PROCEDURES

Agenda

- Quick Write: List things in your house that contain carbon
- CO_2 demonstration
- Complete WS1+WS2
- Form groups and discuss WS3
- Tomorrow's Topic: Discuss Food Labels and Carbon Consumption

Lecture

Introduction (5 min): Students pull out a sheet of paper list things in their house that contain carbon. Most students think of consumable products, but more common objects such as furniture, wood floors, plants, and people also contain carbon. Using the PowerPoint presentation (PPT) as a guide, introduce the properties of carbon and the origins of organic compounds.

Hook (15 min):

CO2 Demonstration

1) Place the following materials on the counter so they are visible: Flask, balloon, baking soda, and vinegar.
2) What does baking soda have in common with vinegar? Household items, Carbon, Organic Compounds, consumable.
3) What is the difference between baking soda and vinegar? Base vs. acid, Sour vs. bitter, opposite ends of the pH scale, powder vs. liquid.
4) What is a base/acid? Substance that accepts/donates e-. Hydroxide ions (-OH) vs. Hydronium ions (H_30).
5) Call for two volunteers, one female (V1) and one male (V2). Ask V1 to measure 50 ml of vinegar using the graduated cylinder.
6) Ask V2 to check the measurement and if it looks good, pour into the flask. Explain that vinegar ($C_2H_4O_2$) is a carboxylic acid, which contains the carboxyl functional group (we'll discuss this later), that easily gives up hydrogen ions (hence acid).
7) Why doesn't anything happen in the flask when the liquid (vinegar) contacts the solid (flask)? There's nothing for the vinegar ions to dissociate with. If we left them alone long enough something might eventually happen.
8) Ask V2 to measure one teaspoon of baking soda.
9) Ask V1 to stretch open the balloon so V2 can pour in the baking soda. Explain that baking soda also known as sodium bicarbonate contains sodium ions and the hydrogen, carbon, and three oxygen atoms are together called the bicarbonate ion or anion (more electrons than protons).
10) Why isn't anything happening in the balloon? Right, same situation as the vinegar and flask, except these are both solids, so we'd probably never see anything happen even if we left them alone for a long time.
11) Now connect the open end of the balloon to the open end of the flask keeping the balloon hanging to one side.
12) What do you think will happen when I lift the balloon and allow the baking soda to fall into the flask? Right, bubbles and gas. What gas? CO_2.
13) Ask V1 to hold the flask and V2 to lift the balloon so the baking soda falls into the flask. Observe the balloon inflate.
14) Set the flask down on the counter, pull the balloon off and tie it at the open end. Pass the balloon to the students. Although carbon is everywhere, we can't see it and we can't smell it, but we can play with

it. Explain that the stuff in the balloon is the same stuff we're exhaling. Briefly talk about lungs and blood flow.

15) Push materials aside, thank V1 and V2 for their assistance, and return to PowerPoint

Body

Part 1 (5 min)**:** Using PPT as a guide, introduce four functional groups (hydroxyl, methyl, carboxyl, and amino). Ask students if they have familiar with these functional groups and brainstorm what the possible chemical structures might look like for each, then for each functional group show its chemical formula and give examples of their functions in carbon compounds.

Part 2 (5 min)**:** Each student gets a copy of Carbon Compounds WS1 (Functional Groups) to complete and add to their journals. Explain that functional groups are not special just because of their elemental components as presented by their chemical formula, but also from their structural formula.

> **Example:** In water (H_2O), the distributions of polar bonds are asymmetrical so there is a net charge; in carbon dioxide the distribution of polar bonds is linear, so the opposite charges cancel each other. This concept also holds for carbon compounds, in which the specific structural arrangement of carbon and associated elements predicts its function.

For each functional group the student will use the given chemical formula to predict and sketch the structural formula, and then explain why they chose that particular structure (why the carbon here and the oxygen there). The hydroxyl functional group is not going to be sketched, why? The chemical and structural formula are the same.

Part 3 (5 min)**:** Using the PPT, reveal the "real" chemical structures for the functional groups. Gather a few wrong answers from students and discuss how they might still serve as other types of functional groups. Tell the students to now sketch the real structural formulas on their worksheet. Next, show the slide on amino acids and discuss how two functional groups (amino and carboxyl) work together to form the building blocks of our bodies (proteins). Students will follow along and take notes in their journals.

Part 4 (10 min)**:** Using PPT, discuss carbohydrates, proteins, lipids, and nucleic acids. Students will follow along and take notes in their journals.

Part 5 (5 min)**:** Each student gets a copy of Carbon Compounds WS2 (Proteins, Carbohydrates, and Lipids) to complete and add to their journals. The goal is to match the descriptive items with the appropriate carbon compound(s) – carbohydrate or protein or lipid. Discuss the answers with the class.

Part 6 (5 min)**:** Show students the food labels, and tell them how much you love peanut butter and jelly sandwiches. The PPT has the nutrition facts for these food labels outlined. Introduce the categories (serving size, total fat, etc), ask students

how these categories relate to the groups of carbon compounds (carbohydrates, proteins, etc), and ask students how they think these nutrition facts correspond with the ingredients listed.

Wrap-up (2 min): Return to PPT and discuss the purpose of Exercise 1 and what students need to do. Tell students to form groups of three.

Exercise 1. Food Labels.

Each student will get a copy of Carbon Compounds WS3 (Food Labels) to complete at home and bring back next time. Students should discuss among themselves which products they might investigate. Each student in the group needs to investigate a product label relatively different from the others. For example, cereal, mayonnaise, and Campbell soup would be appropriate.

Tonight at home (10 min)**:** Students will select a food product label and record the nutrition information and ingredients in the space provided on WS3 (Part 1 – Nutrition Facts). If they can, have them remove and staple the food label to the worksheet.

Tomorrow in class (15 min)**:** Students will form groups of three or four and complete WS3 (Part 2 – Compare and Contrast Food Labels).

ASSESSMENT

Objective 1: Using WS1, students will predict and sketch possible structural formulas of functional groups based on the chemical formulas they listed on the worksheet. After a brief discussion, students will sketch the "real" structural formulas.

Objective 2: Using WS2, students will distinguish between proteins, carbohydrates, and lipids by matching those four groups of carbon compounds to descriptions and examples listed on the worksheet.

Objective 3: Using WS3, students will record nutrition facts and ingredients from a food product label found in their home and use that information to complete Part 1 - Nutrition Facts. Next time students will compare and contrast food labels and answer questions on Part 2 – Compare and Contrast Food Labels.

REFERENCES

Design in the Classroom

http://ditc.missouri.edu/designTasks/bakingSoda/index.html