Bay Area Scientists in Schools Presentation Plan

Lesson Name Green Polymers
Presenter(s) The Sarpong Group
Grade Level 5th **Standards Connection(s)** chemical reactions to make molecules

California Science Standards

5th Grade Physical Science: Elements and their combinations account for all the varied types of matter in the world.

a. Students know that during chemical reactions, the atoms in the reactants rearrange to form products with different properties.

b. Students know all matter is made of atoms, which may combine to form molecules

f. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds

Next Generation Science Standards

5-PS1-3. Make observations and measurements to identify materials based on their properties.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4) Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3	**PS1.A: Structure and Properties of Matter** Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3) **PS1.B: Chemical Reactions** When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Scale, Proportion, and Quantity** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)

Common Core Connections:

ELA/Literacy

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2),(5-PS1-3),
(5-PS1-4)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-PS1-2),(5-PS1-3),(5-PS1-4)

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-2),(5-PS1-3),(5-PS1-4)

Mathematics

MP.2 Reason abstractly and quantitatively. (5-PS1-1),(5-PS1-2),(5-PS1-3)

MP.4 Model with mathematics. (5-PS1-1),(5-PS1-2),(5-PS1-3)

MP.5 Use appropriate tools strategically. (5-PS1-2),(5-PS1-3)

FOSS Connections: 5th Grade: *Measuring Matter; Mixtures and Solutions*

Abstract: Polymers are an important part of our day-to-day lives. This lesson explores the construction of polymers from monomers, some properties of polymers, and the degradation of polymers, with connections to green chemistry ideas.

Vocabulary/Definitions:

- ☐ polymer – a very large molecule composed of repeating units
- ☐ monomer – a single unit that is used to make polymers
- ☐ degrade – break down
- ☐ molecule—a group of atoms chemically bonded together that act as a unit
- ☐ polymerization reaction—a chemical reaction that links monomers together to form a polymer
- ☐ Cross-linking—making chemical bonds between two polymer chains

Materials

A. Making Polymers

- Plastic Cups
- Elmer's Glue
- Borax
- Water
- Food Coloring
- Plastic Spoons
- Ziploc Bags

B. Properties of Polymers

- Plastic Cups
- Coffee Filters
- Rubber Bands
- Water
- Pipettes
- Distilled Water
- Sodium Polyacrylate
- Brine Solution

C. Degrading Polymers

- Legos
- Magic Nuudles
- Styrofoam Packing Peanuts
- Large Container
- Water

We will bring everything with us, but access to water would be helpful.

Classroom Set-up:

We will start and end in a large group; we will talk to the teacher in advance to learn about the classroom setup and the best way to divide the class into three groups for the stations segment of the lesson.

Classroom Visit

1. Introduction

Personal Introduction: **2 Minutes**

We are graduate students and postdoctoral researchers (can calculate "grade level" for the students) from UC Berkeley studying organic chemistry! We are originally from all over the world, but we all share a passion for science!

Topic Introduction: **10 Minutes**

In a polymerization reaction, small molecules called "monomers" react to form "polymers," which are very large molecules composed of repeating units. Discuss some common polymers (e.g., Teflon, Kevlar, plastics, rubbers, etc.).

Real life analogies:

1. A train, which is composed of boxcars.
2. A wall, which is composed of bricks.

Have everyone join hands to form a "polymer" of people. Note that in a real polymer, the monomers are the same – like if you cloned one student and made chain of his clones!

Discuss recycling and green chemistry (everyday life and how the same concepts can be applied to chemistry)

Problems: things don't degrade; need to recycle them or reuse them in current form.
-biodegradability
-what's recyclable, what's not recyclable (cardboard, metals, not Styrofoam)

2. Learning Experience(s): 36 Minutes

For the bulk of the lesson, the students will be divided up into three groups to visit stations (~12 minutes/station)

A. Making Polymers Station

Concepts: polymerization

Key terms: cross-linking, hydrogel

Instructions: *(Have each student assist with part of the procedure. Have the students make observations of the solutions throughout the experiment.)*

1) Fill one cup with water and add a spoonful of Borax. Stir the solution and set it aside.

2) Fill a second cup with about 1 inch of glue

3) Add about 5 spoonfuls of water to the glue and stir

4) Add 2-3 drops of food coloring and stir until well mixed

5) Add about 3 spoonfuls of the borax solution and stir well. You may need to add more of the borax solution if the slime is still watery. While stirring, explain to the students that the Borax is *crosslinking* the molecules in the glue to each other, which causes the material to stiffen.

6) After the slime is fully formed, let it sit for about 30 seconds, then remove it from the cup.

7) Divide the slime up so each student has a piece, put it in a sealable Ziploc bag, have the students write their name on their bag, and set the bags of slime aside to give to the teacher for distribution later in the school day.

B. Properties of Polymers Station

Concepts: physical properties (flexibility, hardness, water absorbancy, etc.), control experiment

Key Terms: control, variable, polyacrylate

Instructions:

1) Place a coffee filter over the top of a plastic cup and secure it with a rubber band. It is important to pull it tight so that it fits like a drumhead.

2) Using a pipette, slowly drop water on the center of the coffee filter and have the students count how many drops it takes for the water to reach the edge of the cup. Explain that this is a *control experiment*.

3) Give a cup, coffee filter, and rubber band to each group of 2 students and have them attach the filter to the cup.

4) Place a small amount (~0.1 g) of polymer (the *variable*) on each coffee filter and have the students make observations about the polymer. DO NOT LET THE STUDENTS TOUCH THE POLYMER. If a student touches the polymer, they should wash their hands.

5) Have the students SLOWLY drop water on top of the polymer, keeping track of the number of drops it now takes to saturate the filter paper. Ask the students to make observations of what is happening to the polymer.

6) Once all groups are done, discuss the observations the students made and the properties of the polymer. Discuss why the students would not want to touch this polymer. Discuss where you might encounter this type of polymer in daily life (diapers, potting soil, heat packs, toys that expand in water, etc.)

7) Take one student's polymer and add a few drops of a saturated salt water solution and have the students make observations about what is happening.

8) To clean up, remove the coffee filter with polymer from each cup and collect the cups and rubber bands. Reminder: DO NOT ALLOW THE STUDENTS TO TOUCH THE POLYMER, AS IT WILL DRY OUT THEIR SKIN/EYES. IF A STUDENT TOUCHED THE POLYMER, THEY SHOULD WASH THEIR HANDS BEFORE MOVING ON TO THE NEXT STATION.

C. Degrading Polymers Station

Concepts: degradation, recycling, green chemistry

Key Terms: biodegradable

Instructions:

1) Ask the students if they have heard the term *degradation* before and if they know what it means. Discuss how some materials can be *degraded* (broken down) more readily than others, which allows them to be recycled into new materials.

2) Pass around a few Styrofoam packing peanuts and have the students describe them. Do the same thing with a few of the magic nuudles.

3) Place a piece of Styrofoam and a piece of magic nuudle in a jar of water and set it aside.

4) Give each student a few Legos and ask them to build something with the pieces they were given.

5) Have each student give their structure to the person to their right, who should then take it apart and build something different with those bricks. This can be repeated a couple of times. Then collect all the Legos.

6) Return to the jar of packing materials. Remove both pieces and have the students make a new set of observations. Discuss the benefits of degradable materials and recycling.

3. Wrap-up: Sharing Experiences and Building Connections 10 Minutes

We will bring everyone back to one group to review the things learned that day. Each station leader will review the experiments, main observations, and key words learned at each station. Encourage the students to think about the many different polymers they encounter every day and the cycle of materials being broken apart and rebuilt. Ask the students if they have any questions about the experiments we performed or about being a scientist in general!

4. Close: 2 Minutes

Clean-Up. Thanks and goodbye.

TOTAL 60 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about polymers and recycling plastics..."

Gak! (*BASIS Lesson developed by Chemical Engineering Graduate Students***) -** You are given the task of making the best gak. The head scientists have come up with three recipes but they need your help to find the best one. Using concepts of engineering and science, together we will explore the new materials and learn methods to test for which one has the best properties. (**Does not include recipe)** http://www.crscience.org/lessonplans/5_Gak_ChemE_10-11.pdf

Polymer Possibilities (*BASIS Lesson Developed by Bioengineering Graduate Students*) - We will be introducing kids to the world of polymers. Examples of polymers are all around us whose properties and uses are largely determined by their chemical structure. We will explain how polymers are large molecules consisting of long chains of repeating units. Through activities we will look together at the structure of polymers and their possible properties. (**Includes recipes of various polymers)** http://www.crscience.org/lessonplans/5_PS_Polymer_Possibilities_11-12.pdf

Gum Drop Chains and Shrinky Necklaces (*Polymer Science Learning Foundation*) - In this activity, learners thread gumdrops together to make a model of a polymer. Then they thread the chains together to mimic crosslinks, and discover how crosslinked polymers act differently than uncrosslinked ones. Use this activity to illustrate about the various structures of polymers. http://pslc.ws/macrog/kidsmac/activity/gumdrop.htm

Reading Connections:

- Janice VanCleave's Molecules by Janice VanCleave – (Children ages 8-12) Includes 20 simple and fun experiments that allow you to discover the answers to these and other fascinating questions about molecules, plus dozens of additional suggestions for developing your own science fair projects. Learn about the structure of molecules with a simple experiment using gum drops and toothpicks; about molecular motion with a glass, a cup, and food coloring; about crystals using Epsom salts, a soap dish, and a paint brush; and much more. All experiments use inexpensive household materials and involve a minimum of preparation and clean up. http://www.amazon.com/Janice-VanCleaves- Molecules-VanCleave/dp/047155054X/