Lesson 2

Biodegradable Plastic

Time: 1 45 min. class period to cook the plastic, at least one day to dry plastic

Overview: Students will learn about the basic chemistry of petroplastics and bioplastics and the difference in impact on the environment that each have. This newsclip provides a good overview to our current problem with plastics. (3min) http://www.youtube.com/watch?v=xc6LvdsyJ4U&NR=1

HCPS III Science Benchmarks

SC.6.6.5 Explain how matter can change physical, chemical forms but total amount of matter remains constant

SC.6.6.6 Describe and compare the physical and chemical properties of different substances
SC.6.1.2 Use appropriate tools, equipment, and techniques safely to collect, display, and analyze data
SC.6.2.1 Explain how technology has an impact on society and science
SC.6.2.2 Explain how needs of society have influenced development and use of technologies

NSES standards

Properties and changes of properties in matter
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Understandings about science and technology
Natural hazards

Risks and benefits
Science and technology in society
Science as a human endeavor

Learning Objectives

1. Students will learn how to identify various plastics based on the Resin Identification Code (RIS) and what is the end result of each

2. Students will design and/or make a biodegradable plastic

3. Students will describe the physical and chemical charasteristics of their biodegradable plastic

4. Students will describe 2 advantages and 2 disadvantages of using petroplastics vs. bioplastics

Background

The word plastic is derived from the greek work *plastikos,* meaning capable of being shaped or molded. Its meaning refers to the malleability of plastic that allows it to be cast, shaped and molded during the manufacture process into a variety of shapes. Currently, 95% of plastics are made from petroleum, which increases our dependence on foreign oil, a non-renewable resource. Many plastics are polymers and are not easily broken down due to the strength of their chemical bonds. Many of these polymers are made from Bisphenol-A or BPA, a compound that has been shown to have negative health effects on a variety of organisms and is not easily broken down.

Did you know that there is a large pool of plastic that collects in what is known as the north pacific gyre and is just north of Hawaiian Islands? This means that a large quantity of the world's garbage collects in the Pacific Ocean not too far from Hawaii and is already washing up on our shores. It is commonly referred to as the Great Pacific Garbage Patch. This is one of the reasons that scientists are currently working on alternative types of plastic, called **bioplastic**.

Bioplastics are called such because they are made from renewable plant sources. However not all bioplastics are biodegradable. The PET or high-density polyethylene (HDPE) PlantBottle manufactured by Coca Cola is an example of a bioplastic that is 30% bio-based but is not biodegradable nor compostable, however it is recyclable. In contrast, Polylactic Acid (PLA) is a bioplastic made from corn that is biodegradable and compostable.

In this lesson plan you will learn how to make a bioplastic that is both biodegradable and compostable with exposure to water and/or UV light. Note if biodegradable plastics get mixed in the other plastics for recycling, the reclaimed plastic is not recyclable because the variance in properties and melt temperatures.

Activity

Materials

1 tsp vegetable glycerin (available at pharmacy or health food stores)
1Tbsp Corn, potato*, arrowroot, or other starch
1 tsp vinegar 5% acidity
4 Tbsp water
Cooking spoon
Cooking pot
Hot plate
Aluminum foil
Optional coloring (see dye list below)
*Option Make your own potato starch

1. peel potatoes and cube
2. place in a high speed blender with just enough water to blend smooth
3. strain off water with a coffee filter, squeeze out excess water
4. substitute for flour in bioplastic recipe, remember contains extra water

Procedure

Step 1. Mix 4 Tbsp of water with starch to make a slurry in the cooking pot.

Step 2. Add 1 tsp vinegar

Step 3. Add 1 tsp glycerin

Step 4. Mix and turn heat on to medium setting. Stir continuously.

The mixture should turn from a liquid white mixture to a clear gel consistency. When it begins to bubble it is done, remove from heat immediately to prevent burning.

Step 5. Spread the gel onto flat sheet of parchment paper or aluminum foil or mold

Let cool for 24 hours.

Insert seeds when still wet to use as a seed strip in the garden for spacing.

Option for experimental design

: Compare the ability of your new plastic to breakdown into soil compared to regular plastic, PLA, and/or PET Plant Bottle. Design an experiment that buries both pieces of plastic and dig up at the end of the semester. Did your plastic break down? How does it compare to the regular plastic? Why do you think there was a difference?

The Resin identification codes: The numbers on plastics for recycling

#**1 Polyethylene terephthalate (PET)**** – this plastic used for soda and water bottles is usually clear and is recyclable. It is however porous, allows bacteria to flourish, and should not be reused as containers. It can be drawn out into long fibers and recycled in to carpets, fiberfill for jackets, fabric for T-shirts, and shopping bags (cannot be recycled again).

#2 High-density polyethylene (HDPE)-** used for milk jugs, detergent and juice bottles. colored forms of this plastic are generally recycled into plastic lumber while clear ones can be recycled into new containers. Some forms are not recyclable and this plastic has a lower risk of leaching and generally considered safe for food.

#**3 Polyvinyl choloride (PVC)** – used to make food wrap, bottles for cooking oil, and water and plumbing pipes. It is a tough plastic but is not considered safe to cook food near it. Vinyl chloride is a known carcinogen and may leach phthalates and dioxins. PVC is often not accepted by recycling programs because it is cost-prohibitive, however it can be recycled.

#4 Low-density polyethylene (LDPE) *– a very flexible plastic used to make grocery bags and squeezable bottles and is considered safe for food. It can be recycled into new bags or plastic lumber, however is not often accepted by curbside pickups due to cost prohibitiveness.

#5 Polypropylene (PP)*- used for yogurt cups, ketchup and syrup bottles. Considered food safe and is increasingly being accepted by curbside recycling.

#6 Polystyrene (PS) – When expanded this makes Styrofoam and is used for

insulation including coffee cups and takeout food packaging. It is a principle component of marine debris and causes problems for birds and fish since they think its food. It is often not recycled since it's cheaper to make new Styrofoam from oil. Increasingly it has been shown to leach harmful chemicals when heated.

Note: One student designed a replacement for styrofoam in class that won the 2011 DuPont award for packaging innovation made from seed husks, perlite and mycelium. For more info see link below.
http://green.blogs.nytimes.com/2009/04/13/using-fungi-to-replace-styrofoam/

#7 Other- essentially all plastics developed after 1987 fall into this category including polycarbonate (BPA) and many "bioplastics". These are generally not accepted by recyclers, however compostable bioplastics such as PLA, which are accepted in some curbside food composting programs.

**** 1,2 are recyclable**
*2,4,5 Generally considered safe for food, care must be taken with heating food.

Suggested Vocabulary

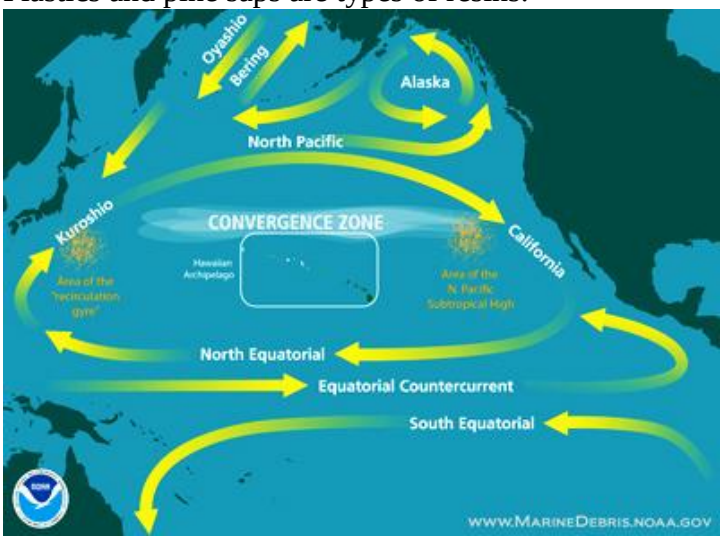
Monomer- an atom or small molecule that can bind chemically to other monomers

Polymer- a molecule composed of repeating monomers

Biodegradable- a characteristic of a substance meaning that it is able to be decomposed by bacteria and/or other biological mechanisms

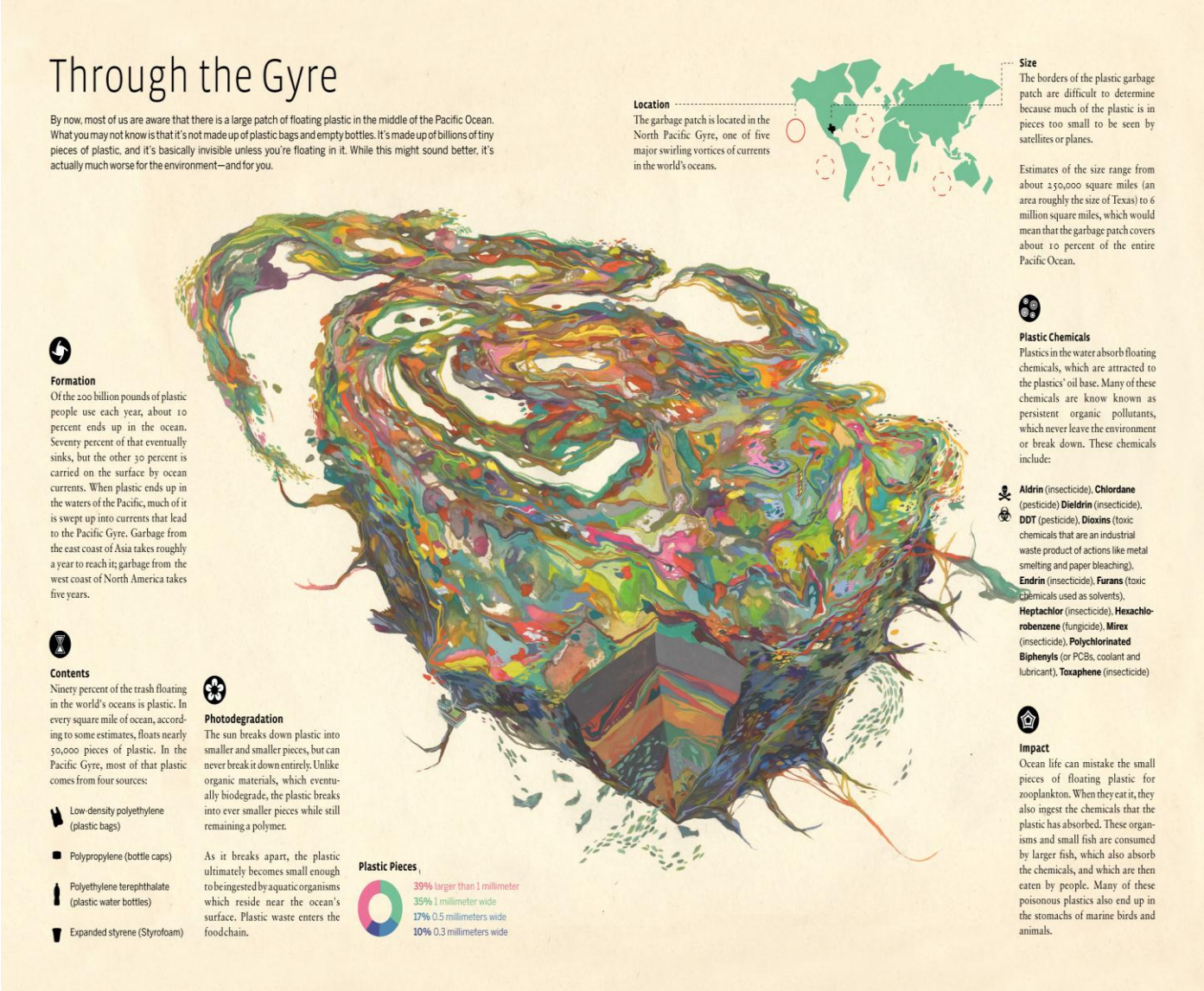
Bioplastic- a plastic that is made from renewable resources

Resin- can be either a natural or synthetic compound that begins in a highly viscous state and hardens with drying, cooloing, and/or other treatment. Plastics and pine saps are types of resins.



The Pacific Gyre

For a video on "Plastiki" - a catamaran made from recycled plastic that sailed to the pacific gyre to raise awareness of the pacific garbage patch
http://www.theplastiki.com/video/
http://www.youtube.com/watch?v=zN4zvl5Kr0k
http://ngadventure.typepad.com/blog/pastiki/



For additional resources

www.green-plastics.net
http://en.wikipedia.org/wiki/Bisphenol_A

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Horton, Robert L; Warkentien, Carol; and Gogolski, Jeanne. 2010. Agriculture at Work: Bioplastic. 4-H Agriscience. Accessed 6/1/2011 from http://www.4-h.org/resource-library/curriculum/

Magraw-Mickelson, Jacob. 5/12/2009. Transparency: The Great Pacific Garbage Patch. Good: Environment. Accessed 6/5/2011 from http://www.good.is/post/transparency-the-great-pacific-garbage-patch/

Name_____
Date _____

Biodegradable Plastic Observation Log

Design and make your plastic from a flour (starch)

Which flour or starch did you use? Why?

Describe your plastic.

Is it brittle or Flexible?

Transparent or Opaque?

Rough or smooth?

Thin or thick?

What did you color your plastic with?

Compare your plastic to someone else's that used a different starch or vinegar.

What would you do differently next time?