

Fantastic Bioplastic!

Objectives

- To create biodegradable plastic from corn starch
- Understand the applications of bioplastic

Skill Level: Middle School

Class time: 45 minutes

Materials

- Cornstarch (2 tbsp per student)
- Sandwich bag (1 per student)
- Vegetable oil
- Disposable pipette
- Corn syrup
- Food coloring
- Water
- Measuring spoons
- Microwave

Next Generation Science Standards

Disciplinary Core Idea:

LS2.A Interdependent Relationship and Ecosystems

Performance Expectations:

MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services

Practices

- Asking questions / defining problems
- Developing / using models
- Planning / carrying out investigations
- Analyzing / interpreting data

Crosscutting Concepts

- Patterns
- Cause and effect: Mechanism / explanation
- Scale, proportion, and quantity
- Systems and system models

<input type="checkbox"/> Math / computational thinking <input checked="" type="checkbox"/> Constructing explanations / design solutions <input type="checkbox"/> Engaging in argument from evidence <input type="checkbox"/> Obtaining / evaluate / communicate	<input checked="" type="checkbox"/> Energy / matter: Flows, cycles, conservation <input type="checkbox"/> Structure and function <input type="checkbox"/> Stability and change
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Background Information

Plastics play an important role in our daily lives. On average, Americans collectively use 2,500,000 plastic bottles every hour, but few of these bottles are recycled or reused. Many of the plastic bottles that we use today are not biodegradable. Biodegradable means that a certain material is capable of being decomposed, or broken down, by microorganisms. Plastics are also used in schools, hospitals, homes, grocery stores, restaurants, businesses, research labs, and many other places. Just look around for a minute and you'll see how many things are made of plastic!

Some types of plastics degrade faster than others, but depending on the type of plastic, it may never break down. Much of it goes to landfills, but it can also end up on the side of the road, in waterways, and different places in our environment. This is becoming a huge problem for our environment and our wildlife, as it is very detrimental and can destroy habitats for us and other organisms.

One giant example of this type of pollution is known as the Great Pacific Garbage Patch. It's a massive body of trash (mainly plastic) located in the middle of the Pacific Ocean, 1,000 miles away from land. The "patch" exists because garbage and waste polluting our waterways flow into the ocean, build up, and are forced out into the ocean by currents and wind. The largest portion of the "patch" floats between Hawaii and California, spans more than twice the size of the state of Texas, and stretches at least 100 feet deep into the ocean. Can you imagine that much trash? Not only is that unsanitary, but it's also really harmful for the marine life in that area. Even though plastic does not biodegrade, it can break off in small pieces that animals might think is food. If the animals eat this plastic, they can get very sick and possibly die. Animals can also get entangled in waste, making it difficult or impossible for them to eat, swim, or fly. This massive amount of pollution has killed all kinds of wildlife: from birds and turtles to many other aquatic species.



Figure 1: The impact of the garbage patch. [Reference](#)

That's a person walking on the garbage!



Figure 2: The Great Pacific Garbage Patch is twice the size of Texas. [Reference](#)

What can we do to prevent plastic pollution like this? Of course, recycling plastic or reusing it is an option. Another alternative is reducing our plastic consumption. These measures could drastically cut down on the amount of waste that litters the earth. However, there are new innovations that could prove beneficial to using plastics sustainably.

Most traditional plastic is made from petroleum, a nonrenewable resource that is harvested by drilling into the earth. A newer technology that could be a sustainable alternative to traditional plastic is called bioplastic. There are two types of bioplastic: biobased and biodegradable. Biobased plastics are defined by a fraction of their carbon content consisting of new carbon

content made from biological material or agricultural resources versus fossil fuel carbon content. This means that there is some petroleum still present in the plastic, and therefore not all biobased plastics are biodegradable. Biodegradable plastic is a plastic that undergoes biodegradation (a process in which the degradation results from the action of naturally-occurring microorganisms such as bacteria, fungi, and algae). Using biodegradable plastics could cut down on the amount of space taken up in landfills and reduce the impact that litter has on the environment. Bioplastics on a whole take less energy to produce, but must be recycled carefully. Bioplastic, much like biofuel, has the potential to reduce our dependence on foreign oil while giving Americans more jobs to fill. Also, the majority of bioplastic is made from renewable resources, such as corn or other plant material, and it can be reproduced fast enough to keep up with our needs. Bioplastic is a better option for the environment and, in turn, everyone in the world.

Engage

The amount of plastic we are using is not only harmful to the environment but we are killing a number of species as well. Marine animals can get caught up in the waste, making it so that the animal is unable to eat or swim. The great thing about plastic is that it can be made to be into biodegradable plastic. This prevents plastic from sitting in landfills or in the ocean. Bioplastics can be recycled and are easier to produce. The great thing about this activity is that students get to see that it is fairly easy to make plastics biodegradable and it can be done with household items.

Explore

Experiment Questions:

- How is renewable, biodegradable plastic made?
- What are some uses for this plastic?
- Is this something people can do at home?
- What were the observations you made that told you the plastic was biodegradable?

Procedure:

1. Place 2 tbsp. of cornstarch in a plastic sandwich bag.
2. Add 2 drops of vegetable oil to the bag using a pipette.
3. Add 1 ½ tbsp. of water to the bag.

4. Add 1/2 tbsp. of corn syrup and mix well. (*What other types of starch could be used to make bioplastic? Think about foods or plants that have starch content similar to that of corn.*)
5. Add 2 drops of your favorite food coloring to the mixture and stir well.
6. Microwave your plastic for 25 seconds on high. Let stand 1-2 minutes before removing.
(Caution: sandwich bag and contents will be VERY hot)
7. Form your plastic into a ball or flatten it out into a sheet and observe what happens. Have students record observations on the Data and Discussion Worksheet.

Explain

- Define biodegradable, renewable, and pollution.
- How can this process be done on a large scale?
- How does this play a role in the ecosystem?
- Who benefits from this?
- Do you think the public is informed about this? What is the best way to reach such a large audience?
- Why aren't all plastics bioplastics or biodegradable?

Elaborate

- What can be done to inform every household of bioplastics?
- What causes the garbage patch to float in the area it does?
- Are there other garbage patches? What countries cause these patches?
- What other household items do you think could yield the same results?

Items containing non-renewable plastic/polymers (these are items that can be recycled, but are made with non-renewable resources):

- Grocery, produce, Ziploc and garbage bags
- Anything with Styrofoam
- Disposable plastic water bottles
- Other disposable plastic bottles
- Milk/water jugs
- Plastic utensils
- Disposable drink lids and straws
- Plastic wrap (like saran wrap)
- Tupperware containers
- Plastic squeeze bottles (like shampoo, toothpaste, and lotion bottles)
- Bleach/detergent containers
- Peanut butter containers

- Baby bottles

Resources

Additional Resources:

There are recipes available online for bioplastic made from [potato starch](#). This experiment is a bit more difficult, as the potato starch must be extracted from potatoes or ordered online and the substance must be dried, but it would yield similar results. The potato starch variation might be a fun experiment for students to try at home.

Some additional sources talk about a teen that wanted to figure out what microorganisms were the fastest at breaking down plastic. The pieces provided include [an article](#) that talks about the student's motivation as well as his [scientific research](#).

Resources Used:

- [Fantastic Bioplastic](#)
- [The Great Pacific Garbage Patch](#)
- [Make Your Own Biodegradable Plastic](#)
- [Biobased or Biodegradable](#)