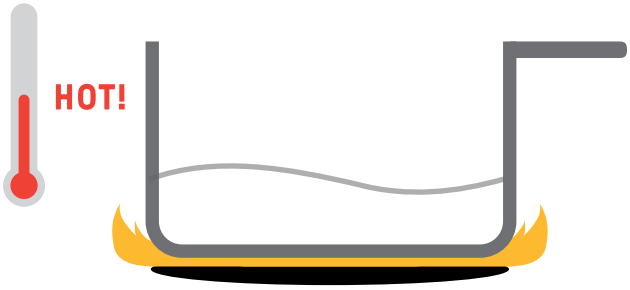
CURIOSITY AT HOME

BIOPLASTICS

Traditional plastics are made from fossil fuels, like petroleum and natural gas. But did you know that plastic can also be made out of renewable biological materials like plant starch or animal protein? We call these bioplastics. With this activity, you can try making your own moldable material from milk protein at home.

MATERIALS

- Whole milk
- Vinegar
- Hot plate & small pot (or microwave and microwave safe bowl)
- Measuring cups
- Measuring spoons
- Stir sticks (metal spoon or fork also work fine)
- Fine mesh strainer or cheese cloth
- Paper towels or cloth towel
- Wax paper or plate
- Science notebook
- Something to write with



Heat milk until it is hot
(cutaway side view)

PROCEDURE

- Get an adult to help you heat up one cup of milk until it is hot, but not boiling. Remove the milk from the heat.
- Make observations of the hot milk. What do you notice about it?
- Add 4 teaspoons of vinegar to the milk. Stir for about a minute.
  - What do you notice happen after you added the vinegar? How does the milk look different?
- Pour the milk through the strainer into the sink (careful, it may be hot!). Left behind in the strainer should be a mass of lumpy blobs.
- Dump the lumpy blobs left in the strainer onto several paper towels or a cloth towel and gently pat them dry. Fold over the edges of the towel and press down to absorb excess moisture.
- Once the blobs are cool enough to handle, hold some in your hands.
  - What does it feel like? What does it remind you of?

Add vinegar and stir
(cutaway side view)

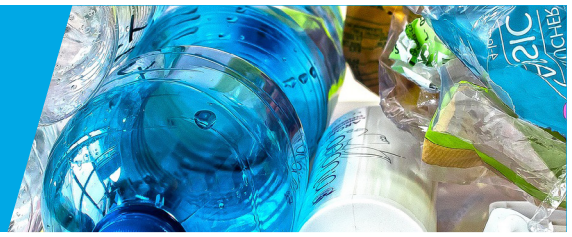
@pacsci

Show us how you're being curious! Share your results with us.

PACIFIC SCIENCE CENTER

CURIOSITY AT HOME

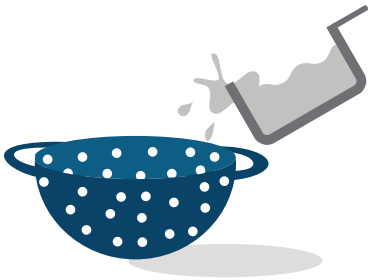
BIOPLASTICS



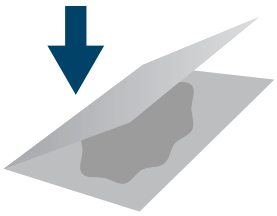
- Squeeze the blobs together. Knead together into a ball, like it is dough.
- Try molding the blobs into whatever shape you want. Place the molded shape on a piece of wax paper or a plate and allow it to dry out over a few days.

EXPLORE MORE

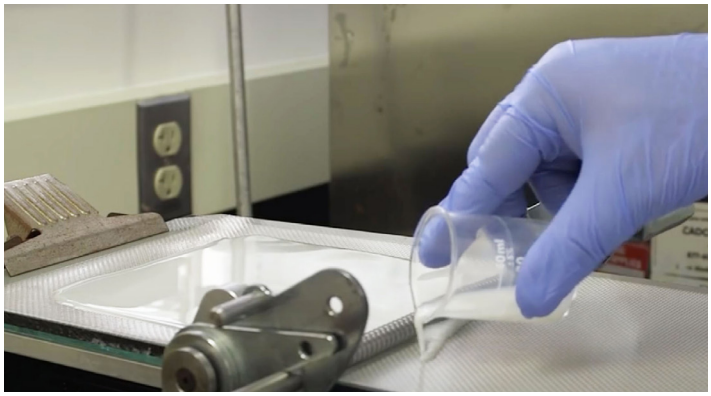
- Go on a scavenger hunt and find as many plastic items as you can. List them in your science notebook. Mark the items that can only be used once (like a yogurt tub) with a circle, and the items that can be used over and over again with a star.
- Next in your scavenger hunt, find 5 items made from **renewable resources**. A renewable resource is something that can be replaced faster than we can use it. Some renewable materials include paper and wood products, natural fiber cloths like cotton, bioplastics, and recycled glass. Write down the five items in your science notebook.
- Environmental engineers often need to compare properties of different materials and consider the advantages and disadvantages of using one material instead of another. For the last part of your scavenger hunt, find two items with the same job that are made of different materials. For example, you could compare a plastic fork versus a metal fork or a wool sweater versus a polyester sweater. In your science notebook, make observations about the properties of both items (shape, color, texture, flexibility, durability, temperature/moisture resistance, etc.). Record these observations in your science notebook. Consider the following questions:
  - What are some similar properties between the two items?
  - What are some different properties between the two items?
  - What would the benefits be for using an item made of one material over the other?



Pour milk through strainer into sink



Press down on towel to get absorb extra moisture



WHAT'S HAPPENING?

Through this process, you made something called casein, which occurs when protein in milk interacts with the acid in the vinegar. The casein in milk does not mix with vinegar, so it clumps together to form blobs. True plastics or polymers are made up of slightly different materials, but they form in a similar way. Check out this video[1] from the American Chemical Society to learn more about how chemical engineers are trying to design biodegradable food wraps made from casein!

[1] https://www.acs.org/content/acs/en/pressroom/newsreleases/2016/august/edible-food-packaging-made-from-milk-proteins-video.html

@pacsci

Show us how you're being curious! Share your results with us.

PACIFIC SCIENCE CENTER

CURIOSITY AT HOME

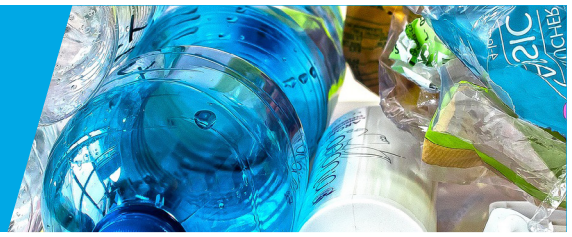
BIOPLASTICS

K–2 GRADE EXPLORATION

- After straining the milk and rinsing the lumpy blobs under cool water, hold some in your hands. What does it feel like? What does it remind you of? Draw a picture of your bioplastic in your science notebook.
- Try molding the blob into a shape. Can you make a shape that is very flat, like paper? Can you make a shape that is hollow inside, like a bowl or cup? Is it easy to mold into a new shape? Why or why not?
- Place your molded shape onto a piece of wax paper or on a plate to allow it to dry. Observe your shape after one to two days. How does it look and feel now? How did it change? What kind of shape would you try to make next time?

CURIOSITY AT HOME

BIOPLASTICS



3–5 GRADE EXPLORATION

- Compare your observations of the milk before and after adding vinegar using words and/or drawings in the table below, or in your science notebook.

Heated milk without vinegar	Heated milk with vinegar

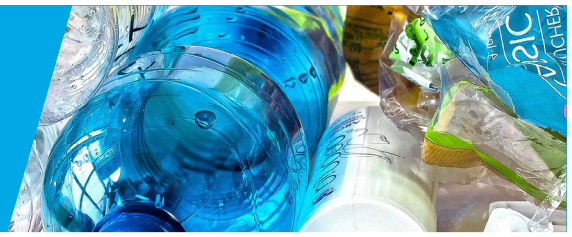
- Casein was often used to make clothing, buttons or jewelry in the 20th century. Can you make button shapes out of the blob? What other shapes can you make? Is it easy to mold into a new shape? Why or why not?
- How does your molded shape change over time? Place your molded shape onto a piece of wax paper or on a plate to allow it to dry. Observe your shape after one to two days. How does it look and feel now? How did it change? Record your observations in the table below, or in your science notebook.

Molded Shape (after 5 minutes)	Molded Shape (after 24 hours)

- How did your shape change after it dried? What would you do differently next time to improve your design?

CURIOSITY AT HOME

BIOPLASTICS



6–8 GRADE EXPLORATION

- There are many variables affecting this chemical reaction. How does temperature affect the chemical reaction? How does the fat content of the milk (half and half, whole, 2%, skim) affect the amount of casein you get? Do milk alternatives (soy milk, almond milk, coconut milk) also contain casein? Does the amount of vinegar used make a difference?
- Repeat the experiment. Pick one variable to change. Possible variables include:
  - Changing the temperature
  - Using a different type of milk (or milk alternative)
  - Using more or less vinegar
- Record your observations in the table below, or in your science notebook.

Control:	**Test:**
• **1 cup of whole milk (heated)** • **4 teaspoons of vinegar**	• _____ • _____
Results:	Results:

- Which of the two mixtures produced the greater yield, or amount, of casein? What else could you try to do to increase the yield?

@pacsci

Show us how you're being curious! Share your results with us.

PACIFIC SCIENCE CENTER