

CRISP Kit Teacher Module

Title of Module:

Making Stuff: Instant cheese Bioplastic

Subject(s) or Unit of Study:

Polymers, Bioplastics, Environmental

Grade Level(s):

5+

Est. Length of Activity:

Est. length of activity

Student Objectives:

Students will learn about bioplastic, a polymer made of plant or animal matter that is cleaner because it breaks down more easily in the environment than petroleum-based synthetic plastics.

Vocabulary:

Monomer, polymer, plastic, casein, polyethylene, biodegradable, polymerization, plasticity, bioplastic

Materials:

- cheesecloth or fine strainer
- clear glass cooking pot* or large, glass Pyrex® measuring cup
- container to catch the whey liquid
- hot plate, microwave, or other heat source (or preheat the milk to more than 37°C/98°F—do not boil or scald—and keep it in a Thermos)
- large spoon for stirring
- paper towels
- safety goggles
- scissors (to cut cheesecloth, if using)
- thermometer
- vinegar, 2 tablespoons per cup of milk
- wax paper
- examples of biodegradable plastics, if available
- examples of casein plastics, if available
- milk, 1 cup ** not provided
- cheese cubes in a plastic baggie ** not provided

Learner Background:

Polyethylene (PE), the most widely-used plastic, is made of long chains of carbon and hydrogen atoms. Polyethylene bags and bottles, which are not biodegradable, often end up in landfills and the ocean. Materials scientists are working to develop polyethylene made from sugars and grain, which are biodegradable and cleaner for the environment.

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Polymers, including plastics, can be synthetic or natural. Today most plastics are synthetic and made from petroleum. It can take hundreds of years or more for light, heat, or moisture to break them down in the environment. When they do degrade, some can leach harmful substances into the water or soil. However, **bioplastics** are usually **biodegradable**, which means they will decay as microbes eat them.

One type of bioplastic is made from the protein found in milk, called **casein** (pronunciation: \k⁻a-'s⁻en, “kay-seen”). Casein plastic, invented in 1899, is made by a process similar to cheese making in which an acid (in this case, vinegar) is added to milk. This causes the casein proteins to unfold and reorganize into long chains of molecules forming a polymer. This process is called **polymerization**. (www.Pbs.org/nova/makingstuff)

Learning Activity or Procedure:

See additional materials

Additional Resources:

www.Pbs.org/nova/makingstuff

Teacher Notes: This activity requires advanced preparation

1. At least one day before the activity, make several casein samples using the *NOVA Making Stuff Cleaner* recipe for Instant Cheese Bioplastic
2. Before the activity, heat the milk to at least 37°C/98°F ****Do not boil or scald the milk****
3. Cut the cheesecloth into squares large enough to be affixed with rubber bands over the mouth of the container that you will use to strain the mixture, separating the curds from the whey.
4. Gather examples of biodegradable products – plastics that contain Polyactic Acid (PLA) plastic (some newer bags of potato chips)

Safety:

Although cheese is generally safe to eat, commercial bioplastics often contain non-bio materials. **DO NOT EAT** the bioplastics

Allow the curds to cool for at least three minutes before handling

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STEM Careers:

Bio-engineer

Research Scientist

Synthetic Biologist

Environmental Technician

Materials Scientist

Environmental Scientists

Health and Safety Engineers

Materials Engineers

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Standards:

Next Generation Science Standards:

NGSS Performance Tasks	5-PS1-1 <ul style="list-style-type: none">Develop a model to describe that matter is made of particles too small to be seen. MS-PS1-2 Matter and its Interactions <ul style="list-style-type: none">Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. HS-PS2-6 <ul style="list-style-type: none">Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
NGSS - (DCI) Disciplinary Core Ideas	MS- PS1.A: Structure and Properties of Matter <ul style="list-style-type: none">Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
NGSS - (CC) Cross-Cutting Concepts	CC-3 Scale, Proportion, and Quantity <ul style="list-style-type: none">Natural objects exist from the very small to the immensely large. MS - Patterns <ul style="list-style-type: none">Macroscopic patterns are related to the nature of microscopic and atomic-level structure
NGSS - (SEP) Science and Engineering Practices	SEP 2- Developing and Using Models <ul style="list-style-type: none">Use models to describe phenomena. SEP 4 – Analyzing and Interpreting Data <ul style="list-style-type: none">Analyze and interpret data to determine similarities and differences in findings. SEP 6 – Constructing conclusions and designing solutions <ul style="list-style-type: none">Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

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Common Core Standards:

<p>CC ELA/Literacy Standards</p>	<p>RI.5.7</p> <ul style="list-style-type: none">• Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.(5-PS1-1) <p>SL.8.5</p> <ul style="list-style-type: none">• Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2)
<p>CC Math</p>	<p>MD.C.3</p> <ul style="list-style-type: none">• Recognize volume as an attribute of solid figures and understand concepts of volume measurement. (5-PS1-1) <p>6.EE.C.9</p> <ul style="list-style-type: none">• Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-2)Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-2)