

Green Chemistry

Grade level: 6-10

Summary of lesson:

Students will develop sustainable bioplastic prototypes made from benign materials in this Green Chemistry unit. They will learn about the life cycle of conventional petroleum-based plastics and consider how each stage of the life cycle could be improved upon to make the process more sustainable. Students will learn about the role that Green Chemistry plays in intentionally designing chemical products that are safer for humans and the environment. During their various trials, students will experimentally determine the role that the concentration and pH of a solution play in breaking down a starch into polymers and monomers. They will also learn how the type and size of starch granules influence the flexibility of your bioplastic. Students employ these chemistry principles to optimize their bioplastic formulation to create alternatives to plastics currently in use. They will consider improvements on the design as part of the prototyping process.

Time/Duration:

Each unit is designed to be 90 minutes. Teachers break down the lesson based on schedule minutes and available time. Example: 7th-8th grade science teaches 1 unit a week, and he meets 3 days a week, once for 55 minutes and twice for 90 minutes. It depends on deep educators who want to take it.

Learning Principles by Subject Area:

- Green Chemistry
- Chemical reactions
- Laboratory safety
- Prototyping

Subject areas/Standards:

Green Chemistry

Massachusetts Science and Technology/Engineering Standards - Middle School

Meeting	Technology/ Engineering Standards	Physical Science Standards	Practices
Meeting 1: Invention Introduction	6.MS.ETS1-1 6.MS.ETS1-5 6.MS.ETS1-6 6.MS.ETS2-2 7.MS.ETS1-2 7.MS.ETS1-7 7.MS.ETS3-4 8.MS.ETS2-4		- Asking questions and defining problems. - Constructing explanations and designing solutions. - Engaging in argument from evidence. - Obtaining, evaluating, and communicating information.
Meeting 2: Inventing for a Sustainable Future	6.MS.ETS2-1 6.MS.ETS2-2 7.MS.ETS1-4	6.MS.PS1-6 7.MS.PS3-7 8.MS.PS1-5	- Asking questions. - Planning and conducting investigations. - Analyzing and interpreting data. - Constructing explanations and designing solutions.
Meeting 3: Reuse and Explore	6.MS.ETS1-1 6.MS.ETS1-5 6.MS.ETS1-6		Asking questions.
Meeting 4: Experimenting with Bioplastics	6.MS.ETS2-2 6.MS.ETS2-3 7.MS.ETS1-7 6.MS.ETS1-6		- Developing and using models. - Planning and carrying out investigations.
Meeting 5: Optimizing our Bioplastic Invention	6.MS.ETS1-1 6.MS.ETS1-6 6.MS.ETS2-2 7.MS.ETS1-2 7.MS.ETS1-7		- Developing and using models. - Planning and carrying out investigations. - Constructing explanations and designing solutions. - Obtaining, evaluating, and communicating information.
Meeting 6: Prototype	6.MS.ETS1-1 6.MS.ETS1-6 6.MS.ETS2-2 7.MS.ETS1-2		- Asking questions. - Developing and using models. - Constructing explanation and defining solutions. - Obtaining, evaluating, and communicating information.
Meeting 7: Communicating Ideas	6.MS.ETS1-6	7.MS-ESS3-4	Constructing explanations and designing solutions

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For more information, contact info-lemelson@mit.edu

Green Chemistry

Massachusetts Science and Technology/Engineering Standards - High School

Meeting	Technology/ Engineering Standards	Physical Science Standards	Practices
Meeting 1: Invention Introduction	HS.ETS1-3 HS.ETS1-6 HS.ETS2-1		- Asking questions. - Constructing explanations and designing solutions. - Engaging in argument from evidence. - Obtaining, evaluating, and communicating information.
Meeting 2: Inventing for a Sustainable Future	HS.ETS4-1	HS.PS3-1 HS.PS3-3	- Asking questions. - Planning and conducting investigations. - Analyzing and interpreting data. - Constructing explanations and designing solutions.
Meeting 3: Reuse and Explore	HS.ETS1-1 HS.ETS2-1		Asking questions.
Meeting 4: Experimenting with Bioplastics	HS.ETS2-1 HS.ETS4-1	HS-PS1-9(MA) HS-PS1-11(MA)	- Developing and using models. - Planning and carrying out investigations.
Meeting 5: Optimizing our Bioplastic Invention	HS.ETS1-3 HS.ETS1-6 HS.ETS4-1	HS-PS1-9(MA) HS-PS1-11(MA)	- Developing and using models. - Planning and carrying out investigations. - Constructing explanations and designing solutions. - Obtaining, evaluating, and communicating information.
Meeting 6: Prototype	HS.ETS1-2 HS.ETS1-3 HS.ETS1-6	HS-PS1-9(MA)	- Asking questions. - Developing and using models. - Constructing explanation and defining solutions. - Obtaining, evaluating, and communicating information.
Meeting 7: Communicating Ideas			

Breakdown of lessons:

1. Invention Introduction

Students do warm-up activities and discuss invention. Students play “Four Corners” to help the educator assign diverse teams.

2. Inventing for a Sustainable Future

Students learn about laboratory safety, inventing, and Green Chemistry. Students create benign lava lamps that use nontoxic materials that easily decompose.

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3. Reuse and Explore

Students demonstrate an understanding of how plastics are produced when a starch is heated in the presence of an acid. Students reuse, experiment, and test the components of their benign lava lamp to examine the properties of a bioplastic in different environments.

4. Experimenting with Bioplastics

Students will comply with laboratory safety procedures to create bioplastics, compare their properties, and identify properties needed for their unique bioplastic prototype.

5 Optimizing Our Bioplastic Invention

Students will examine the role that concentration and pH of the solution play in the properties of a bioplastic. Students use their knowledge of bioplastic properties to brainstorm ideas for a prototype.

6. Prototype

Students optimize the bioplastic-making process to create a unique bioplastic with specific properties needed to create their prototype. Students will then write a pitch to communicate about their invention.

7. Communicating Ideas

Students communicate a purposeful invention that uses their new minds-on and hands-on skills from Green Chemistry.

Materials: [Link to List](#)

