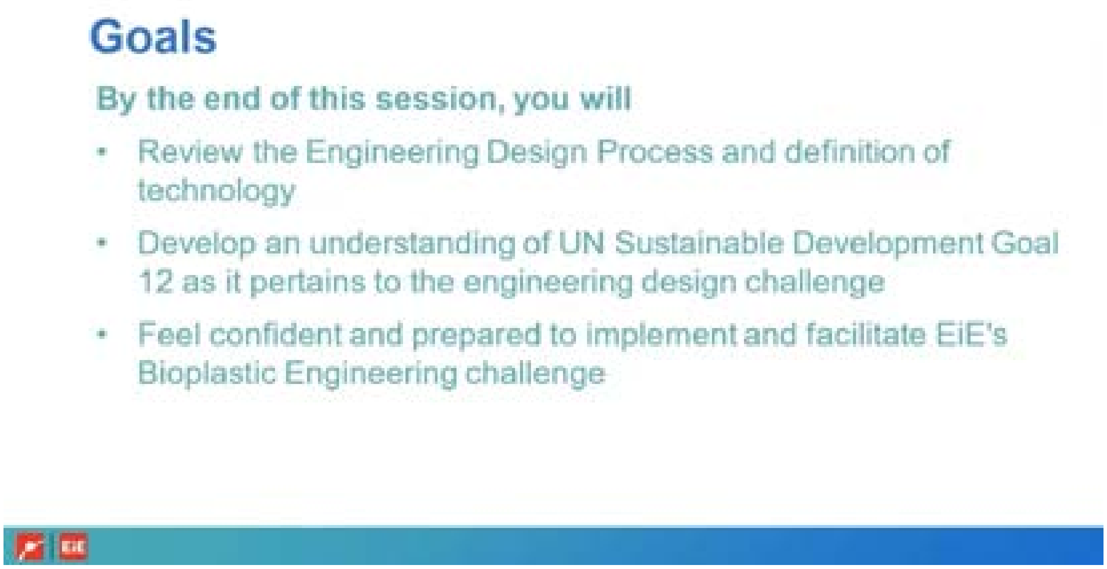
Engineering Design Challenge

Webinars

Teacher Professional Development Webinar



Webinar with Biotechnology Professionals

Tips for Teachers

Virtual Webinar

Watch the following video to learn tips from a Museum educator.

Questions?

Contact Mallory Schmidt: mschmidt@mos.org.

Are You Ready to

“See Yourself in STEM”?

An Engineering Design Challenge for Grades 6–8

The Museum of Science, Boston, and EiE® are proud to support this year’s Mass STEM Week theme, “See Yourself in STEM.” We take great pride in our mission, “To inspire a lifelong love of science in everyone,” and we believe that together we will create a generation of problem solvers for a better world. To allow educators and students alike to see themselves in STEM, the Museum of Science and EiE have developed an engineering design challenge for educators and students across the state.

The design challenge focuses on plastic: what it is, how it’s made, its environmental consequences, and the benefits of making it biodegradable. This focus was inspired by the Sustainable Development Goals (SDGs) developed by the United Nations Foundation and adopted by 193 countries in 2015. The goals seek to end extreme poverty, reduce inequality, and protect the planet by the year 2030. The following goal inspired the Museum of Science and EiE when designing the challenge for Mass STEM Week 2022:

- SDG 12: Sustainable Consumption and Production Patterns

This goal seeks to combat issues such as excessive material footprint per capita, release of harmful chemicals into air, water, and soil, and waste generation.

Learn more about the Sustainable Development Goals.

This design challenge spans the 6–8 grade band. Students learn about the use of plastics in their school, consider the harms caused by plastic use, and design bioplastics with appropriate properties to replace common plastic objects, such as utensils, plates, cups, and cling wrap.

This design challenge aligns with the 2016 Massachusetts Science and Technology/Engineering (STE) Standards. Students address real-world challenges through practical application of their science and mathematics knowledge and are empowered to see themselves as innovative problem solvers.

The design challenge also aligns to the three goals of the MA STEM Advisory Council:

1. Building foundational STEM skills for all through applied learning: The Museum of Science has decades of experience supporting students’ understanding of STEM disciplines through its programs, curricula, and exhibits.

2. Developing guided pathways to college, careers, and lifelong learning: The Museum of Science and EiE believe students find content interesting and engaging when it is relevant to their lives. Our curricula, programs, and exhibits provide this relevance for students and help them understand the work of STEM professionals.

3. Ensuring alignment to economic & workforce development through employer partnerships: The Museum of Science ensures alignment to economic and workforce development through its strong corporate, higher education, and nonprofit partnerships with the STEM workforce throughout Mas-

sachusetts. Our programs, exhibits, and curricula reflect and expand upon the knowledge we gain through these partnerships.

About the Massachusetts STEM Advisory Council:

The STEM (Science, Technology, Engineering, Mathematics) Advisory Council is established by M.G.L. Chapter 6, Section 218 in order to expand access to high-quality STEM education for students across the Commonwealth. Members of the Council include individuals from academia, business, government, and non-profits who believe in the necessity of a STEM-literate and skilled citizenry ready to meet the needs of a 21st Century workforce.

Learn more about the Massachusetts STEM Advisory Council.

STEM Choice Board

Follow Museum of Science social media pages and showcase your students' work by posting photo or video evidence from the STEM Choice Board.

Use the hashtag #MassSTEMWeek or #SeeYourselfInSTEM when you share!

Facebook
@museumofscience

LinkedIn
@museumofscience

Instagram
@museumofscience

Twitter
@museumofscience

S	T	E	M
Post about how you are using **science knowledge** during this Design Challenge!	Draw and share a **plan** for your design.	Learn from **failure.** Post your best design failure!	Post about how you are using **math knowledge** during this Design Challenge!
Show us your **materials**.	Imagine **multiple solutions** and show us at least two!	What does an engineer look like? You! Post a photo to let us know **"I Look Like an Engineer!"**	Demonstrate how you **decomposed** the design challenge into smaller tasks.
Communicate what you learned about the **properties** of your materials.	**Improve** the design. Post about how you've improved your design!	Post about what field of engineering most interests you. **"I want to be a....engineer."**	Capture data while you are **testing** your design!
Learn about the **Sustainable Development Goals.** Post your findings.	Research technologies designed by **female engineers!** Share who you learn about.	**Investigate** your future! Research and share about engineering schools in MA!	Share any **patterns** you discovered in your data.

Biotechnology Professionals

What better way to help your students see themselves in STEM than hearing from professionals whose jobs connect to the Mass STEM Week challenges?

The following video shows real biotechnology professionals who work for Massachusetts companies. Students will watch portions of this video throughout the week.

What Is Engineering?

Engineering is the process of using creativity and an understanding of materials, tools, mathematics, and science to design things that solve problems.

In this Mass STEM Week design challenge, learners think like engineers!

The Engineering Design Process

Engineers follow a flexible step-by-step development process that EiE calls the Engineering Design Process (EDP). Through their work with the Engineering Design Process, students gain insights into the nature of problem-solving:

The Engineering Design Process is not linear.

Engineers often start in the middle or end of the process, and they may repeat steps as they design a technology.

Failure is part of the process.

Learning from failure is an integral part of making successful engineering designs.

To recognize success, first define it.

To evaluate the success of a solution, engineers first define what a design must do (criteria) and what it must not do (constraints).

Solutions involve tradeoffs.

Every solution has costs and benefits. Choosing a solution involves deciding which benefits are most important and which costs are acceptable.

For these design challenges, the EDP consists of eight steps, which guide students as they think about their engineering work and discuss their ideas with others.

Identify

- Define the problem in your own words.

Investigate

- Learn about what others have done.
- Explore possible materials or processes you could use for your design.
- Conduct science experiments to gather data.

Imagine

- Use your creativity to think of lots of ideas that could work.
- Evaluate the pros and cons of each idea.
- Pick one idea that is a good starting point.

Plan

- Discuss how it will work.
- Draw diagrams and list materials.
- Decide how you will test and evaluate.

Create

- Follow your plan.

Test

- Test your design.
- Record your observations and findings.
- Figure out which parts are working well and which parts are not.

Improve

- Decide what to change.
- Put your changes into a new plan.
- Build your improved design and test again.

Communicate

- Explain strengths and weaknesses of your solution.
- Share how you used the Engineering Design Process.
- Ask people for feedback.

What Is Technology?

Many people think the word technology refers only to electronic or "high-tech" devices. In fact, any object, system, or process designed by people to solve a problem is technology.

In this Mass STEM Week design challenge, students design technologies of their own!

Watch this video to learn more:

watch video

Designing Bioplastics

Challenge Context

In this challenge, learners explore the properties that make conventional fossil-fuel-based plastics both useful and harmful. They design bioplastics with similar useful properties but fewer harmful ones.

Engineering Design Challenge: To reduce plastic pollution, design a bioplastic technology that can fulfill the same function as a conventional plastic technology.

Criteria

Design solutions must

- have properties like those of a conventional plastic technology (details in Lesson 1).
- fulfill the same function as the conventional plastic technology (details in Lesson 3).
- biodegrade (details in Lesson 4).

Constraints

Design solutions must not

- take more than 24 hours to create (including drying).
- be larger in any dimension than the diameter of a standard ceramic plate.

Structure

The challenge consists of five lessons that guide students through the Engineering Design Process.

Lesson	Description	Goal
1	Context Setting	Identify the challenge of reducing plastic waste and investigate different kinds of conventional plastic.
2	Materials Exploration	Investigate how different processes produce different bioplastic properties.
3	Solution Design	Investigate results, imagine possible bioplastic designs, then plan and create one design.
4	Solution Improvement	Test the bioplastic's function and biodegradability. Improve the design.
5	Communication	Communicate about bioplastic technologies.

EiE® Lessons Powered by Pear Deck™

EiE® teamed up with Pear Deck™ to create interactive versions of these lessons. Pear Deck makes it easy for educators to connect with every student by engaging them through discussion and interactive prompts.

Pear Deck is free and integrates with tools you already use, like Google and Microsoft products.

Get started today!

Adapting the Context

You can adapt the context of this engineering design challenge and provide additional resources relevant to your local community. For example, learners may observe plastics in a variety of locations, including a cafeteria, gymnasium, or classroom.

Resources

Beat Plastic Pollution (United Nations Environmental Programme)

Marine Plastic Pollution (International Union for Conservation of Nature)

Planet or Plastic? (National Geographic)

Planning

Goals

By the end of this challenge, learners will

- Identify the challenge of reducing plastic waste and investigate different kinds of conventional plastic.
- Investigate how different processes produce different bioplastic properties.
- Imagine possible bioplastic designs, then plan and create one design.
- Test the bioplastic's function and biodegradability. Improve the design.
- Communicate about bioplastic technologies.

Materials

Drawing, sketching, writing:

Engineering Journal, writing utensil

Investigation:

Conventional plastics of various kinds (such as utensils, bottles, plates, bowls, cling wrap, rulers, or balls)

Measurement:

Teaspoons, tablespoons

Bioplastic Ingredients:

Agar (1 oz/student), cornstarch (3 oz/student), glycerin (1 oz/student), water

Tools for Creating Bioplastic:

Paper bowls, spoons, ceramic plates, paper towels, microwave, hot mitts, toothpicks, masking tape

Testing:

Small food items (such as pieces of cereal), water, weights

Timing

5 Lessons

30–60 minutes each

3–5 hours total

Vocabulary

General Engineering

- Constraints
- Criteria
- Engineer
- Engineering
- Engineering Design Process
- Process
- Property
- Technology

Bioplastics Specific

- Biodegrade
- Bioplastic
- Chemical Engineer

This challenge is aligned with the following MA curriculum standards and UN Sustainable Development Goal:

MA Science Standards

6.MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.

6.MS-ETS2-2 (MA). Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.

7.MS-ETS1-4. Generate and analyze data from iterative testing and modification of a proposed object, tool, or process to optimize the object, tool, or process for its intended purpose.

7.MS-ETS1-7 (MA). Construct a prototype of a solution to a given design problem.

7.MS-LS2-5. Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.

8.MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

UN SDG

SDG 12: Ensure sustainable consumption and production patterns.

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

Lesson 1: Context Setting

20 minutes at home
30–50 minutes in class

Goal

Identify the challenge of reducing plastic waste and **investigate** different kinds of conventional plastic.

Learners explore their local environment to determine the different ways in which plastic is used. They explore the properties of different kinds of plastics and consider how those properties are suitable for different functions.

Materials & Prep

Educator:

- Plastics 101
- School Trio Win National Engineering Competition
- UN SDG 12: Sustainable Consumption and Production
- Identify (biotech engineers video 1)
- Engineering Design Process poster

Learners:

- writing utensil
- Engineering Journal (page 2, page 3, and page 4)

TIP

Familiarize yourself with the UN Sustainable Development Goals pages, which contain a variety of videos, infographics, facts, and figures.

EDP Steps

Access the interactive version of this lesson, powered by Pear Deck™

Pre-Work

20 minutes

Have learners share page 2 of their Engineering Journals with their family members. This page describes Mass STEM Week and includes the STEM Choice Board.

Invite learners to watch the Plastics 101 video and start thinking about the kinds of plastic they use in their everyday lives. Learners can research or ask family members about the ways in which they use plastic. Have them record their ideas on page 3 of their Engineering Journals.

If time permits, you can also have them read the article "School Trio Win National Engineering Competition," which describes student development of bioplastics.

Lesson

30–50 minutes

Introduction

5–10 minutes

Play Identify for the class. Tell learners that, as described in the video, they will be identifying a problem. Help learners identify the problem for the week by asking the following questions:

- **How do you use plastic in your everyday life?** *Accept all responses. Possible responses include for containers (such as cups, bottles boxes, bags), tools (such as toothbrushes, pens, phones), and clothing (such as shoes).*

Explain to learners that all the items they have named are examples of **technology**, an object, system, or process designed by people to solve a problem. They will continue thinking about plastic technologies.

- **What about plastic makes it useful for technologies?** *Accept all responses. Possible responses include that it can be shatterproof, lightweight, flexible, and easy or difficult to break (depending on the type).*

- **What about plastic makes it harmful?** *Accept all responses. Possible responses include that it lasts for a long time and can damage the health of animals and other living things.*

Explain to learners that special qualities and characteristics of a material are **properties**. They have just listed beneficial and harmful properties of plastic. Limiting the use of materials with harmful properties is one of the major challenges in the world today, which is why the United Nations identifies it as a component of one of its Sustainable Development Goals.

- **According to the plastics video, what are some solutions to the harmful properties of fossil-fuel-based plastic?** *Responses will vary. Possible responses include using organisms that can break down the plastic and manufacturing bioplastics from living things.*

Explain that this week, learners will work on the challenge of designing **bioplastics**—plastics made of materials found in living things, such as plants or algae—that have the same beneficial properties as conventional plastics but fewer harmful properties. This work will help protect animals and other living things.

Activity

10–15 minutes

Tell learners they will begin by investigating the plastic technologies they use in their school. They will determine which beneficial properties each type of plastic has. This knowledge will later help them design bioplastics with the same beneficial properties. Ask:

- **Where in the school do we use many different plastic technologies?** *Accept all responses. Possible responses include a cafeteria, classroom, or gymnasium.*

Select one of the locations suggested by your learners and travel there. At your selected location, have learners examine the different plastic technologies present. On page 4 of their Engineering Journals, have them record technologies, their functions, and the beneficial properties that enable those functions. (For example, the function of a spoon is to hold food that is not entirely solid. To enable this function, it has the beneficial properties of hardness, inflexibility, and curved edges.)

Remote Learning

- If your students are learning remotely, they can investigate the functions and properties of plastic technologies around their homes.

Share Your Learning!

- Learners can share photos of plastic technologies they find and tag @museumofscience, using the hashtag #MassSTEMWeek or #SeeYourselfInSTEM. Search using the hashtags to find other Massachusetts engineers' posts. Ensure learners consult with an adult before posting online.

Reflection

5–10 minutes

Return to your classroom and have students discuss their findings, either all together or in small groups.

Remote Learning

If your students are learning remotely, they can share their findings in breakout rooms or on shared documents.

To encourage discussion, ask questions such as the following:

- **What plastic technologies did you investigate?** *Responses will vary. Possible responses include utensils, wrappers, plates, pens, and balls.*
- **Of the plastic technologies you investigated, which do you think it would be best to replace with bioplastics? Why?** *Responses will vary. A possible response is that it is best to replace single-use plastic technologies, such as utensils and wrappers, because that replacement would significantly reduce the amount of trash produced. Those items could be composted instead of being thrown away.*
- **If we want to replace those technologies with bioplastics, what properties do those bioplastics need to have?** *Responses will vary but should connect to the function of each technology. Possible responses include that a wrapper must be easy to tear and a fork must have sharp tines.*

Look Ahead

5 minutes

Explain that this week, learners will think like **chemical engineers:** people who use their understanding of chemistry to design things that solve problems. They have already begun using the **Engineering Design Process**—the steps engineers use to design something to solve a problem—by identifying the problem of plastic pollution and investigating the properties of conventional plastics. Share the Engineering Design Process poster and explain that students will use all the steps over the course of the week.

Explain that tomorrow, learners will investigate how to make bioplastics with various properties. The knowledge they gain will help them design successful replacements for conventional plastics.

Lesson 2: Materials Exploration

10–20 minutes at home
40–60 minutes in class

Goal

Investigate how different processes produce different bioplastic properties.

Learners explore the kinds of materials used to make bioplastics. They observe how different processes for combining these materials result in different bioplastic properties.

Materials & Prep

Educator:

- Special Report Video (3:24–5:14)
- Investigate (biotech engineers video 2)
- Microwave (or hot plate)
- Hot mitts

Learners:

- Writing utensil
- Engineering Journal (page 5, page 6, and page 7)
- Teaspoons, tablespoons
- Agar, cornstarch, glycerin, water
- Paper bowls, spoons
- Ceramic plates, paper towels
- Masking Tape

TIP

Consider ways to connect the activities in this lesson to concepts students have studied in science, such as molecules and chemical bonds.

EDP Steps

Access the interactive version of this lesson, powered by Pear Deck™

Pre-Work

10–20 minutes

Have learners watch the Special Report Video from 3:24 to 5:14 to become familiar with how materials from living things can create bioplastics. On page 5 of their Engineering Journals, have them brainstorm common materials made from plants that might be useful for making bioplastics.

Lesson

40–60 minutes

Introduction

5–10 minutes

Play Investigate for the class. Tell learners that, as described in the video, they will be investigating possible solutions to the problem they identified. Specifically, they will investigate different processes for making bioplastics. They will determine how different processes create different properties.

To prompt learners to think about this work, ask the following questions:

- **What is a process?** *Accept all responses. Learners may define a process as a routine or way of doing something. They may give examples of familiar processes, such as getting dressed, brushing their teeth, or following a recipe.*

If necessary, explain that a **process** is a series of actions or steps leading to a result or goal. Just as the engineer in the Special Report video designed a process to produce liquid bioplastic, learners will investigate different possible processes for creating their own bioplastics.

- **What kinds of materials from plants could we use in our processes?** *Responses will vary. Possible responses include sugars, syrups, starches, and nectars. Learners may give examples of common ingredients from plants, such as cornstarch and maple syrup.*

Explain that students will have access to the following materials, which are similar (or possibly identical to) the ones they named:

- Agar
  - sugars from algae, often used to grow bacteria
- Cornstarch
  - carbohydrates from corn, often used in cooking
- Glycerin
  - sugar alcohol from fermentation, often used in cooking
- Water

Remote Learning

- If your students are learning remotely, have them locate similar sugars or starches in their home and ask their caregivers if they can use some to create their bioplastics.
  - The role of agar is to make the bioplastic thinner; substitutes include gelatin and pectin.
  - The role of cornstarch is to make the bioplastic thicker; substitutes include flour, potato starch, and xanthan gum.
  - The role of glycerin is to make the bioplastic more flexible; substitutes include corn syrup, vegetable oil, and honey.

Activity
25–35 minutes

Explain that learners will now have the chance to explore different processes for making bioplastics. They will work in small groups and follow the instructions on page 6 of their Engineering Journals. Each group will record the process it tests on page 7.

As learners work, supervise the microwave and ensure they are using it appropriately.

Instead of using a microwave, learners can make their bioplastics by stirring together ingredients on a hot plate for 1–4 minutes. If they do so, ensure they are using the hot plate safely.

Remote Learning

If your students are learning remotely, have them ask for adult supervision while using a microwave.

Note
The Engineering Journal lists six different process options for creating bioplastic. To ensure that learners have a range of results to examine in the next lesson, you may want to assign a process to each group to ensure all processes are used.

Share Your Learning!
Have learners take videos and photos of the processes they are testing. Post pictures on social media and tag @museumofscience, using the hashtag #MassSTEMWeek or #SeeYourselfInSTEM.

Reflection
5–10 minutes

Have learners discuss their investigation by asking questions such as the following:

- **What did you observe about your materials as you mixed and heated them?** *Accept all responses. Learners may have noticed the materials changing color or texture.*

- **What kinds of bioplastics do you expect these processes will make?** *Accept all responses. Learners' observations of the processes may have given them ideas about what the properties of the resulting bioplastics will be.*

Look Ahead
5 minutes

Explain that tomorrow learners will observe the properties of their bioplastics when they are dry. They will then plan and create their bioplastic technologies.

Store all bioplastic samples in a safe place where they can dry overnight.

Lesson 3: Solution Design

5 minutes at home
45–60 minutes in class

Goal

Investigate results, **imagine** possible bioplastic designs, then **plan** and **create** one design.

Learners investigate the results of the processes they tried. They use their findings to select among various imagined designs, make a plan, and create a bioplastic technology.

Materials & Prep

Educator:

- Special Report Video (5:30–8:06)
- Imagine, Plan, and Create (biotech engineers video 3)
- Microwave (or hot plate)
- Hot mitts

Learners:

- Writing utensil
- Engineering Journal (page 4, page 7, page 8, page 9, and page 10)
- Teaspoons, tablespoons
- Agar, cornstarch, glycerin, water
- Paper bowls, spoons
- Ceramic plates
- Toothpicks
- Masking Tape

EDP Steps

Access the interactive version of this lesson, powered by Pear Deck™

Pre-Work
5 minutes

Have learners watch the Special Report Video from 5:30 to 8:08 to become familiar with the concept of criteria for a bioplastic technology.

Lesson
45–60 minutes

Introduction
5–10 minutes

Play Imagine, Plan, and Create for the class. Explain that today, as described in the video, learners will imagine different solutions, make a plan, and follow their plan to create a technology. Specifically, learners will complete four steps of the Engineering Design Process:

- **Investigate** the results of their bioplastic processes.
- **Imagine** processes to meet the criteria of a specific technology.
- **Plan** a process.
- Follow the plan to **create** a bioplastic technology.

Explain to learners that they will begin their work today by investigating the results of the processes they carried out yesterday.

Return each bioplastic sample to the group that created it. Have learners investigate the samples and record their observations on page 7 of their Engineering Journals.

Have groups share their findings with each other and use them to fill out the chart on page 8 of their Engineering Journals, where they will list the effects of using more or less of each material in their process.

Activity
30–40 minutes

Have groups review page 4 of their Engineering Journals to imagine the different technologies they can make. Instruct each group to imagine three technologies they might make, think about the pros and cons of each, then choose one and record it on page 9 of their Engineering Journals.

Ask:

- **When you have made your technology, how will you know if it has been successful?** *Responses will vary. Possible responses include that it has the same good properties as the conventional plastic version of the technology, it can complete the same functions as the conventional plastic version, and it can biodegrade.*

If necessary, explain that something **biodegrades** when it breaks down into different materials because of organic processes. (Something that breaks down into smaller pieces of the same material, such as conventional plastic, has not biodegraded.) The resulting materials—such as water and carbon dioxide—are then available for use in other organic processes, such as photosynthesis.

Explain that the things a successful design needs to do or have are called ***criteria***. Have learners record criteria for their technologies on page 9 of their Engineering Journals.

Ask:

- **What are the limits on your designs?** *Responses will vary. Possible responses include that they cannot take more than 24 hours to dry and cannot be too large to fit on the plate for microwaving.*

Explain that limits on a design are called ***constraints***. Have learners record constraints for their technologies on page 9 of their Engineering Journals.

Now that they have considered the criteria and constraints for their technologies, have each group plan a process to make a biodegradable version of their selected technology. Have them record the process on page 10 of their Engineering Journals.

When the plan is complete, have them follow it to make their bioplastic technology. As necessary, provide groups with toothpicks to shape their bioplastic before microwaving it.

Reflection
5 minutes

Have learners discuss their designs by asking questions such as the following:

Why do you think this process will produce bioplastic with the properties you want? Responses will vary. Learners should reference the results of their investigation of different processes.

How do you think you should test your bioplastic? Responses will vary. Learners will likely suggest using the technology for its designated function (such as a spoon holding soup) or similar function (such as a spoon holding water).

Look Ahead
5 minutes

Explain that tomorrow learners will test their bioplastic technologies and improve them using the information they gather.

Store all bioplastic samples in a safe place where they can dry overnight.

Lesson 4: Solution Improvement

5 minutes at home
45–60 minutes in class

Goal

Test the bioplastic's function and biodegradability. **Improve** the design.

Learners test their bioplastic technologies on the functions for which they were designed. They use the results to improve their processes. In addition, they set up tests to determine how well their bioplastics biodegrade.

Materials & Prep

Educator:

- Special Report Video (5:30–8:06)
- Test and Improve (biotech engineers video 4)
- Microwave (or hot plate)
- Hot mitts

Learners:

- Writing utensil
- Engineering Journal (page 11 and page 12)
- Teaspoons, tablespoons
- Agar, cornstarch, glycerin, water
- Paper bowls, spoons
- Ceramic plates
- Toothpicks
- Masking Tape

EDP Steps

Pre-Work

5–10 minutes

Have learners watch the Special Report Video from 8:41 to 9:32 to become familiar with methods of testing bioplastic technology and the concept of testing to failure. Have them consider possible methods of testing their technologies and record them on page 11 of their Engineering Journals.

Lesson

45–60 minutes

Introduction

5–10 minutes

Play Test and Improve for the class. Explain that today, as described in the video, learners will test and improve the technologies they have designed.

Specifically, they will complete two steps of the Engineering Design Process:

- **Test** the bioplastic technologies.
- Use what they learn from testing to **improve** their technologies.

Explain the materials that groups can use for their tests, such as food items, water, small weights, and other classroom supplies.

Safety Note

- Ensure any foods used for testing will not cause allergic reactions.

Remote Learning

- If your students are learning remotely, have them consider household objects that they can use to test their technologies.

Have the members of each small group share the possible tests they imagined on page 11 of their Engineering Journals. Have each small group choose one test to carry out and record it. Ask:

- **The engineers in the Special Report video test their bioplastics until they fail. Why is testing to failure important?** *Responses will vary. A possible response is that testing until a design fails provides information about the full range of a variable (such as weight, temperature, or stretch) the design can handle.*

Activity
30–40 minutes

Return each bioplastic technology to the group that made it. Have learners test the technologies and record their observations on page 11 of their Engineering Journals. Where possible, have them test until each technology fails and record the conditions under which it did so.

When groups are finished testing, ask:

- **Which properties did your technologies have? Which properties do they still need?** Accept all responses. A possible response is that a bioplastic was hard but not sufficiently flexible.
- **Another criterion for your technologies is that they biodegrade. How can we test whether the technologies biodegrade?** *Responses will vary. A possible response is by putting them outside in an area exposed to natural phenomena such as light and temperature fluctuations, precipitation, and the activity of organisms.*

If time permits, have learners bring their bioplastic technologies to a designated location and leave them there to biodegrade.

Note

- It can take several months for bioplastics to biodegrade. Ensure your selected area will not be disturbed and that you check on the bioplastics regularly before having learners revisit them.

Using their findings from the function test, have groups make plans for improved versions of their bioplastic technologies on page 12 of their Engineering Journals. When their plans are complete, have them make the new versions.

Reflection
10 minutes

Have learners discuss their work by asking questions such as the following:

- **What did you find most difficult about improving your process?** *Responses will vary. Possible responses include knowing how large a change to make or retaining good properties while improving properties that are not yet good.*

Look Ahead
5 minutes

Explain that tomorrow learners will test their improved bioplastic technologies and think about ways to communicate what they have learned.

Store all bioplastic samples in a safe place where they can dry overnight.

Lesson 5: Communication

5–10 minutes at home
45–60 minutes in class
50 minutes at optional webinar

Goal

Communicate about bioplastic technologies.

Learners test their improved bioplastic technologies. They explore ways to communicate about their designs and the features of bioplastic they have discovered.

Materials & Prep

Educator:

- Biotechnology Careers
- Communicate (biotech engineers video 5)

Learners:

- Writing utensil
- Engineering Journal (page 12 and page 13)
- Small food items, water, weights

EDP Steps

Access the interactive version of this lesson, powered by Pear Deck™

Pre-Work

5–10 minutes

Have learners watch Biotechnology Careers to learn about careers in biotechnology and how those careers might connect to their interests.

Lesson
45–60 minutes

Introduction
5 minutes

Show students Communicate. Explain that today, learners will complete the final steps of the Engineering Design Process:

- **Test** their improved bioplastic technologies.
- Explore ways to **communicate** about their bioplastic technologies.

Activity: Test
15–20 minutes

Tell students they will use the tests they designed on their improved bioplastic technologies.

Return each improved bioplastic technology to the group that created it. Have learners test the technologies and record their observations on page 12 of their Engineering Journals. Remind students to test until their technologies fail.

Have students reflect on the tests by asking the following question:

- **How were these test results different from your test results yesterday? What can you learn from this difference?** *Responses will vary. Students may notice that their technologies are either more or less effective at completing their functions. From this difference, they may draw conclusions about how changes in bioplastic processes affect the properties of the bioplastic.*

Activity: Communicate
20–25 minutes

Tell students that the final step of the Engineering Design Process is to communicate about their technologies and the things they've learned. Ask:

- **What are some possible audiences we want to communicate to?** *Responses will vary. Possible responses include family members, friends, people at school, the local community, politicians, policymakers, and professional biotechnology engineers.*
- **What different media could we use to communicate?** *Responses will vary. Possible responses include social media posts, videos, podcasts, and newsletters.*
- **Why is it important to communicate about our work?** *Responses will vary. A possible response is that sharing results encourages people to pollute less by using bioplastic rather than conventional plastic. Another response is that their findings could help engineers develop more effective bioplastics.*

In their small groups, have students choose one audience, medium, and message and record them on [page 13](#) of their Engineering Journals.

Share Your Learning!

- If time permits, have students create and share their messages about bioplastic.

Optional Webinar
50 minutes

To continue learning about biotechnology and meet a professional engineer, show students the end-of-week webinar:

Glossary

Biodegrade
to break down into different materials because of organic processes

Bioplastic
a plastic made of materials found in living things, such as plants or algae

Chemical Engineer
a person who uses their understanding of chemistry to design things that solve problems

Constraints
limits on a design

Criteria
what a successful design needs to do or have

Engineer
a person who designs things to solve problems

Engineering
the process of using creativity and an understanding of materials, tools, mathematics, and science to design things that solve problems

Engineering Design Process
the steps engineers use to design something to solve a problem

Process
a series of actions or steps leading to a result or goal

Property
a special quality or characteristic of a material

Technology
an object, system, or process designed by people to solve a problem

We Want Your Feedback

Please take our PD session evaluation survey and whole-week evaluation survey.