



FUTURELAB+

CHEMISTRY IN THE EARTH SYSTEM

*Sustainability and
Environmental Impact*


Going Green in Biopharma

Developed in partnership with:
Discovery Education

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Single Pages (use a comma): T3, T6

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Cover Image

A light micrograph of a section through cardiac muscle showing heart cancer.

PHYSICS OF THE UNIVERSE / DETECTING THE UNKNOWN

Going Green in Biopharma

DRIVING QUESTION

Why is it important that biopharmaceutical companies act sustainably?

OVERVIEW

In this lesson bundle, students dig into two concepts that they might not readily associate with biotech-sustainability and environmental impact. Students will learn about some of the main ideas that a company must look at when wanting to go “green,” including how they use and dispose of materials, chemicals, water, and energy. First, students learn what an environmental footprint is and take an online survey to assess their own environmental footprint. They then relate their own environmental footprint to that of a larger biotech lab or company and estimate the impact the lab or company can have on the environment if it isn’t working towards sustainability and green practices. Next, students break into pairs, with each pair being assigned one of four sustainability categories—energy, transportation, water, and waste. Each pair will view the 360 video “Making Medicines 360,” which gives students a virtual tour of laboratories at a biotechnology company. They record ways in which they think the company may be using their assigned resource as they watch the video and look around the laboratory using the 360 capabilities of the video. Next, teams with the same sustainability category come together to compare their observations about how their resources may be used in

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ACTIVITY DURATION

Three Days (45-minute sessions)

ESSENTIAL QUESTIONS

What is environmental sustainability and how do our choices impact it?

How do biopharma companies use resources and are there ways to make their use more sustainable?

Are there improvements that could be made in a high school science lab that could increase sustainability and reduce waste?

OBJECTIVES

Students will be able to:

Learn what an environmental footprint is and determine the size of their own footprint.

Survey how a biopharma company is using resources, such as water, energy, and materials.

Discuss strategies that companies in biopharma could use to reduce their environmental footprint and reduce waste.

Create a sustainability plan for a high school science lab by identifying where and how resources are used.

OVERVIEW (CONTINUED)

the lab and in the company. Once the groups have finished, students survey how the company in the video is working to achieve its sustainability goals, and will view a video discussing Green Biopharma goals. Once they have an understanding of their sustainability goals and actions, they create a fictional social media account to inform the public about how biopharma is “going green.” As the final piece of the lesson, students form groups of three and create a sustainability plan for the chemistry lab at their school. They will use an online CAD program (such as Tinkercad) to create an accurate map or blueprint of their chemistry lab, marking places where materials, chemicals, water, or energy are used. They then add ideas for ways that they can make their lab more sustainable as captions on their blueprint. Each group will present their sustainability plan to the whole group for feedback. As students work through the activities and discussion in this lesson, they complete a BioPharma Sustainability Journal that is used in the culminating project of the lesson.

STUDENT TASKS

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>
Take an online survey to learn what an environmental footprint is and determine their own based on resource use.	Discover how Genentech—a biopharma company—is going green.	Create a blueprint of a high school chemistry lab, identifying where resources are used.
Examine and record the way a biopharma company is using resources.	Create a social media awareness account to inform others about how the biopharma industry practices sustainability.	Design and advocate for a sustainability plan for a high school to better manage laboratory waste, conserve energy and water, and minimize transportation needs.

MAKE CONNECTIONS!

How does this connect to careers?

Environmental scientists use their knowledge of the natural sciences to protect the environment and human health. They may clean up polluted areas, advise policymakers, or work with industries to reduce waste.

Environmental laboratory technicians test for contaminants that affect the environment and the health of humans and wildlife. Some lab technicians may collect samples from the field. They may work under other job titles like environmental technician, environmental specialist, and laboratory specialist.

Sustainability analysts work with organizations to collect data on the sustainability of their practices. After analyzing data, they provide recommendations and suggestions on how to operate more sustainably.

Energy managers audit the energy output of buildings to make sure they are operating efficiently. They are often consulted when new developments, buildings, or communities are being built so that they can advise on the most efficient way to provide power.

Environmental lawyers work on issues of environmental regulation. They may be called on to defend organizations being accused of environmental malpractice or may help individuals who have been impacted by environmental malpractice sue for damages.

Social media managers are experts at using social media platforms to market products and share messages. They create posts and optimize social media performance by analyzing data.

How does this connect to our world?

Environmental scientists are all but unanimous in their assessment: we must act now to curtail the effects of climate change. Citizens have heard the message and are increasingly holding industries accountable for their environmental impact. Biotech companies use large amounts of energy and natural resources in their work. As stewards of the future, these companies must build sustainability measures into every step they take.

In this lesson, students learn about some of the ways that biopharmaceutical organizations offset their carbon footprint. They are also introduced to many different careers that work to advance sustainable practices.

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine—which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.

SOCIAL-EMOTIONAL LEARNING

Students practice social awareness and self-management skills to successfully understand what others are feeling, while appreciating and interacting positively with their diverse groups during the lesson. Many students might have a personal interest in environmental and sustainability issues and can bring these interests and knowledge into discussions. This requires all discussion participants to demonstrate empathy and practice self-management skills as personal choices about how resources are used are discussed.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

This lesson applies culturally and linguistically responsive instruction to the study of content connected to the use and availability of resources globally. Students will also explore the challenges that implementing environmentally friendly practices present to large companies. Peer support for culturally and linguistically diverse students' use of standard English helps to bridge the content from scholastic research to the reality of solving complex problems with a varied population.

COMPUTATIONAL THINKING PRACTICES

In this lesson, students put four computational thinking strategies into practice: analyzing data, collecting data, developing algorithms, and building models. As students review their environmental footprint and complete their eco journals, they are

gaining hands-on experience with analyzing data. When students develop social media posts designed to reach a broad audience, they are actually utilizing the computational thinking strategy of developing algorithms to maximize the success of their post. Finally, students use the computational thinking strategy of building models to develop a TinkerCad model of a lab.

ADVANCING INCLUSIVE RESEARCH

This lesson explains why it is important that biopharmaceutical companies act with environmental consciousness. In the course of their work, they use many resources to develop, create, and market their products. If biotech companies want to build relationships with historically marginalized communities, it is essential that they demonstrate environmental stewardship. This work shows respect to those who rely on the land for their livelihoods and helps to foster stronger, healthier communities.

CONNECTION TO THE PRODUCT LIFE CYCLE

The use of eco-friendly products and green chemistry that can be used in a biochemistry lab is important as biotechnology companies and research labs seek to incorporate sustainability practices into their methods of product research and **development**. The opportunity to reduce environmental harm while developing new medicines and therapies will be helpful for resource management and sustainability for the future.

Day 1

Slides

COMPUTATIONAL THINKING IN ACTION

The environmental footprint calculator is a helpful tool that demonstrates the value of the computational thinking strategy of analyzing data. Once a student has inputted data about their activities, they are given a score, or ecological footprint value. This value allows them to analyze their impact compared to others and ideate on ways they can reduce their ecological footprint.



Slides 1-7

Students explore their environmental footprint. (15 minutes)

- 1 To begin this lesson, tell students that they are going to explore something called an ecological or environmental footprint. They will measure their own individual ecological footprint, then look at the impact the United States is having on resource use and discuss the role that large corporations have in determining this.
- 2 Ask students to go to the [Ecological Footprint Calculator](#) on their student devices by providing them with the link. Tell them to answer the questions they are presented to the best of their ability and accuracy.
- 3 When they have completed the Ecological Footprint Calculator, give each student a copy of the [Biopharma Sustainability Journal](#). This journal is organized into entries that pair with activities in the lesson. Direct students to the Day One Entry in the [Biopharma Sustainability Journal](#) to begin.
- 4 Tell students to use the results of their ecological footprint calculator and the links provided to answer the questions in **Day One Entry: Introducing the Problem—Ecological Footprints and Sustainability**. Give students 10 minutes to complete this entry.
- 5 Next, ask students to form small groups of three. Groups should move to sit together and should take five minutes to discuss and compare their answers to the questions in **Day One Entry**, with a focus on questions five and six.

Slides 8-12

Students evaluate their thoughts and feelings on the topic of eco-friendly practices. (15 minutes)

- 1 When the time for student discussion is over, direct students' attention to the signs in the four corners of the classroom. The signs should read "STRONGLY AGREE," "AGREE," "DISAGREE," and "STRONGLY DISAGREE." Tell them that they will be participating in an activity called [Four Corners](#).

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Day 1

Continued

INDUSTRY AND CAREER CONNECTION

As students learn about different regulations and expectations placed on industries, they simulate the work of many different environmental professionals. For instance, environmental lawyers hold companies accountable to environmental regulations. Sustainability analysts advise companies on how to reduce or offset their environmental impact.

Slides 8–15

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- 2 Read the following statements as they are displayed on the overhead screen and ask students to move to the corner that represents their opinions and feelings most accurately.
-
- a. STATEMENT 1: Individuals and families should be expected to make choices to reduce their ecological footprint.
 - b. STATEMENT 2: Corporations should be expected to make choices to reduce their ecological footprint.
 - c. STATEMENT 3: Corporations and businesses bear more responsibility than individuals and families to reduce their ecological footprint.
 - d. STATEMENT 4: Businesses can be successful while making sustainability a priority in their company.
-
- 3 As students move to the corner of their choice after each statement, use a random calling technique, such as *Pick a Stick*, to ask a few students from each corner to give the reasons why they chose that corner to represent their opinion. Students should cite information from their sustainability journal.

SLIDES 13–15

Students examine and record the way a biopharma company uses resources. (15 minutes)

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- 1 Next, explain to students that some industries such as energy, mining, transportation, and agriculture have direct impacts on the environment and are required by law to mitigate and follow strict standards to reduce their negative impact on the environment. However, there are many industries that we may not think about that also need to maintain standards of sustainability and eco-friendly practices, such as biopharmaceutical companies—the companies that produce drugs and medical treatments using biotechnology.
-
- 2 Using a *Think, Pair, Share* discussion strategy, ask students to find and sit with a partner in the class. They should have one student device for the pair. Each person should also have their sustainability journal and a writing utensil.

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Day 1

Continued

Procedure

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- 2 Ask students to look at **Day Two Entry: The Ecological Footprint of a Biopharma Company**. Assign each pair one aspect that contributes to a company's ecological footprint—energy, transportation, water, and waste. Explain that students should go to the link in the journal to view the video Making Medicines in 360. As they view the video, they should record any instance they see or think that their assigned resource is being used, created, or consumed in their **Day Two Entry**.

 - 3 Give student pairs 10 minutes to view the video and record information in their sustainability journals.

 - 4 Once students are done, ask student pairs to join with another pair with the same energy, transportation, water, or waste assignment to compare the notes they made in their journals. Give groups five minutes to compare and add or revise anything in their **Day Two Entry**. This is a variation of the earlier discussion strategy. It is called *Think, Pair, Square*.

 - 5 For any remaining time in class, ask each group to choose a representative to report the ways that energy, transportation, water, and waste are used in the video to the whole group. This should leave students with a better

Day 2

Slides 16–18

INDUSTRY AND CAREER CONNECTION

Here, students learn about the ways that Genentech is working to increase its commitment to environmental sustainability. The responsibility for this work is shared by many professionals, including environmental laboratory technicians and sustainability analysts.

COMPUTATIONAL THINKING IN ACTION

As students complete their journals, they are practicing the computational thinking strategy of collecting data. This skill requires students to effectively navigate sources and to know how to verify the information they find.

Slides 16–18

Students discover how Genentech, a biopharma company, is going green. (25 minutes)

- 1 Begin the class by reflecting on Day 1 of this lesson. Ask students to read the questions on the slide and think about how corporations might make improvements on their use of resources as they create their products. Tell students that today they will look at how some biopharmaceutical companies are making important changes to decrease their environmental footprint and increase sustainability.
- 2 Remind students that in the previous class period they viewed the video of how a biopharma company makes its medicines, looking for ways they used resources or created waste in the process. Reveal to students that the same company they looked at yesterday has industry-leading programs to help them “go green in biopharma” and that they will be examining them in this lesson.
- 3 Ask students to go to the **Day Three Entry: Green Goals and Actions** in their **Biopharma Sustainability Journal**. In this entry, they will be learning about the various ways that Genentech, a leading biotechnology company, has created sustainability goals and is making decisions to increase environmental sustainability in the company and for the planet.
- 4 To get students started, ask them to look at the Green Biopharma category in the journal entry chart. Play the video *Better Chemistry* on the overhead screen. Using pause and play, ask students to write down anything that they find interesting, important, and inspiring in the column in the journal.
- 5 Give students 15–20 minutes to use the links provided in their journals to learn about Genentech’s green goals, sustainability plans, and things they are already doing in the company and find their “I’s” (things that are interesting, important, and inspiring). They should record these in the appropriate column of their journal.

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Day 2

Continued

COMPUTATIONAL THINKING IN ACTION

As students think about how to get as much attention as possible for their post, they are using the computational thinking strategy of developing algorithms. Algorithms are sets of step-by-step instructions that live at the heart of all computer platforms and social media platforms. Algorithms study how people interact with different social media posts, and in turn, influence what gets seen and shared. Students who wish to work in social media and marketing must learn about how to work alongside algorithms in order to make sure their content is seen.



Slides 19–20

Slides 19–20

Students create a social media awareness account to inform others about how the biopharma industry practices sustainability. (15 minutes)

- 1 Next, tell students that they are going to play the role of a social media manager for Genentech. The company feels that it is important that customers and patients know about the green initiatives that Genentech has and is implementing to reduce their environmental impact. Their job is to create a social media account and posts on a social media platform that will highlight and create awareness of some of the environmental sustainability accomplishments and goals that the company has.
- 2 Ask students to go to a website called *Fakebook* that will allow them to use an editable template to create a fictional Facebook account with posts, hashtags, and pictures. Students should choose a name for their account and fill in all sections of the *Fakebook* template using the information about Genentech's green initiatives, goals, and accomplishments from the **Day Three Entry**. They should add at least three posts with appropriate pictures and hashtags that will get the public's attention and show that Genentech is going green in Biopharma.
- 3 Give students 15 minutes to complete their social media profiles and posts. Ask students to share the link to their *Fakebook* with the instructor via email when they are done.
- 4 For the final minutes of class, the instructor can click on the links to some of the students' fakebook profiles and display them on the front screen for student reactions and feedback.

Day 3



Slides

Slides 21–27

Students create a blueprint of a high school chemistry lab, identifying where resources are used. (35 minutes)

- 1 Tell students that for the next part of this lesson, they will be looking locally for ways that environmental footprints can be reduced. Explain that as the final part of this lesson, they will focus on their school, and specifically their own chemistry lab to create sustainability initiatives and green goals for the future. Ask students to form teams of three or four.
- 2 If they are not in the classroom with the chemistry lab already, the instructor should arrange a quick “field trip” for the class or create a schedule for individual teams to visit and take pictures of the lab for the first part of the activity. Or, if this is not possible, the instructor can display a photo of the chemistry lab on the overhead screen.
- 3 Tell students that they will first be using a computer-aided drawing program called *Tinkercad* on their student devices. They should use photos of the chemistry laboratory to create an accurate and detailed blueprint on Tinkercad. If students are not familiar with Tinkercad, the instructor may want to have students watch the instructional video: *TinkerCAD—Tutorial for Beginners*.
- 4 As the group is creating their blueprint, they should also be creating a list of where energy, transportation, and water are used or created in the lab in the **Day Four Entry: The Ecological Footprint of a High School Chemistry Lab**.
- 5 Once the initial laboratory blueprint is finished, they should add signs or captions to their blueprint that identifies where and how these resources are used or created.
- 6 Give students 30 minutes to create their finished and labeled blueprint. They should also complete the final column in the table for **Day Four Entry**, adding their ideas for how to create green and sustainable practices for each of the four areas.

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COMPUTATIONAL THINKING IN ACTION

Here, students are using the computational thinking strategy of building models to create their blueprint.

Day 3



CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

The use of brainstorming strategies allows culturally diverse learners to share their thoughts in a safe environment. Since the merits of any idea are not questioned, the ideas are simply shared.

Slides 28–29

Slides 28–29

Students will design and advocate for a sustainability plan to better manage laboratory waste, conserve energy and water, and minimize transportation needs. (10 minutes)

- 1 To conclude this lesson and complete their sustainability journal, students should find **Day Five Entry: Advocacy for Going Green**. Explain to students that for the final part of the lesson, they will use what they have learned about environmental footprints and sustainability in biopharma to compose a fictional letter to their school district's school board members.

The letter should explain how and why their high school chemistry lab should go green. They should cite examples of green and sustainable practices used by biopharma companies and incorporate the ideas they recorded in their **Day Four Entry** and on their blueprint in their letter.
- 2 Give students the remainder of the class period to compose their letters. If time allows, give them the opportunity to share their letters with other classmates for feedback and revisions. Have them *Brainstorm* how many of the ideas shared in the letters are feasible and may be implemented without cost or approval. *What could the students start doing now?*

National Standards

Next Generation Science Standards

Science Engineering Practices (SEP)

Practice 5 Using Mathematics and Computational Thinking

Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.

Practice 6 Constructing Explanations and Designing Solutions

Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Ideas (DCI)

ESS3.A Natural Resources

All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

ESS3.C Human Impacts on Earth Systems

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

ETS1.B Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Crosscutting Concepts (CC)

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Connections to Engineering, Technology, and Applications of Science

Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.



Educator Resources

Four Corners Signs

Directions

Cut out each of the signs and place them on different walls or corners of the room.

Agree

Disagree

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Educator Resources

Four Corners Signs

Continued

**Strongly
Agree**

**Strongly
Disagree**


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Biopharma Sustainability Journal

Day One Entry: Introducing the Problem—Ecological Footprints and Sustainability

Directions

Go to the source listed in the left column and review the information on the webpage, then answer the questions.

	Video	Questions	Response
1	 <p><i>Ecological Footprint</i></p>	What is an ecological footprint and what does it measure?	
		After completing the Ecological Footprint Calculator, how many “Earths” would it take if everyone used resources as you do?	
		In exploring the data you were given with your results, what contributed most to this number?	


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Biopharma Sustainability Journal

Day One Entry: Introducing the Problem—Ecological Footprints and Sustainability

Continued

	Video	Questions	Response
2	 <p><i>What is Ecological Overshoot</i></p>	Why is it important to understand our ecological footprint as an individual, as a country, and globally?	
		<p>What things do you think you could change to reduce your ecological footprint?</p> <p>What things would be difficult to change?</p>	
		<p>What responsibility do you think businesses and corporations have in reducing our ecological footprint and practicing sustainability?</p> <p>Explain.</p>	


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Biopharma Sustainability Journal

Day One Entry: Introducing the Problem—Ecological
Footprints and Sustainability

Continued

	Article	Questions	Response
3	 <i>4 reasons it's hard to become a sustainable business</i>	Why might it be difficult for businesses and companies to follow a sustainability plan while trying to maximize their sales and profits?	

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Biopharma Sustainability Journal

Day Two Entry: The Ecological Footprint
of a Biopharma Company

Directions

Open the video *Making Medicines in 360*. While viewing, list all references to your assigned resource. Drag the screen or press the arrows in the upper left corner to change your perspective. Look and Listen. There may be clues from the narrator as to what resources are used. Don't miss anything!



1 Check your assigned resource. ☐ Energy ☐ Transportation ☐ Waste ☐ Water

2 List *any* reference to your resource.





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Biopharma Sustainability Journal

Day Three Entry: Green Goals and Actions in Biopharma

Directions

As you explore each aspect of Genentech's Environmental Stability Plan, record your "I's"—things that you find Interesting, Important, and Inspiring. You should identify things Genentech is doing that all companies should adopt as goals and policies in the future. You should have at least four to five responses for each column.

	Topic and Link	What is <i>Interesting, Important, and Inspiring</i> ?
1	 Sustainability Goals	
2	 Green Genes	
3	 Green BioPharma	
4	 Workplace Wellness	

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Biopharma Sustainability Journal

Day Four Entry: The Ecological Footprint of
a High School Chemistry Lab

Directions

As you use images of the chemistry lab to create your blueprint
or floor plan on *Tinkercad*, complete the chart below to
brainstorm about where each area that requires environmental
sustainability practices could be seen in the lab.

	Ecological Impact	Where in the chemistry lab are these used or created?	How could green or sustainability practices be added to these areas?
1	Energy		
2	Transportation		
3	Water		
4	Waste		

