AG/ENVIRONMENTAL Plant to Pharmaceutical

Product Development: Collaboration, Feedback, and Revision

Developed in partnership with: Discovery Education and Ignited

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This document is separated into two sections, For Teachers [T] and Student Resources [S], which can be printed independently.

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Follow the tips below in the Range field of your Print panel to print single pages or page ranges:

Single Pages (use a comma): T3, T6

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Cover Image

The Solanaceae plant family is rich in bioactive metabolites and has played an essential role in traditional medicine.

Product Development: Collaboration, Feedback, and Revision

DRIVING QUESTION

How do teams communicate to evaluate and improve a product?

OVERVIEW

Plant compounds can heal human conditions. Pharmaceutical companies have used this knowledge to expand access to treatment over time. Students will think back to the ethical values frameworks introduced in Lesson 2 to create and evaluate models, marketing plans, and production plans for a plant-based medicine. Communication channels will be established within and across functional role teams to provide feedback and align the message to different external parties, such as regulators, news media, patients, doctors, etc. Integrating ethical decision-making is an essential function within biotech companies that students will have an opportunity to emulate.

In this lesson, students will provide kind, specific, and helpful feedback to classmates within and across Project Team career roles. Students will integrate received feedback into revisions of their project products, and prepare to present their plant-based medicine to their audience. Opportunities will be provided for structured "project tuning" protocols, supporting students to interact constructively with peers during the feedback process.

ACTIVITY DURATION

Five class sessions (45 minutes each)

ESSENTIAL QUESTIONS

How is feedback essential to creating a final product?

How can revision help make a product more specific for its purpose?

How do different Sub-Teams within the Project Team collaborate to make a medicine for a particular patient?

OBJECTIVES

Students will be able to:

Refine their products from Lesson 7.

Communicate the rationale behind the design, finance, and communications strategy.

Collaborate across teams to give and receive feedback using the Class Ethics Framework document (from Lesson 2).

Prepare for the showcase in Lesson 9.

Have you ever wondered...

How do biotech companies collaborate with medical professionals and patients to make sure that the right patient gets the right medication at the right time?

Medical science liaisons (doctors and researchers on staff at a Biotech Firm) create communication materials and meet with individual doctors at conferences, hospitals, and practices to answer questions about the safety, efficacy, and patient population for new drugs. The Access Solutions Team makes sure that patients have access to appropriate medications regardless of their economic situations. Finally, the Communications Team works to make sure that the media is able to spread information broadly when new drugs are discovered to educate patients about new medicines that may be appropriate for their care.

Materials

Student Guide

Project Team Progress Check Capture Sheet

Peer Feedback Capture Sheet

Construction materials for molecular model

- Cardboard
- · Modeling clay
- 3D printer (if available)
- Popsicle Sticks
- Ribbon
- Pipe Cleaners
- Beads
- Toothpicks
- Paper (many colors)
- Paint

Make Connections!

How does this connect to the larger unit storyline?

As biotech development firms move a particular product through the product life cycle, they must review and revise products in order to meet regulatory guidelines. The feedback process is essential to determine and incorporate necessary changes to create a successful product. Teams collaborate with colleagues in different career roles to gain a better understanding of where products need improved depth, clarity, and communication of information.

How does this connect to careers?

Communications professionals are in charge of communicating a diverse array of scientific materials to a wide range of audiences. Their creativity in messaging and close collaboration with researchers, medical professionals, the media, and legal leads to engaging and targeted communication products.

Product and supply chain management professionals are responsible for taking a process that might take place in one lab to a process that scales up in multiple labs to accommodate hundreds, thousands, or even millions of patients, all while maintaining the quality and efficacy of the product. The skills needed include quantitative analysis, collaboration, communication with partners, an understanding of biochemical processes, and an understanding of logistics and supply chain issues.

Biochemists focus on how small molecules impact molecular processes within cells. They are amazing at figuring out direct and indirect ways to measure cellular changes that cannot be observed by eye or sometimes even with a microscope. They solve problems, create new methods to address questions without answers, and collaborate with other roles at the Biotech Firm to share their most promising work through presentations and written communication.

How does this connect to our world?

Students will gain valuable experience sharing their thinking and products with classmate "colleagues."

Successful collaboration, communication, and critical thinking in the feedback and revision processes are key Twenty-First Century skills.

This lesson series is designed for students to embody diverse career roles while also experiencing the product life cycle in a studentcentered format.

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 problembased 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

Social awareness skills will be utilized as students recognize strengths in each other's work during the peer review process, and will develop empathy and concern toward the feelings of others when providing kind, specific, and helpful feedback. Effective communication during peer review, while seeking and offering support, will provide opportunities to promote relationship skills.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students provide feedback on how different Project Teams identified group memberships and social markers of their described patient population for a plant-based medicine. Project Teams will review each others' Benefits Sharing Agreements, which provides an opportunity for students to recognize and redress bias in the biotech product development process. Additionally, students will provide kind, specific, and helpful feedback, promoting respect for different strategies used by different groups in creating the Finance Plan, the Molecular Model, and the Communications Strategy.

ADVANCING INCLUSIVE RESEARCH

As a medicine goes from discovery to develop to manufacture to commercialize, many professionals beyond researchers interact to complete this work. Increasing the diversity of these practitioners, both at the lab bench and beyond, will help biotech companies create new plantbased medicines for diverse patient populations.

COMPUTATIONAL THINKING PRACTICES

In this lesson, students will use technology to seek and provide kind, specific, and helpful feedback to peers so that they can improve their practice as they demonstrate learning. Perseverance and tolerance for ambiguity will be developed as students share their ideas and integrate feedback in the form of revisions to their work. Working as part of a team. students will continue to assume various roles while collaborating to work effectively toward a common goal. Opportunities to use collaborative technologies and feedback protocols will support student exploration of local and global issues as they develop their plantbased medicine project.

CONNECTION TO THE PRODUCT LIFE CYCLE

As a medicinal plant product moves from discovery to develop to manufacture. there are internal and external approval processes that occur to verify that the product is safe and efficacious. All of these processes revolve around clear communication, review, and feedback, and lead to more effective medicines that are hopefully available to the patients that need them. Throughout this lesson, students will be modeling this internal and external feedback process as they meet with other Sub-Teams working on the same product and with their own Project Teams working on a specific medicine to make their products more cohesive and compelling for their pitches in Lesson 9.

Procedure

Teacher Note > The goal for the week is for the Project Sub-Teams to meet with their broader Project Teams and other Sub-Teams with the same role to gather kind/specific/ helpful feedback that the students can then use to iterate their draft products in preparation for the showcase during Lesson 9. Not all teams may be at the same point in their projects, and some teams may not be ready to receive feedback on Day 1. A suggested plan for varying workflows based on individual student needs is below.

Team has draft of final product



LEARNING OUTCOMES

Students will be able to:

Construct and receive kind/ specific/helpful feedback.

Reflect on progress and set priorities.



Procedure

Teacher Note > *Remind students to consider the skills and connections using the Career Profile Role Capture Sheet from Lesson* 6.

Project Team Groups (5 minutes)

- 1 Using the Project Team Process Journal section of the **Student Guide** each Sub-Team decides on the priority for class time. Project Teams with unfinished drafts from Lesson 7 will need to prioritize completion of tasks in their **Student Guides**. Project Teams with completed drafts can move on to the peer review process.
- 2 Invite students to preview the Rubric for Biotech Unit Challenge. Reassure them that this rubric will not be used for a final grade of their project until the end of Lesson 9.

Teacher Note > Options for final "pitch" format presentation can include: a slide deck, video, infographic, newspaper article, or pamphlet for a doctor's office.

Small group, pairs, or larger critique groups (30 minutes)

- 1 Sub-Teams with completed drafts (**Student Guide**) seek feedback from peers.
 - **a.** Teams can receive peer feedback from a similar Sub-Team in a different group that is also ready for feedback, or from any Sub-Team that is at the same point in the project.
 - **b.** Students may choose to use the *Peer Feedback Capture Sheet* in the student handouts to support the peer review process.
 - c. Students can choose to informally provide feedback, such as reading other **Student Guides** on their own or having the information presented to them.
 - **d.** Students seeking additional support or structure can utilize the *Seven Minute Project Tuning Protocol* from High Tech High.
- 2 Sub-Teams who have prioritized completing unfinished tasks in their **Student Guides** may need teacher support and feedback during work time to finish.

Day 1 Continued



Procedure

Project Team Groups (10 minutes)

Students use the Project Team Process Journal section of the **Student Guide** to reflect on their progress and set priorities for the next day. Students assign homework to themselves as needed based on how class time was utilized. Have students *Project Team Progress Check Capture Sheet* move any questions for the Project Team Lead (teacher) into the relevant area on sticky notes for feedback between classes.

Teacher Note > Career connections continue as students communicate and collaborate to iterate on their draft products and prepare for the product presentation. Each Sub-Team represents a different career.

- Biochemist: Molecular Modeling Sub-Team
- Communications: Communications Sub-Team
- Manufacturing and Supply Chain Management: Finance Sub-Team



LEARNING OUTCOMES

Students will be able to:

Communicate effectively with Product Teams and Sub-Teams as well.



Procedure

Project Team Groups (5 minutes)

Using the Project Team Process Journal section of the **Student Guide**, each Sub-Team decides on the priority for class time use based on the current state of each of their **Student Guides**. Project Teams with completed drafts can move on to the peer review process if they did not have the opportunity on Day 1. Project Teams who received feedback can prioritize reviewing it and making revisions. Project Teams with unfinished drafts from Lesson 7 will need to prioritize completion of tasks in their **Student Guides**.

Small group, pairs, or larger critique groups (30 minutes)

- 1 Sub-Teams with completed drafts (**Student Guide**) seek feedback from peers if they did not receive feedback on Day 1.
 - **a.** Teams can receive peer feedback from a similar Sub-Team in a different group that is also ready for feedback, or from any Sub-Team that is at the same point in the project.
 - **b.** Students may choose to use the *Peer Feedback Capture Sheet* in the student handouts to support the peer review process.
 - **c.** Students can choose to informally provide feedback, such as reading other **Student Guides** on their own or having the information presented to them.
 - **d.** Students seeking additional support or structure can utilize the *Seven Minute Project Tuning Protocol* from High Tech High.
- 2 Sub-Teams who received peer feedback on Day 1 may review the *Peer Feedback Capture Sheet* and work on revisions.
- 3 Sub-Teams who have unfinished tasks in their Lesson 7 **Student Guide** may need teacher-made modifications to the scope of their project to complete their drafts and move on to the peer review process. A teacher may:
 - Reduce the depth of a particular task to simplify or shorten it.
 - Reduce the overall number of tasks.
 - Suggest changes to the mode of communicating or presenting information to meet student reading, writing, or timing needs.

Day 2 Continued



Project Team Groups (10 minutes)

Procedure

- 1 Students use the Project Team Process Journal section of the **Student Guide** to reflect on their progress and to set priorities for the next day. Students assign homework to themselves as needed based on how class time was utilized. Have students *Project Team Progress Check Capture Sheet* move any questions for the Project Team Lead (teacher) into the relevant area on sticky notes for feedback between classes.
- 2 Suggest to students to reexamine the Project Team Process Journal section of the **Student Guide** to:
 - **a.** Understand how their work to this point has connected to the product life cycle.
 - **b.** Acknowledge their own contributions and the contributions of others.





LEARNING OUTCOMES

Students will be able to:

Utilize peer feedback for review and revisions.

Participate in a Gallery Walk for additional feedback.



Procedure

Project Team Groups (5 minutes)

Using the Project Team Process Journal section of the **Student Guide**, each Sub-Team shares with the Project Team the goal for the day. Students may receive additional feedback today or initial feedback if they have not yet had the opportunity.

Whole Group (25 minutes)

Teachers can invite all Project Teams to participate in a Gallery Walk of project products to provide a second (or first, for some) round of feedback using the *Peer Feedback Capture Sheet*.

Project Team Groups (15 minutes)

- 1 Students use the Project Team Process Journal section of the **Student Guide** to reflect on their progress and determine any revisions based on peer review to incorporate into their products. Students should assign homework to themselves as needed based on revision plans.
 - **a.** Teachers may check in with each group to determine which, if any, need support with creating final revisions.

LEARNING OUTCOMES

Students will be able to:

Revise for final presentation of team product.

Reflect on progress and meeting team goals.

Procedure

Sub-Teams (5 minutes)

Each Sub-Team makes plans for revisions, using the *Project Team Progress Check Capture Sheet*.

Project Teams (5 minutes)

Each Sub-Team makes and shares plans for revision using the *Project Team Progress Check Capture Sheet*.

Teacher Note > *Ensure that all students know what to prioritize if they need extra support with decision making.*

Sub-Teams (35 minutes)

- 1 Sub-Teams will work on revisions as recommended by peers, and work on final product items that are not yet complete.
- 2 At the end of the day, Sub-Teams reflect on their progress and assign themselves homework if needed. Project teams may also choose to make a checklist or goals for tomorrow's tasks.

LEARNING OUTCOMES

Students will be able to:

Finalize products and Finalize products and presentations.

Build a presentation that is thorough and pleasing for an audience.



Procedure

Teacher Note > *All Sub-Teams should have finalized their products and their presentations by the end of the day. Remind student groups that presentations will begin at the start of the next week.*

Sub-Teams (5 minutes)

Each Sub-Team makes plans for revisions if needed, using the Project Team Process Journal section of the **Student Guide**. Teams can also plan to practice presenting their final products to each other to prepare for their final presentations in the next lesson.

Project Teams (5 minutes)

Each Sub-Team makes and shares plans for revision or presentation practice using the *Project Team Progress Check Capture Sheet*.

Teacher Note > *Ensure that all students know what to prioritize if they need extra support with decision making. Additionally, it may be helpful for students to sign up for a presentation time so that they are able to show up prepared for the Lesson 9 showcase.*

Sub-Teams (35 minutes)

- 1 Sub-Teams will work on revisions as recommended by peers, and work on final product items that are not yet complete. Teams with completed products should practice presenting their final products to each other to prepare for their final presentations in the next lesson.
- 2 Suggest a presentation flow for students, although students are encouraged to design their own format based on their chosen presentation method (slide deck, video, brochure, etc.). Presentations should include:
 - a. Introduction (team members, roles, and product name and purpose).
 - **b.** The Communications Team should describe the plant, medicinal compound and disease target(s), and patient population.
 - **c.** The Modeling Team should present and explain a model that shows how the plant compoundtreats diseases or symptoms.
 - **d.** The Finance Team should present a financial analysis, reasoning for production method, and Benefits Sharing Agreement.
 - e. Conclude with an invitation for questions from audience.

Day 5 Continued



Procedure

- 3 Suggest to students that at this point, the Project Team Process Journal section of the **Student Guide** should be completed.
 - **a.** This document will be of support as students complete their final project reflections during Lesson 9.
 - **b.** If all steps are not completed, this is a sign to students that they may need to assign themselves homework.
 - **c.** This document also supports students in acknowledging their own contributions and the contributions of others.
- 4 Optional Extension: Student groups prepare for the showcase during Lesson 9.

National Standards

Next
Generation
Science
Standards

LS1-2 From Molecules to Organisms: Structures and Processes

Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

LS1-6 From Molecules to Organisms: Structures and Processes

Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

ETS1-2 Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Science and Engineering Practices

Developing and Using Models (Molecular Modeling Team) Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Constructing Explanations and Designing Solutions (Communications Team)

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

Obtaining, Evaluating, and Communicating Information (Finance Team)

Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

Career and Technical Education (CTE)

A2.6

Prepare a presentation comparing the benefits and harm that can be the result of biotechnology innovations in both the research and application phases and which course of action will result in the best outcomes.

National Standards

CTE

Continued

A4.5

Discuss the structure and function of the macromolecules that compose cells, including carbohydrates, lipids, DNA, RNA, and protein molecules

A7.3

Describe intellectual property.

A7.6

Articulate issues of ethical concern, including plagiarism, copyrights, trademarks, and patents and use online data resources and searchable databases to investigate a copyright, trademark, or patent.

A9.4

Cite examples of plant parts or extracts used as pharmaceuticals.

A9.5

Use the Internet to find information about traditional pharmaceuticals, herbal remedies, and recombinant pharmaceuticals.

A9.7

Design a flowchart describing the steps for creating a new drug from hypothesis to distribution.

7.3

Understand the need to adapt to changing and varied roles and responsibilities.

7.4

Practice time management and efficiency to fulfill responsibilities.

7.5

Apply high-quality techniques to product or presentation design and development.

9.2

Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decisionmaking skills as applied in groups, teams, and career technical student organization activities.

Project Team Progress Check Capture Sheet

Directions

Complete this activity using sticky notes at the start of each work period during the Plant Medicine Biotech Project.

Project Team Name	Project Team Members
Communication Team Members	

Communications Team Progress Check

	Brainstorm	Draft	I need feedback from my team members on:	l need feedback from another team on:	I need feedback from the Project Team Lead on:
My goal(s) for day:					
My goal(s) for day:					

We need

help on:

Tasks completed

Questions?

Project Team Progress Check Capture Sheet

Continued

Project Team Name	Project Team Members
Finance Team Members	

Finance Team Progress Check

	Brainstorm	Draft	I need feedback from my team members on:	l need feedback from another team on:	l need feedback from the Project Team Lead on:
My goal(s) for day:					
My goal(s) for day:					

We need

help on:

Tasks completed

Questions?

Project Team Progress Check Capture Sheet

Continued

Project Team Name	Project Team Members
Molecular Modeling Team Members	

Molecular Modeling Team Progress Check

	Brainstorm	Draft	I need feedback from my team members on:	l need feedback from another team on:	l need feedback from the Project Team Lead on:
My goal(s) for day:					
My goal(s) for day:					
We need					

help on:

Tasks completed

Questions?

Peer Feedback Capture Sheet

Directions

Answer the questions below by seeking feedback from your Project team and/or Project Lead (teacher).

My Peer Reviewer(s)

1. A celebration my reviewer provided was:

3. Specific changes I will make to my next draft or iteration:

a.

b.

2. Two helpful suggestions my reviewer gave me were:

a.

b.

d.

с.

Rubric for Biotech Unit Challenge

Constructing Explanations and Designing Solutions

Directions

The Medicinal Plant Products (Financial Plan, Communication Plan, and Medicinal Plant Model) should be assessed after presentations during this lesson.

Observable Features of Medicinal Plant Model, Financial Plan, and Communications Plan	Meets Expectations 8–10 points	Progressing 5-7 points	No attempt O points
Constructing explanations			
a. Students explaine if and/or how a disruption in cellular processes allows a plant-based compound to treat a described disease or condition in a particular patient population, making a claim about a <i>cause and effect</i> <i>relationship</i> .			
b. Students use <i>quantitative</i> reasoning to explain how a particular production method is appropriate for their plant compound based on evidence from research and the unit as they plan to <i>scale production from the lab to</i> <i>the public consumer</i> .			
c. Students use <i>patterns</i> to identify the connections among the target audience, financial plan, molecular model, and target patient population in a format that meets the needs of the identified target audience.			

Rubric for Biotech Unit Challenge

Constructing Explanations and Designing Solutions

Continued

Observable Features of Medicinal Plant Model, Financial Plan, and Communications Plan	Meets Expectations 8–10 points	Progressing 5-7 points	No attempt O points
Designing Solutions			
 a. Creation of a detailed system model including: prototype sketch 2-D or 3-D engineering prototype model 			
Students can explain how the model illustrates the mechanism of action of their plant-based medicine.			
b. Creation of a detailed financial analysis that uses <i>scale, proportion, and quantity.</i>			
Students utilize a spreadsheet to illustrate: — environmental impacts — stakeholder benefits sharing — production efficiency — cost of their plant-medicine compound			
c. Presentation product illustrates a system model of the plant-based medicine and its production scaling plan for a specific target audience.			
With teacher approval, format choices may include: — video — slide deck — newspaper article — brochure			
 The communications product is: professional targeted to a specific audience accurate representative of the science described by other team members 			

Rubric for Biotech Unit Challenge

Constructing Explanations and Designing Solutions

Continued

Observable Features of Medicinal Plant Model, Financial Plan, and Communications Plan	Meets Expectations 8–10 points	Progressing 5-7 points	No attempt O points
Peer Feedback and Iteration			
a. Students give and receive kind, specific and helpful feedback throughout the project to refine their understanding of:			
 <i>patterns</i> used to identify a patient population 			
 system models to describe the cellular process of a particular plant medicine 			
 scale, proportion, and quantity to analyze which production method best suits their particular plant medicine 			
b. Students integrate peer feedback into all project iterations.			
c. Students document their revision process and the choices they make about what feedback to consider.			
Final Score			
Grade		· · · · · · · · · · · · · · · · · · ·	