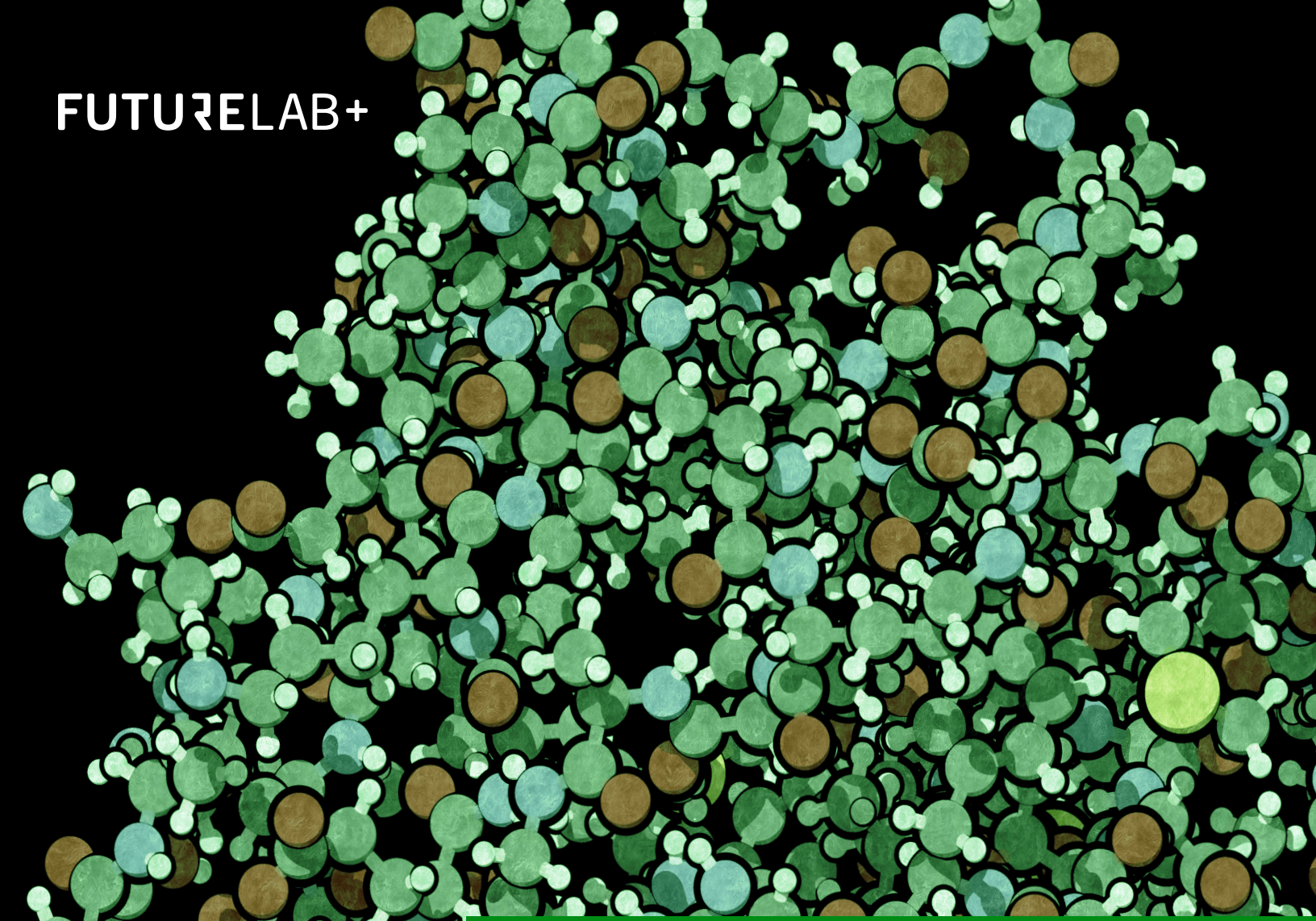
FUTURELAB+



AG/ENVIRONMENTAL

Alternative Proteins

Unit Overview

Developed in partnership with:

Discovery Education and Ignited

AG/ENVIRONMENTAL / ALTERNATIVE PROTEINS

Unit Overview

FINAL PROJECT PRODUCT

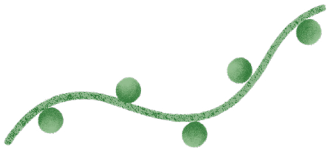
Digital portfolio of a novel GE product

OVERVIEW

In this unit, students will explore how community struggles can be solved through genetic engineering (GE) technology. Students are introduced to the terms GMO (genetically modified organism) as the recognized term for genetically engineered crops and products, as well as genetically engineered (GE) as the scientifically accurate and industry standard terminology. Students learn about GE products and their advertising by exploring product examples. They will use PCR and lateral flow testing to determine if a food product has been made with GE crops. Then students will explore the technology and protein products behind genetic engineering, and develop an ad around a selected GE product. Next they investigate Golden Rice products and their impact on the Philippines through a cultural, social, and economic lens, and debate using this product as a solution for Vitamin A deficiency. Next they will evaluate GE technology industries, the products produced by those industries, and the community struggles they were designed to solve. For their final project, students will brainstorm a novel GE product that would positively impact their community, develop a production plan, and launch an educational campaign for their GE product.

STUDENT-FACING UNIT TASK

As a group, you will take on the role of a research team looking to brainstorm a novel GE product. From food insecurity to climate change, you will identify a struggle in your own community. You will interview community stakeholders and ideate a solution to the struggle with a focus on equity and cultural respect. You will then explore the production of this novel GE product through the lens of biotechnology, sustainability, and educational marketing. As a scientist, it is important to tell the facts and provide evidence about a product so consumers can make an informed decision. As a marketing specialist, it is important to convey excitement around a new product. Can you create an educational website that describes your product accurately while enticing your potential customers to make a purchase?



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Lesson 1: Identifying GMOs

DRIVING QUESTION

Why might someone buy a GE Product over a non-GE product?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify GMOs and non-GMOs both in images and in real life. **Conduct** and **analyze** PCR tests. **Understand** how genetics can help identify GE products. **Argue** whether a GE product should or should not have been created. **CTE:** 5.4, A1.4, A9.2	Students will be exposed to careers as **grocery** and **produce managers**. This connects to the **discovery** phase of the product life cycle as students are learning about current advances in genetic engineering and are acting as researchers to test for the presence of certain genes.	Slices of apple (optional) GMO Cards to Sort GMO Card Sort Reflection Capture Sheet GMO vs. Non-GMO Ad Sheets CER Initial Capture Sheet GMO Notes Capture Sheet Project Notebook PCR Results Sheet CER Draft Capture Sheet CER Final Capture Sheet Poster paper Sticky notes	The goal of this unit is for students to develop a novel GE product based upon community needs and stakeholder input. Students will later create an ad campaign to educate the public on their product. In this lesson, the foundation is laid for students to identify differences between GE and non-GE products and to build a claim based on evidence to argue for or against the validity of certain GE products.	This lesson starts the storyline by introducing students to the concept of genetically modifying products. Students are asked to find genetically engineered products in real life, and to think about the ethical questions of creating them.

Lesson 2: Detecting Genetically Engineered Crops

DRIVING QUESTION

How can we detect genetically engineered crops in our food?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Describe how Bt-corn differs from corn labeled "USDA organic" using scientific text. **Extract, amplify,** and **visualize** DNA from food products to determine if they contain genes present in Bt-corn using scientific protocols. **Detect** proteins present in Bt-corn using lateral flow tests. **Identify** patterns in the presence of Bt-corn genes and proteins in food products using experimental results. **Create** a scientific model to explain what occurs inside Bt-corn in a food product to make it different from standard (non-genetically engineered) corn using experimental results. **CTE:** A3.3, A3.5, A8.1, A8.6, A8.7	Students will be exposed to careers in **plant geneticists** and **research associates**. Genetically engineered crops are examples of products developed by biotechnology companies. This connects to the **development** phase, during which techniques such as PCR and lateral flow are used to confirm a crop was successfully engineered to produce the desired new trait.	Lab Preparation (for teacher): — Background Reading: Bt-Maize and Organic Crops — Background Reading: What is Polymerase Chain Reaction (PCR)? — Background Reading: Analyzing PCR and Lateral Flow Results — Vocabulary Tool — Student Protocol, Part 1: DNA Extraction and PCR — Student Protocol, Part 2: Gel Electrophoresis — Student Protocol, Part 3: Lateral Flow — Student Guide Lab Part 1: DNA Extraction and PCR — Lysis buffer — 5M NaCl — TE/RNase — Organic cornmeal — Conventional cornmeal — 91–100% Isopropanol — 70% Ethanol — GE master mix — GE primer mix — Positive control DNA — dH2O Lab Part 2: Gel Electrophoresis — 1X TAE running buffer — 2% agarose gel with DNA stain — 10X loading dye — 100 bp ladder Lab Part 3: Lateral Flow — Lysis buffer — Lateral flow strips — Conventional cornmeal (Bt-corn) Lab Part 1: DNA Extraction and PCR — P1000 micropipettes — P1000 tips — P200 micropipettes — P200 tips — P20 micropipettes — P20 tips — 1.5 mL microtubes — PCR tubes — Microtube rack — PCR tube rack — Centrifuge — Thermal Cycler — Heat block set at 99°C — Cap locks — Permanent marker — Dry waste beaker — Sink or wet waste beaker — Paper towel — Crushed ice — Plastic micropestles Lab Part 2: Gel Electrophoresis — P20 micropipettes — P20 tips — Microtube rack — Dry waste beaker — Sink or wet waste beaker — Electrophoresis gel setup — UV light source and UV safety goggles Lab Part 3: Lateral Flow — P1000/P200 micropipettes — P1000/P200 tips — 1.5 mL microtubes — Microtube rack — Permanent marker — Dry waste beaker — Plastic micropestles	In this lab, students first choose a food product containing corn and extract its DNA. They then use Polymerase Chain Reaction (PCR) and gel electrophoresis to detect the presence or absence of the Bt gene cry1Ab in the DNA sample. They also perform a lateral flow test to detect the presence or absence of delta endotoxin proteins, one of which is encoded by the cry1Ab gene, that are responsible for the pest-resistant property of Bt-corn. Students then collect class data to determine the prevalence of Bt-corn in the foods they sampled and draw a scientific model explaining what happens inside Bt-corn at the molecular level.	Students will observe the ubiquitous nature of GMOs by testing corn products in the foods they eat.

Lesson 3: DNA to Alternative Proteins

DRIVING QUESTION

How are GE products produced from genes for proteins?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify the relationship between gene and protein (expression of the gene). **Describe** the various genetic engineering techniques currently available for modification. **Assess** the presence of an altered gene in a laboratory activity. **Identify** the genetic engineering technique used to produce a GE product of interest. **Market** a GE product of interest for a specific stakeholder. **Communicate** scientific information about gene-editing techniques. **CTE:** A3.1, A5.1, A9.2, A9.3	Students will be exposed to careers as **research scientists, marketing and public relations (PR) experts,** and **digital artists**. This fits into both the **discovery** portion of the product life cycle as students research existing technology, and the **commercialization** stage as they develop targeted ads for a specified consumer.	GE Product Profile Capture Sheet GE Product Analysis Codon Chart Protein Slide Capture Sheet Protein Slide Rubric Alternative Proteins Exit Ticket Exploring Genetic Engineering Infographic Exploring Genetic Engineering Methods Capture Sheet GE Product Spotlight PSA Ad Advertising Development Tips 101 Target Audience Spotlight PSA Ad Exit Ticket Alternative Protein Speed Dating Protocol Capture Sheet PSA Ad Grading Rubric Project Notebook	In this lesson, students will explore GE products on a genetic and alternative protein level. After learning more about the history of genetic engineering and recombinant DNA technology, students will gain first-hand experience in the lab where they will test the presence of a GE product protein. To conclude, students will select a GE product of interest and develop a stakeholder-focused ad that communicates the biotechnology process, gene, and alternative protein of the selected product.	Students will be practicing marketing and ad development in this lesson to prepare for their final learning artifact. The skills students use in this lesson, including taking stakeholder opinions to develop an ad, will carry into the final project.

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Lesson 4: Golden Rice Case Study

DRIVING QUESTION

How can GE technology help solve a community challenge?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Construct an explanation on how Golden Rice is used to solve a community problem. **Recognize** key players and community impact of Golden Rice production. **Describe** the GE technology used to make Golden Rice. **Illustrate** and **communicate** Golden Rice production from farm to consumer. **CTE:** 3.4, 4.1, A1.1, A1.6, A2.4, A5.1, A9.1	Students will be exposed to careers as **sociologists, plant and food scientists, food science technicians,** and **economists**. Groups will also investigate the safety of Golden Rice, find out about the **manufacturing** of the product, and touch upon **commercialization** as they explore community values.	Discover Golden Rice Capture Sheet Case Files A Day 1 Exit Ticket Careers Highlight Capture Sheet Case Files B Knowledge Profiles Capture Sheet Recap Assessment Capture Sheet GE Product Production Pipeline Infographic Manufacturing and Commercialization Flowchart Capture Sheet Analysis of Other Group Work Capture Sheet Golden Rice Case Study Rubric Projector with sound for videos Poster board Markers or colored pencils Sticky notes or whiteboard	During this lesson, students will investigate Golden Rice as a case study into how GE technology can impact a community on a local level. Students will discover the product through case study files, dig deeper into their discovery by exploring the GE technology through a cultural lens, and then collaboratively illustrate how the product is manufactured and commercialized in a final flowchart artifact.	This case study on Golden Rice manufacturing and commercialization serves as an example of how GE technology can solve a global (or local to the Philippines) health crisis. This example and the investigative skills involved in the process will be used for the final website.

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Lesson 5: Bioethics Debate

DRIVING QUESTION

Is Golden Rice the best solution for the community challenge of Vitamin A deficiency (VAD)?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify the stakeholders and their position on the impact of Golden Rice in the Philippines. **Describe** the pros and cons of bringing Golden Rice into the Philippines using sources from their research. **Debate** Golden Rice from the perspective of the assigned stakeholder. **Compare** Golden Rice in the Philippines to Golden Rice in their community. **CTE:** 7.8, A1.4, A2.1, A2.4	Students will be exposed to careers as **local (rice) farmers, foreign** service workers, and **nutritionists**. This connects to the **discovery** phase of the product life cycle as students study current GE technology, and the **development** phase as students explore stakeholder perspectives on Golden Rice.	Stakeholder Information Sheets Stakeholder Interviews How to Identify a Good Source Position Statement Capture Sheet Counterclaim Capture Sheet Individual Reflection Capture Sheet Project Notebook Computer and internet access	In this lesson, students will be debating this question from multiple perspectives, including a stakeholder with a vested interest in the production of Golden Rice, and a stakeholder from the Philippines who opposes this GE product. Students will take a deep dive into the concerns and hopes of different stakeholders from the Philippines. The class will then engage in a Socratic Seminar with each student group representing the opinions of their stakeholder with a conscious effort to practice equity, empathy, and respect as group conclusions are made.	This lesson will allow students to increase empathy for different stakeholders as well as gain an understanding of all the stakeholders involved in bringing a new GE technology to market. They will need to identify stakeholders in their local community to interview or survey about their novel GE product later in the unit.

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Lesson 6: Industries with GE Technology

DRIVING QUESTION

What GE technology is worth investigating in our community?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Summarize four GE industries associated with the agriculture supply chain and their corresponding GE products. **Distinguish** genetic engineering careers and stakeholders involved in GE production in various industries. **Compare** community challenges with GM product goals to determine if products would be beneficial to one's own community. **CTE:** 4.3, 5.1, 5.6, A9.2	Students will be exposed to careers as **clinical research physicians** and **agricultural workers**. This investigative approach covers the **discovery** phase as students explore spotlight careers, the **development** phase as students learn about specific products and how they solve a community challenge, and touches on **manufacturing** as students understand how a single product impacts multiple communities via diverse careers.	Industry Profile Posters Career Exploration Capture Sheet Medical Industry Packet Farming Industry Packet Nutrition Industry Packet Food Retail Packet Notice, Think, Wonder Capture Sheet Industry Packet Resources Capture Sheet Career Cards Community Challenges Capture Sheet Concept Map Capture Sheet Sticky notes Internet device	In this lesson, students will collaboratively assess which careers and community roles are connected with their industries or industry products prior to digging deeper into community challenges that many connect to the highlighted GE products. To organize the information obtained in this lesson, student groups will collaboratively complete a concept map to draw connections among GE industries, GE products, careers, and community challenges.	This lesson starts the storyline by surveying the various GE products that currently exist in the market, as well as the industries in which they are associated. After learning about the technology behind genetic modification of organisms and exploring a Golden Rice example, students will then transition to products that are available in the market and be able to assess their own community's needs in the context of GE products. The GE examples mentioned in this unit will be used to frame their work in the final ad campaign product.

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Lesson 7: Project Rollout

DRIVING QUESTION

What novel genetically engineered (GE) product can make a positive contribution to our local community?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify and **describe** an anchoring GE product (product already on the market) that can be used to guide the ideation of a new GE product idea. **Identify** and **describe** a novel GE product concept that has the potential to solve a community challenge. **Create** a website platform that will be used to communicate final project information. **Explain** the genetic technologies that were used to create the anchoring GE product, relating DNA structure to function. **CTE:** 4.1, 5.1, 5.4, 7.3, 7.4, A1.1, A1.2, A1.5, A5.1, A5.2, A9.1, A9.2	Students will be exposed to careers as **user interface designers** and **product designers**. In this lesson, students first summarize existing GE products and the problems they have solved, which connects to the **discovery** phase of the product life cycle. They also begin to explore tools to communicate product purposes and to advertise future technologies to potential clients, which builds on the **manufacturing** and **commercialization** phases of the product life cycle.	White board or large poster for student brainstorming Access to a computer with internet access Project Notebook Brainstorm Capture Sheet Anchoring GE Product Brainstorm Capture Sheet Product Life Cycle Analysis Capture Sheet Novel GE Product Proposal Capture Sheet Project Platform Set-Up Exit Ticket	Using materials and acquired knowledge from previous units, students will be asked to integrate current GE products, GE industries, and community challenges to begin the ideation process of producing a new GE product concept. The final student learning product will be introduced in this unit and students will begin the concept development process as they begin investigating and adding to their collaborative website.	This project roll-out will be used to kickstart students into the production of their final project; a foundation will be set for moving forward.

Lesson 8: Community Outreach—Developing Knowledge

DRIVING QUESTION

Why should the public care about my novel GE product?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify stakeholders in their own community. **Write** and **ask** targeted questions to learn how their community will react to their novel GE product. **Develop** and **execute** a plan to reach out to stakeholders to gather feedback. **Communicate** knowledge about novel GE products from various lenses. **CTE:** 2.2, 2.3, 2.4, 2.5, A1.4, A2.1, A2.4	Students will be exposed to careers as **marketing analysts, community liaisons, industry experts, genetic engineers,** and **product designers**. Students will focus on the **development** phase of the product life cycle as they engage in early stage community research. Students will be engaging with the community through surveys and interviews, while also keeping in mind the **commercialization** phase of the product life cycle. This commercialization phase is the focus on their final ad campaign and informational website.	Stakeholder Contact List Interview Questions Capture Sheet Script Template for Emails Project Notebook Interview Summaries Capture Sheet	Now that student groups have identified a local community challenge and developed a novel GE product concept, they will address the following question: does the community accept this solution? Students will develop interview questions and community surveys to gather quantitative and qualitative data around their local community's acceptance of and attitude toward their novel GE product concept. This information will then be used to bolster the informational website and final ad campaign (final product) with quotes, data, and tone that enhance public buy-in.	Students are engaging with the local community to gauge acceptance and attitudes around the proposed novel GE product. They will gather information about GE product hesitancy as well as the community challenge they identified in the prior lesson. This will inform students on their informational website and ad campaign (final project).

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Lesson 9: Sustainability and Manufacturing

DRIVING QUESTION

Why are GE products regulated and how does this influence their manufacturing?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Describe sustainability practices that should be considered when manufacturing a novel GE product. **Identify** a potential product pipeline for manufacturing a novel GE product. **Summarize** safety and efficacy data or requirements when producing a novel GE product. **Provide** feedback on a large-scale manufacturing plan for a novel GE product. **CTE:** 5.3, 6.2, 7.5, A2.4, A2.6, A9.1, A9.3	Students will be exposed to careers as **sustainability directors** and **sustainability engineers,** and **research** and **development teams**. During this lesson, students will be exploring the **development** and **manufacturing** stages of the product life cycle. The development stage involves government agency approvals, and the manufacturing activities require students to dig deeper into how a product can be produced.	GE Product Production Pipeline Infographic Manufacturing of GMOs Webquest Article Exit Ticket Project Notebook Manufacturing Research Guide Lesson 9 Exit Ticket Sticky notes Computer Internet access	In this lesson, students will be asked to formulate a plan on how to produce their novel GE product by identifying local and global organizations or stakeholders that would play a role in production. Sustainability in both efficacy of product and in the environmental impact is also an important consideration that will be explored. The majority of this unit is about application of knowledge learned from previous lessons. Open-ended research will be required of students as they collaborate on the most effective way to obtain and communicate this information on their final website product.	GE product production was a large focus in the earlier lessons, and now students will be asked to apply this knowledge to a novel GE product. Sustainability is also a focus between units and should always be a focus when considering products that will be given to consumers.

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Lesson 10: Ad Campaign—Commercialization

DRIVING QUESTION

How can you effectively commercialize your novel GE product?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify and **highlight** important data from survey results and interviews for both advertising and informational purposes. **Develop** a series of advertisements to compel their local community to utilize their novel GE product. **Curate** information about GE products, including their novel GE product, into an informational website to be shared with the local community. **CTE:** 2.5, 4.3, A2.4, A2.6, A9.1, A9.3	Students will be exposed to careers as **marketing directors, public relations directors,** and **user interface designers**. The main focus of this lesson is **commercialization**, including creating the framework for community support in novel products. Students design targeted ads and an informational website using the qualitative and quantitative data collected in community surveys and through reviewing other product pipelines. This focus emphasizes customer relations and serves to commercialize the product designed in the last several lessons.	Interview Notes Capture Sheet Survey Analysis Capture Sheet Project Notebook	Students will start by analyzing the data collected in Lesson 8 from various community stakeholders. This will inform the scripts and drafts of the ad series. Finalizing the information website with the ad campaign and last-minute revisions will finish off the project.	This is the final lesson. Students will take all they have learned about GE products, their novel GE product, and their local community to create a series of ads that will finalize their informational website.

Career and Technical Education (CTE) Standards

Anchor Standards

2.0 Communications
Acquire and accurately use Health Science and Medical Technology sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats. (Direct alignment with LS 9–10, 11–12.6)

2.2
Identify barriers to accurate and appropriate communication.

2.3
Interpret verbal and nonverbal communications and respond appropriately.

2.4
Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format.

2.5
Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

3.0 Career Planning and Management
Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans. (Direct alignment with SLS 11–12.2)

3.4
Research the scope of career opportunities available and the requirements for education, training, certification, and licensure.

4.0 Technology
Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Health Science and Medical Technology sector workplace environment. (Direct alignment with WS 11–12.6)

4.1
Use electronic reference materials to gather information and produce products and services.

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Career and Technical Education (CTE) Standards

Anchor Standards

Continued

4.3
Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

5.0 Responsibility and Flexibility
Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Health Science and Medical Technology sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques. (Direct alignment with WS 11–12.7)

5.1
Identify and ask significant questions that clarify various points of view to solve problems.

5.3
Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment.

5.4
Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

5.6
Read, interpret, and extract information from documents.

6.0 Responsibility and Flexibility
Initiate and participate in a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Health Science and Medical Technology sector workplace environment and community settings. (Direct alignment with SLS 9–10, 11–12.1)

6.2
Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities.

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Career and Technical Education (CTE) Standards

Anchor Standards

Continued

7.0 Responsibility and Flexibility
Initiate and participate in a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Health Science and Medical Technology sector workplace environment and community settings. (Direct alignment with SLS 9–10, 11–12.1)

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.

7.8
Explore issues of global significance and document the impact on the Health Science and Medical Technology sector.

Health Science and Medical Technology Standards

A1.0
Define and assess biotechnology and recognize the diverse applications and impact on society.

A1.1
Use data to explain how biotechnology fields such as pharmaceuticals, agriculture, diagnostics, industrial products, instrumentation, and research and development are impacting human life.

A1.2
Describe the use of model organisms in biotechnology research and manufacturing.

A1.4
Research and identify public misunderstandings related to biotechnology and discern the source of these misunderstandings.

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Career and Technical Education (CTE) Standards

Health Science and Medical Technology Standards

Continued

A1.5
Evaluate the impact of biotechnological applications on both developing and industrial societies, including legal and judicial practices.

A1.6
Explore and outline the various science and non-science fields and careers associated with biotechnology.

A2.0
Understand the ethical, moral, legal, and cultural issues related to the use of biotechnology research and product development.

A2.1
Know the relationship between morality and ethics in the development of biotechnology health care products.

A2.4
Understand the critical need for ethical policies and procedures for institutions engaged in biotechnology research and product development.

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.

A3.0
Demonstrate competencies in the fundamentals of molecular cell biology, including deoxyribonucleic acid (DNA) and proteins and standard techniques for their purification and manipulation.

A3.1
Define and describe the structure and function of DNA ribonucleic acid (RNA) and proteins, explain the consequences of DNA mutations on proteins.

A3.3
Employ standard techniques of DNA extraction, purification, restriction digests, bacterial cell culture, and agarose gel electrophoresis and document and evaluate results.

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Career and Technical Education (CTE) Standards

Health Science and Medical Technology Standards

Continued

A3.5
Predict outcomes of DNA and protein separation protocols.

A5.0
Integrate computer skills into program components.

A5.1
Use the internet and world wide web to collect and share scientific information.

A5.2
Use a variety of methods, including literature searches in libraries, computer databases, and online for gathering background information, making observations, and collecting and organizing data.

A8.0
Follow sustainable and safe practices with high regard for quality control.

A8.1
Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.

A8.6
Properly and safely use and monitor a variety of scientific equipment, including pH meters, microscopes, spectrophotometers, pipettes, micropipettes, and balances.

A8.7
Determine which equipment is appropriate to use for a given task and the units of measurement used.

A9.0
Understand that manufacturing represents inter-connectedness between science and production.

A9.1
Describe the major steps of a product's move through a company's product pipeline.

A9.2
Identify several products obtained through recombinant DNA technology.

A9.3
Outline the steps in production and delivery of a product made through recombinant DNA technology.

Third Party Evaluator Evidence/Findings

Completed by: American Institute of Research

Sponsored by Genentech, Futurelab+ brings together a coalition of partners to develop an innovative, modular, two-year biotechnology curriculum, including instructional materials, to expose students and educators to the breadth of education and career pathways across biotechnology. To increase adoption and access to such curricula in California and beyond, the modular curriculum was designed to align with the *California Career Technical Education (CTE) Model Curriculum Standards for Biotechnology*, meet at least one year of the *University of California science (D) subject requirement*, and incorporate some of the three-dimensional learning innovations of the *Next Generation Science Standards* (NGSS).

The two-year biotechnology curriculum provides four core units per year; each core unit has nine lessons and a lab that each take approximately one week to complete, or 9–10 weeks for the full unit. In total, the biotechnology curriculum has 72 lessons and eight labs that span two full instructional years. Because the Futurelab+ biotechnology curriculum is modular, teachers can select specific units and materials to design biotechnology courses that are relevant and appropriate for their students and teaching environment.

Unit 6: Alternative Proteins

Version Reviewed/ Date: May 16, 2022

California (CTE) Model Curriculum Standards for Biotechnology

Full Report

[Futurelab+... priority to meet California CTE Biotech Standards...] Evidence of which California CTE Biotechnology standards are addressed within the curriculum and where they are addressed is included in the *full report*.

University of California Science (D)

Full Report

Because teachers and schools can choose which portions of the curriculum to include in their final course designs, this *report series* provides evidence of where each unit meets specific criteria for the UC science (D) subject requirement and, when incorporated into a full year-long course, where the curriculum could meet at least one year of the UC science (D) subject requirement, contingent upon review and approval by UC. Subsequently, the evidence provided within the report can be used by teachers for submitting Futurelab+ course materials for UC science (D) subject approval.

The purpose of this report is to provide evidence for alignment of Unit 6 of the Futurelab+ Biotechnology Curriculum with the UC science (D) subject requirement. To help educators submit their final courses for UC science (D) subject review, the American Institutes for Research (AIR) also provides a sample unit and lab summaries, which follow the guidelines for writing a UC science (D) course (March 17, 2021).

Specifically, AIR reviewed each unit for evidence of the extent to which they meet the eight Course Content Guidelines for the UC science (D) subject requirement. This report provides specific examples to demonstrate where and how materials satisfy these criteria. Based on our review, we believe there is a strong body of evidence that will translate to Unit 6 meeting the UC science (D) subject matter requirement.

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Third Party Evaluator Evidence/Findings

Continued

Next Generation Science Standards (NGSS)

Full Report

As an organizational partner, the American Institutes for Research (AIR) provided external feedback on alignment to the three sets of standards to Futurelab+ curriculum developers during the formative period of the biotechnology curriculum. AIR is now providing external feedback and evidence on the final curriculum's alignment to each set of standards: CTE, UC science (D) subject requirement, and NGSS in a series of three reports. The eight reports in the NGSS series provide feedback on aspects of NGSS in a sample of the curriculum (one lesson from each unit). Developers selected Lesson 4 (Golden Rice Case Study) from Unit 6 (Alternative Proteins) for this report.

Of note, because the primary design element of the curriculum was alignment to CTE, AIR used the NGSS Lesson Screener (not the Educators Evaluating the Quality of Instructional Products [EQuIP] Rubric) to identify aspects of the curriculum that incorporate NGSS. The EQuIP Rubric is typically used to determine whether a unit was designed for the NGSS. Because the curriculum was designed to align primarily to CTE standards, it was not expected that the curriculum would meet all NGSS criteria. Nevertheless, in their current form, the materials from Unit 6, Lesson 4, meet one and approach four of the six criteria. AIR created the approaching rating to indicate where a modification to materials would increase the rating to adequate. For more information, please see the *full report*.