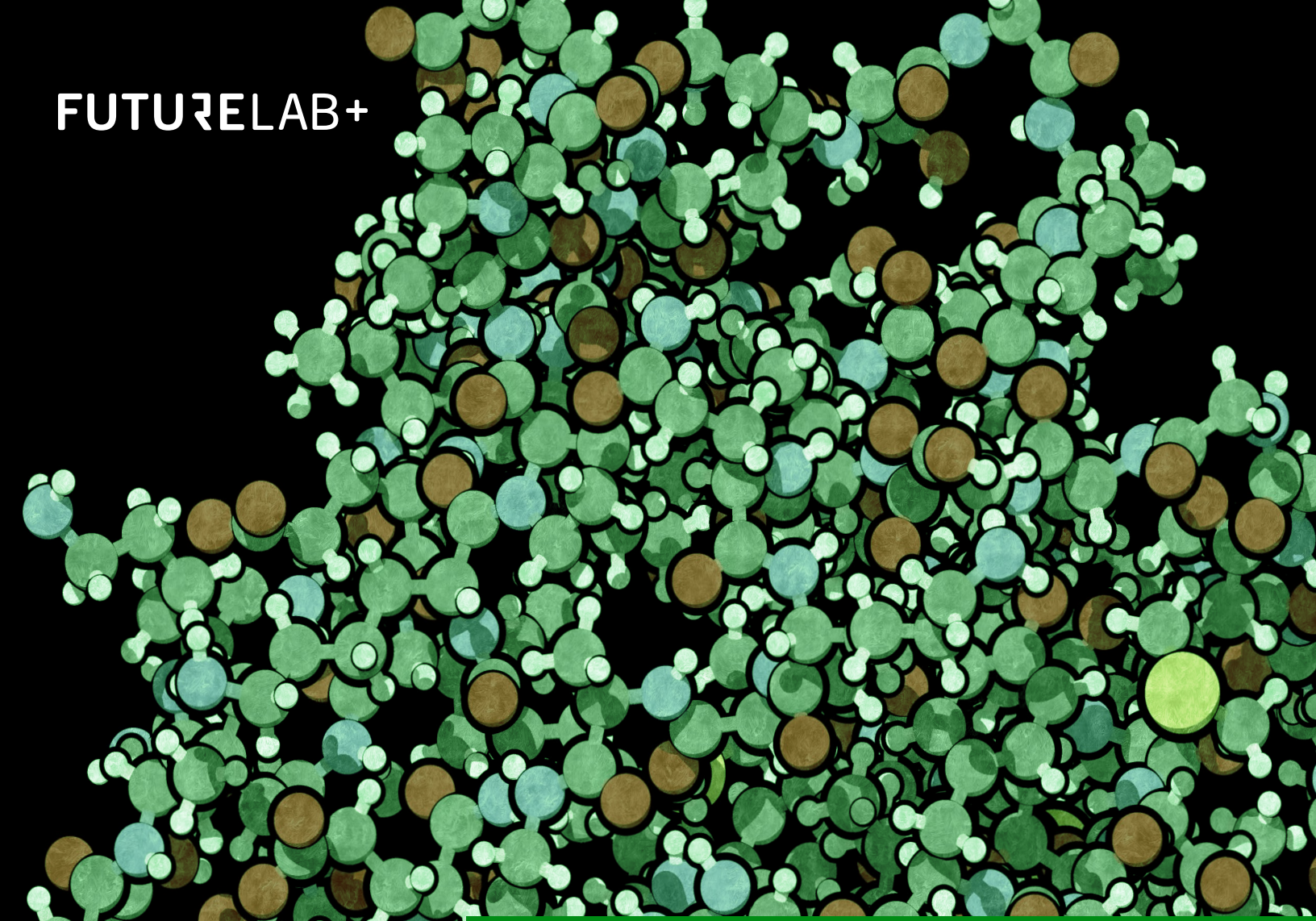
FUTURELAB+



AG/ENVIRONMENTAL

Alternative Proteins

Industries with GE Technologies

Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** →

Print the **Student Section** →

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

Select the appropriate printer icon above to print either section in its entirety.

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

Page Range (use a hyphen): T3–T6

Cover Image
This model of a protein in cow's milk is a common allergen. Could a genetically engineered modification help?

AG/ENVIRONMENTAL / ALTERNATIVE PROTEINS

Industries with GE Technologies

DRIVING QUESTION

What GE technology is worth investigating in our community?

ACTIVITY DURATION

Five class sessions
(45–50 minutes each)

OVERVIEW

GE technology involves product development in many fields including medicine, agriculture, nutrition, food retail, material science, and biomedical science. With a myriad of industries involved in the genetic modification of consumer food, students will be given an opportunity to focus on four industries and industry products included at the forefront of GE technology.

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.

ESSENTIAL QUESTIONS

Which careers and industries are invested in the production of GE products?

What community challenges are driving the production of GE products?

In what ways can a community benefit from GE products?

OBJECTIVES

Students will be able to:

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.

Materials

- **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**

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 will practice responsible decision making as they learn to make a reasoned judgment around which GE products can solve which community challenges. They will additionally practice self-management skills as they use planning and organizational tools to synthesize information into a more manageable format.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

This lesson will promote respect for students' differences as community challenges will be discussed. Students will be prompted to think about the various societal challenges in the context of their own communities, as well as determine genetic engineering solutions to local and global injustices and inequalities.

ADVANCING INCLUSIVE RESEARCH

Students will identify how various industries or industry products have impacted specific community challenges. While being sensitive to their community's challenges, including historic divides, stereotypes, and prejudices, they will identify products and technologies that were initially designed to solve challenges. They will consider how including the needs of diverse populations in all phases of research improves the end product. This assessment will give them insight direction for digging deeper into community challenges that many connect to the highlighted GE products.

COMPUTATIONAL THINKING PRACTICES

Students will implement culturally relevant learning activities that address a diverse range of ethical, social, and cultural perspectives as they explore community challenges. Additionally, students will be empowered to select personally meaningful topics that connect to their own experiences.

CONNECTION TO THE PRODUCT LIFE CYCLE

Students will explore different industries (medical, farming, nutrition, food retail) and their uses of GE products to solve challenges. This investigative approach covers the **discover** phase, as students explore spotlight careers, the **develop** 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.

Have you ever wondered…

What GE products are being created currently?

From Bt eggplant to nutrient-fortified produce, the list of products made with GE technology is vast. Agriculture-focused products will be a highlight of this lesson in connection with the industries of medicine, food retail, nutrition, and farming.

What careers are involved in the production of genetically modified products?

The production of genetically modified products does not end with the editing of genes. Many stakeholders are involved in the production and many careers (professional as well as technical) are involved with GE products.

What community challenges are GM products capable of solving?

From optimizing the shelf life of produce to providing food equity to the production of vaccines, GE products increase the quality of life for many communities. These communities, despite their differences, have common challenges such as climate change, equal access to healthy food, and equal access to health care. GE products have the potential to mitigate the impacts of these challenges on the lives of people in the community.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

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.

How does this connect to careers?

Students will explore several specific careers involved in genetic engineering in this lesson. Examples include:

Clinical research physicians complete or oversee studies that focus on improving human health. They are often involved in pharmaceutical trials, and are checking for safety, effectiveness, and appropriate doses of new medications or procedures.

Agricultural workers support farmers with a wide variety of tasks, whether in the planting and harvesting of crops, in the care of physical farming facilities and machinery, or in the caretaking of animals involved in a farm. Agricultural workers require physical stamina and problem solving skills for their work.

How does this connect to our world?

Genetically modified products are present in our world and have the potential to mitigate community challenges, yet not every GE product is universal. Assessing community challenges through an equity lens, and discussing how GE products fit in as a potential solution to the problems, requires students to critically think about global and local issues—all while connecting the topics to GE technology.

Day 1

LEARNING OUTCOMES

Students will be able to:

Identify and **analyze** the roles of industries that are involved in the creation of GE products.

Procedure

Teacher Note > *Prior to class, set up Industry Profile Posters around the room. Leave enough space for students to post sticky notes around each poster.*

Individual Work (20 minutes)	
1	Each student will get eight sticky notes. Have students write their name (or roster number to keep it anonymous) at the bottom of each sticky note. They will use two sticky notes per poster (one per question). They will have five minutes per poster to read the titles of articles (news, videos and primary literature) and write down on their sticky notes: **a.** What part of this industry interests you? **b.** What do you wonder about this industry?
2	Assign students individually to their starting poster. Once they have written their answers to the two questions on the sticky notes, they should place the sticky notes on the poster, positioned as close to the part of the poster to which they relate without covering words or images on the poster.
3	Rotate students to the next poster after five minutes.
4	While students are rotating, walk around and read the "wonder" questions on the sticky notes. You can prepare to answer a few of the questions before students decide which industry to research.

Whole Group (10 minutes)	
1	Explain to students that they will be placed into groups. Each member of the group will be responsible for learning about one of the industries and then sharing what was learned with their group members.
2	Using the wonder questions from the sticky notes, answer the most frequent or more basic wonder questions, if able.
3	Allow students to ask further clarifying questions about each of the industries so they can better choose which industry they would like to research.

Continues next page >

Day 1

Continued

Procedure

Small Group (10 minutes)	
1	Place students into groups of three to four. These will be their groups for the rest of the unit, including the final Ad Campaign Website development assignment.
2	Give each student the *Career Exploration Capture Sheet*.
3	Allow students in their groups to decide who will become the expert of each of the four industries. For groups of three, suggest that students split up the work for the fourth industry among the group members.

Individual Work (10–15 minutes)	
1	Once groups have assigned members their industries, give the groups the *Medical Industry Packet*, the *Farming Industry Packet*, the *Nutrition Industry Packet*, and the *Food Retail Industry Packet*.
2	Distribute the *Notice, Think, Wonder Capture Sheet* to each student.
3	Have students start looking at the materials associated with their chosen industry. They will complete the *Notice, Think, Wonder Capture Sheet* by the end of Day 2.

Day 2

Procedure

LEARNING OUTCOMES

Students will be able to:

Explain the roles of certain industries in the production of GE products in the agricultural field.

Investigate the GE products produced by certain industries in the agricultural field.

Identify careers involved in the creation of GE products in their assigned industry.

Medical

Farming

Nutrition

Food

Whole Group (5–10 minutes)

Have students Think-Pair-Share one thing they learned about their industry from the day before. Have students make note of the takeaways from their assigned industry to make sure they are not missing anything. Have students take note of the big takeaways from the other industries so they have some familiarity.

Teacher Note > *This might be best done by creating a table on the whiteboard with the different industries and then adding student ideas into the correct industry as they arise.*

Individual Work (30–40 minutes)

1. Invite students to continue working individually to review the material in their industry packet and complete the *Notice, Think, Wonder Capture Sheet*.

   a. Students do not need to review or read all sources. They are trying to gain a working understanding of the field without becoming overwhelmed by all that the field has to offer.

2. Prior to leaving, have students write down the three products they found most interesting, two careers that they were introduced to, and one thing they still wonder about GE technology and the industry.

3. Each student should complete the Discover—Industry Spotlight section of their Project Phase Chart Capture Sheet from their **Project Notebook**.

Teacher Note > *These two steps can be homework if there is not enough time to thoughtfully respond before the end of class.*

Teacher Note > *Group students for the final project. These should be groups of three to four students who will be working together for the duration of the unit.*

Day 3

Procedure

LEARNING OUTCOMES

Students will be able to:

Investigate and **explain** the careers involved in their assigned industry.

Small Group (10–15 minutes)

Have each student share within their group a brief explanation about the assigned industry. Students should be sure to include how GE technologies are currently being used in the industry.

Small Group (5 minutes)

1	Introduce the Card Sort activity.
2	Give each group a set of *Career Cards*. Tell groups to work together to sort the careers cards into the correct industry.

Teacher Note > *Career Card Sort Key (Note: Answers may vary, depending on group discussions.)*

Medicine (Medical Advancement and Vaccines)
- *Clinical Research Doctor*
- *Nurse*
- *Research and Development Scientist*
- *Genentech Senior Bioprocess Technician*

Farming (Sustainable Practice and Crop Production
- *Farmer*
- *Plant Geneticist*
- *Agricultural Worker*
- *Soil Analyst*

Nutrition (Wellness and Meat Protein)
- *Nutritionist/Dietician*
- *Restaurant Owner*
- *Cafeteria Food Services Worker*
- *Homeopathic Health Practitioner*

Food Retail (Food Storage and Shelf Life)
- *Stocker*
- *Grocery Store Buyer*
- *Farmer's Market Stand Owner*
- *Food Bank Employee*

Individual Work (20–30 minutes)

Using the Internet, have students research the careers involved in their industry (based on the card sort) and complete the *Career Exploration Capture Sheet*.

Teacher Note > *This can be assigned as homework if there is not enough time.*

Teacher Note > *Students are not meant to read all the material. They should choose four different sources (one for each of the different products) to complete the table, or they can read multiple sources for each of the products and complete the table row for that product. Depending on your population, you might want to require students to look at one of each type of source. English Language Learners might want to just view the video resources. Students with strong science and English backgrounds might find the research articles more engaging. The goal of this activity is for students to gain a general understanding of how GE products are being used in different industries. The Industry Packet Resources Capture Sheet has more resources and short summaries for all the resources.*

Day 4

LEARNING OUTCOMES

Students will be able to:

Identify community challenges that may be improved upon with the use of GE products.

Apply research of the agricultural GE industries and products to **solve** potential community challenges.

Procedure

Whole Group (5–10 minutes)

Review the different industries that students were learning about the last three days.

Small Group (35–50 minutes)

1	Ask group members to summarize learning from their industries and career exploration with their group members.
2	Give each group the *Community Challenges Capture Sheet*. Students should then identify which industries work to solve each of the provided community challenges. Once they have identified the industries, they can identify which products or technologies were designed to help solve the challenge.

Teacher Note > *Stress that students should not stereotype any community or group. Be sensitive to your community's historic divides, stereotypes, and prejudices to help steer your students away from furthering any of these. Students will be coming up with community challenges specific to their community on Day 5 to complete the capture sheet.*

3	Students may need to use the Internet to do brief research on the community challenges listed.

Teacher Note > *As homework, ask students to think about challenges that are specific to their community. Encourage them to ask family or friends for input. Have they experienced any community challenges that might be solved by GE products?*

Day 5

Procedure

LEARNING OUTCOMES

Students will be able to:

Identify community challenges that may be improved upon with the use of GE products.

Apply research of the agricultural GE industries and products to **solve** potential community challenges.

Whole Group (20–25 minutes)

Discuss the community challenges students identified as homework. As a class, complete the last three rows of the table on the *Community Challenges Capture Sheet* about local community challenges.

Teacher Note > *If students are having trouble brainstorming challenges in your community, here are some other ideas that can start the thinking process:*

a. Drought leading to low-crop yield
b. Climate change leading to changed growing seasons
c. Insect evolution leading to failed fields
d. Lack of access to fresh fruits and vegetables year round
e. Lack of food security and affordability
f. Lack of access to nutritious food to prevent illness or disease

Small Group (10–15 minutes)

Have groups complete the *Community Challenges Capture Sheet* by working to identify which industries work to solve each community challenge. Once they have identified the industries, they can identify which products or technologies were designed to help solve the challenge.

Individual Work (20–30 minutes)

Invite students to review the learning of the last few days by connecting industries to products and community challenges on the *Concept Map Capture Sheet*. Then have them expand their thinking by picking five GE products that could help their community.

Teacher Note > *This final time period gives students a chance to identify the five GE products in which they are most interested, thus preparing groups to decide the industry and product they will draw from to inspire their novel GE creation.*

National Standards

Next Generation Science Standards	**Science and Engineering Practice** Obtaining, evaluating, and communicating information 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)	**A2.4** Understand the critical need for ethical policies and procedures for institutions engaged in biotechnology research and product development.
	A2.5 Describe the dilemma of health care costs related to advancements in biotechnology and public access to treatments.
	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.
	4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.
	5.1 Identify and ask significant questions that clarify various points of view to solve problems.
	5.6 Read, interpret, and extract information from documents.

Career Exploration Capture Sheet

ANSWER KEY **Do not share with students**

Directions

After your group has determined which careers are associated with the industry you have chosen to research, investigate those careers and complete the table below. For the pros and cons, think about what you would like or dislike about working in the career in your future—consider your soft skills and interests when deciding.

Industry		Medical		
A	Career Name	Clinical research doctor		
1	Facts	Average Education Needed	MD or PhD	
		Average Salary	About $96,000/yr	
		Average Work Hours	Typical 9–5 hours	
2	Pros List two positive aspects of the career.	Answers will vary.		Answers will vary.
3	Cons List two negatives of the career.	Answers will vary.		Answers will vary.

Continues next page >

Career Exploration Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical		
B	Career Name	Nurse		
1	Facts	Average Education Needed	Bachelor of science in nursing (there are also two- and three-year programs); can pursue MA or DNP after completion of four-year program	
		Average Salary	$75,000–$110,000/yr	
		Average Work Hours	Average 40-hour weeks, but often divided into three or four 12-hour days	
2	Pros List two positive aspects of the career.	Answers will vary.		Answers will vary.
3	Cons List two negatives of the career.	Answers will vary.		Answers will vary.

Continues next page >

Career Exploration Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical		
B	Career Name	Research and development scientist		
1	Facts	Average Education Needed	MA or PhD	
		Average Salary	$81,000/yr	
		Average Work Hours	Average 40-hour weeks with typical work hours	
2	Pros List two positive aspects of the career.	Answers will vary.		Answers will vary.
3	Cons List two negatives of the career.	Answers will vary.		Answers will vary.

Continues next page >

Career Exploration Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical		
B	Career Name	Genentech senior bioprocess technician		
1	Facts	Average Education Needed	BA/BS preferred or AS plus five years experience	
		Average Salary	$48,000/yr	
		Average Work Hours	8–10 hour days, three to four days per week including weekends	
2	Pros List two positive aspects of the career.	Answers will vary.		Answers will vary.
3	Cons List two negatives of the career.	Answers will vary.		Answers will vary.

Continues next page >

Notice, Think, Wonder Capture Sheet

ANSWER KEY **Do not share with students**

Directions
From your industry's packet, chose four different products you learned about. Then, complete the steps listed below to explore and understand GE Products.

A–D	Enter the name of each product you choose onto one of the four capture sheets provided.
1	Notice: while you read and watch the different sources, write down what you notice about the product and its GE technology and the industry as a whole in the space provided. List at least three points per source.
2	Think: after you are finished reading the article or watching the video, write down what you think about the product and GE technology in the space provided.
3	Wonder: after you are finished reading the article or watching the video, write down a question that you wonder in the space provided. List at least one point per source.
4	Explain: after you complete steps 1–3 for two or three products, complete the final Step 4. Can you now answer any of your questions?

Answers represent four potential products that a student might select for the Medical Industry.

Continues next page >

Notice, Think, Wonder Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical
A	Product Name	Viral Vector Vaccines (VVV)
1	Notice Address both the product and GE technology. List at least three points per source.	— VVV genetically engineered to carry the pathogen's antigen so that it causes the body to produce its own antigens against the disease. — VVV must be well-characterized, easily and safely produced, and provide long lasting immunity. — Oxford-Astrazeneca COVID-19 vaccine uses a chimpanzee viral vector.
2	Think Address both the product and GE technology.	VVVs are beneficial because they cannot cause disease. The process is mostly the same for every VVV, so that seems like it would allow for vaccines to be produced more quickly when there is a need for a VVV for a new virus.
3	Wonder Think of at least one question per source.	How is "long-lasting immunity" defined, and does that definition vary depending on the disease the vaccine is made for? I wonder why VVVs cannot cause disease.
4	Explain Answer your own questions.	Yes. VVVs cannot cause disease because they have been genetically modified so that they cannot replicate in the body.

Notice, Think, Wonder Capture Sheet

ANSWER KEY — **Do not share with students**

Continued

Industry		Medical
A	Product Name	GE Mosquitoes
1	Notice Address both the product and GE technology. List at least three points per source.	— Mosquito bites are tied to viral outbreaks throughout North and South America (dengue, chikungunya, zika, and others). — GMO mosquitoes mate with wild mosquitoes and cause the offspring to die. The mosquitoes with the lethality gene are dependent on an antibiotic that is not in the wild so they die before reaching maturity. — This technique can reduce wild mosquito populations in a village by 95%.
2	Think Address both the product and GE technology.	I think that this is an effective way to reduce mosquito populations and the diseases caused by them.
3	Wonder Think of at least one question per source.	Can this same technology be used to eliminate other diseases that mosquitoes carry?
4	Explain Answer your own questions.	Yes. Similar technology is being used for mosquitoes that carry malaria, but it does not kill the mosquitoes.

Continues next page >

Notice, Think, Wonder Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical
A	Product Name	Edible vaccines
1	Notice Address both the product and GE technology. List at least three points per source.	— Vaccines are costly to produce, control, store, and distribute in certain parts of the world. — Edible vaccines are foods that already provide nutrition, with the added benefit of vaccinating against disease. — The seeds from these genetically altered plants can be distributed worldwide.
2	Think Address both the product and GE technology.	This seems like a potentially easier delivery system that could be more cost effective than traditional vaccines. However, public trust could be a problem. I think it would be harder to convince populations to eat a vaccine that is in their food.
3	Wonder Think of at least one question per source.	How is the correct dosage determined? How much of a plant would someone need to eat before becoming immune?
4	Explain Answer your own questions.	UT Austin developed an edible vaccine that is on a sheet. This suggests that dosing could be more precise than other edible vaccines.

Continues next page >

Notice, Think, Wonder Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Industry		Medical
A	Product Name	Hep B vaccine
1	Notice Address both the product and GE technology. List at least three points per source.	— Hep B is 100 times more infectious than HIV and most people do not know they are infected. — The original Hep B vaccine requires three doses (few adults complete all three), but the new Hep B vaccine requires only two. — In 2017, 8/10 children worldwide were vaccinated.
2	Think Address both the product and GE technology.	This is a vaccine that will save many lives and is therefore a good thing. The potential risks are almost zero, as the vaccine is derived from yeast and the only known side effect is anaphylaxis, which is incredibly rare.
3	Wonder Think of at least one question per source.	The sources all cite childhood vaccination. Can adults also get the vaccine and become immune to Hep B?
4	Explain Answer your own questions.	Yes. Adults can get the vaccine; however, adults over 40 have a lesser chance of it being effective.

Community Challenges Capture Sheet

ANSWER KEY **Do not share with students**

Directions

Now work to identify which industries are working to solve that challenge and how they are working to solve it. Does the challenge affect your community? Use your best knowledge from this unit to complete the table.

1. Discover. Use research artifacts provided by your teacher to explore more about Golden Rice.

A	Food Deserts	The Food Empowerment Project defines *Food Deserts* as "geographic areas where residents' access to affordable, healthy food options (especially fresh fruits and vegetables) is restricted or nonexistent due to the	absence of grocery stores within convenient traveling distance. For instance, about 2.3 million people (or 2.2 percent of all United States households) live more than one mile away from a supermarket and do not own a car."
1	What industries are working to solve it?	Farming Retail	
2	How are they currently working to solve it? Provide at least one example.	Foods that are cheaper to produce (i.e., corn that is resistant to insects or AquAdvantage Salmon) can be offered in lower income neighborhoods. Also foods that last longer after being harvested (i.e., apples that are resistant to browning or tomatoes that are resistant to mold) can be shelved in areas in which they are not typically sold.	
3	Do you think this challenge affects your community? Explain.	Answers will vary.	

Continues next page >

Community Challenges Capture Sheet

ANSWER KEY **Do not share with students**

Continued

B	Cost of Prescription Drugs	In March of 2019, in *Do Prescription Drugs Have to be So Expensive?*, The Atlantic reported that "many drugs cost more than $120,000 a year. A few are even closing in on one million dollars. The Department of Health and Human Services estimates that Americans spent	more than $460 billion on drugs—16.7 percent of total health-care spending—in 2016, the last year for which there is definitive data. On average, citizens of other rich countries spend 56 percent of what Americans spend on the exact same drug."
1	What industries are working to solve it?	Medical	
2	How are they currently working to solve it? Provide at least one example.	Using GE technology for vaccines can make them cheaper to produce and allows for more regulated quality.	
3	Do you think this challenge affects your community? Explain.	Answers will vary.	

Continues next page >

Community Challenges Capture Sheet

ANSWER KEY — **Do not share with students**

Continued

C	Education Around Healthy Nutrition	Health Journal (*Nutrition quality of food purchases varies by household income*) found that "lower household income has been consistently associated with poorer diet quality. Household food purchases may be an important intervention target to improve diet quality among low income populations."	
1	What industries are working to solve it?	Nutritional	
2	How are they currently working to solve it? Provide at least one example.	Impossible Burger allows for better nutrition as too much meat consumption is not healthy. Golden Rice can increase Vitamin A intake in populations that need it. Nutrient-rich oil provides more nutrients in everyday foods. Folic acid-rich rice allows for better nutrition.	
3	Do you think this challenge affects your community? Explain.	Answers will vary.	

Continues next page >

Community Challenges Capture Sheet

ANSWER KEY **Do not share with students**

Continued

D	Obesity	According to the National Institute of Diabetes and Digestive and Kidney Diseases (*Overweight & Obesity Statistics*), the "factors that may contribute to weight gain among adults and youth include genes, eating	habits, physical inactivity, TV, computer, phone, and other screen time, sleep habits, medical conditions or medications, and where and how people live, including their access to healthy foods and safe places to be active."
1	What industries are working to solve it?	Medical Nutritional	
2	How are they currently working to solve it? Provide at least one example.	Insulin production in yeast. Apples that are resistant to browning are more appealing to shoppers, meaning people are more likely to purchase them. People are more likely to purchase tomatoes that do not mold and are less likely to bruise.	
3	Do you think this challenge affects your community? Explain.	Answers will vary.	

Continues next page >

Community Challenges Capture Sheet

ANSWER KEY **Do not share with students**

Continued

E	Climate Change	According to the United States Environmental Protection Agency in *Climate Impacts on Agriculture and Food Supply*, "agriculture and fisheries are highly dependent on the climate. Warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to	shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past."
1	What industries are working to solve it?	Farming	
2	How are they currently working to solve it? Provide at least one example.	Use of GE crops that are drought resistant or provide resistance to an invasive pest.	
3	Do you think this challenge affects your community? Explain.	Answers will vary.	

Continues next page >

Community Challenges Capture Sheet

ANSWER KEY **Do not share with students**

Continued

2. Later, with your class, you will fill in the last four community challenge boxes with local challenges.

A–D Answers will vary.

1	What industries are working to solve it?	Answers will vary.
2	How are they currently working to solve it? Provide at least one example.	Answers will vary.
3	Do you think this challenge affects your community? Explain.	Answers will vary.

Continues next page >

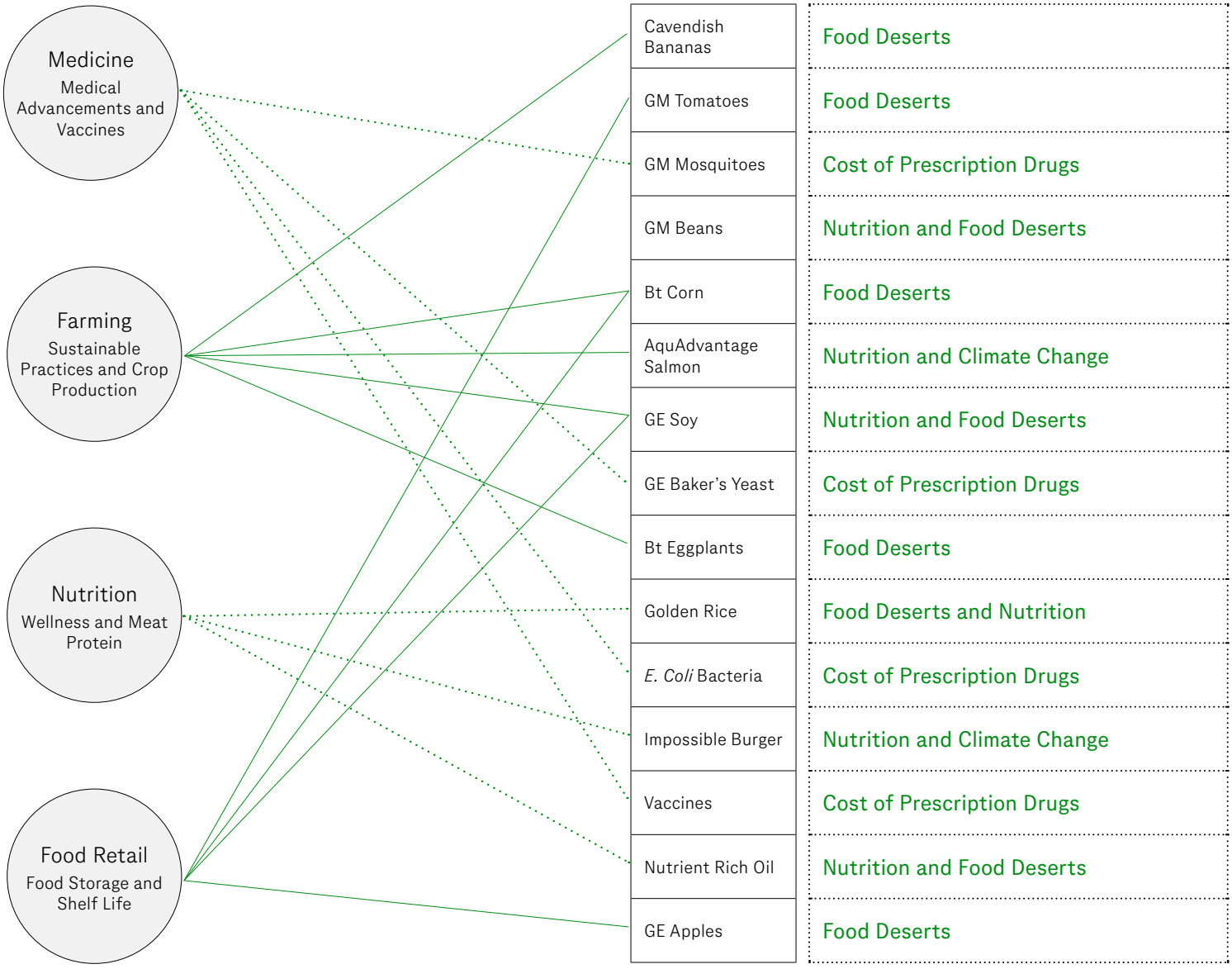
Concept Map Capture Sheet

ANSWER KEY — **Do not share with students**

Directions

Connect industries to products and community challenges.

1. Draw a line connecting each industry to its associated products. Then, fill in the adjacent box with the challenge the product was designed to solve.



Continues next page >

Concept Map Capture Sheet

ANSWER KEY **Do not share with students**

Continued

2. Pick five products and explain how they could be used in your local community to make a positive impact.

Answers will vary.

Educator Resources

Industry Profile Posters

Directions
Organize these posters at various stations around the classroom. Leave enough space for students to post sticky notes around each poster. Invite students to look at posters as they walk around the room and respond to each of the questions listed, one response per sticky note.

Questions:

1. *What part of this industry interests you?*
2. *What do you wonder about this industry?*

Thumbnail Example of a Poster

Medical Industry

The medical industry is a large industry spanning from drug development to patient care. With advancements in GE technologies, more and more drug proteins are able to be produced by using plants or bacteria as the production centers. These treatments can have better success than synthetic (lab-made) alternatives because they are the same as the body would produce.

Continues next page >

Medical Industry

The medical industry is a large industry spanning from drug development to patient care. With advancements in GE technologies, more and more drug proteins are able to be produced by using plants or bacteria as the production centers. These treatments can have better success than synthetic (lab-made) alternatives because they are the same as the body would produce.

Farming Industry

GE technology has transformed the farming industry. From weed management to insect control, from fungus resistance to increased yield, GE technologies allow farmers to produce more and therefore earn more.

Nutrition Industry

Adequate nutrition is a rising problem around the world. Increased crop yields can help with food scarcity, but specific vitamins are needed to fully solve some nutritional dilemmas. To solve this dilemma, scientists are looking for ways to enhance the nutritional value of edible crops.

Food Retail Industry

Brown spots, blemishes, and shelf life are all things that can reduce profits in the food retail sector. From grocery stores to farmers markets, most shoppers are looking for the “perfect” fruit. GE technology can help reduce these imperfections and increase the time fruit can be in the store before becoming overripe.

FUTURELAB+

Medical Industry Packet

Directions

The group's expert for the Medical Industry should review the links provided, and chose a few to review to complete the Notice, Think, Wonder Capture Sheet. You should not review all the resources listed, just a few that seem most interesting.

News Articles

1. *Yes, some COVID vaccines use genetic engineering. Get over it.*
2. *COVID-19: How do viral vector vaccines work?*
3. *How did they make insulin from recombinant DNA?*
4. *Edible vaccines could soon be an alternative to needles thanks to UT researchers*
5. *Genetically Modified Mosquitoes*
6. *750 Million GM Mosquitoes Will Be Released in the Florida Keys*
7. *A Look at Each Vaccine: Hepatitis B Vaccine*

Research Papers

1. *Edible Vaccines: Promises and Challenges*
2. *Disease Prevention: An Opportunity to Expand Edible Plant-Based Vaccines?*
3. *Malaria Control with Transgenic Mosquitoes*
4. *Overview of clinical studies with hepatitis B vaccine made by recombinant DNA*

Videos

1. *What is a viral vector vaccine?*
2. *Insulin: A GMO Story*
3. *Dr. Offit Addresses New Hepatitis B Vaccine for Adults*
4. *Stopping malaria…one mosquito at a time*

Products

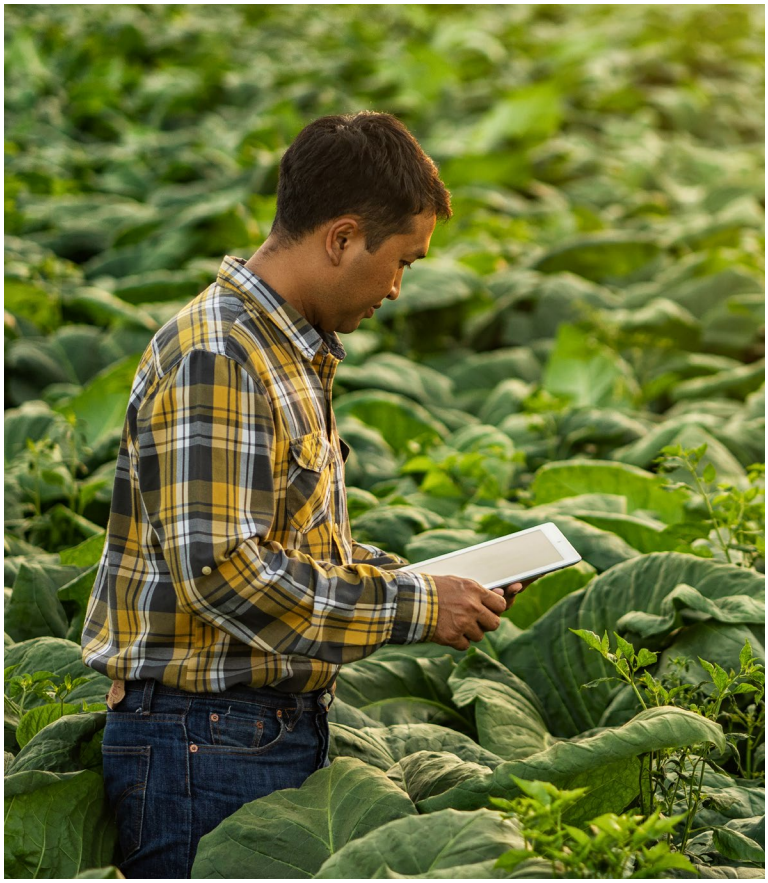
1. Viral Vector Vaccine
2. GM *Escherichia coli* bacteria (create insulin)
3. GM Baker's Yeast (create HepB Vaccine)
4. Edible Vaccines
5. GM mosquitoes (prevent the spread of malaria)

FUTURELAB+

Farming Industry Packet

Directions

The group's expert for the Farming Industry should review the links provided, and chose a few to review to complete the Notice, Think, Wonder Capture Sheet. You should not review all the resources listed, just a few that seem most interesting.



News Article

1. *GM banana shows promise against deadly fungus strain*
2. *Use and Impact of Bt Maize*
3. *Genetically Engineered Salmon: The Quest for a Super Fish*
4. *Bt Eggplant*
5. *CRISPR might be the banana's only hope against a deadly fungus*
6. *Beans and Biotech: Why Soybeans Are the Stars of Genetically Modified Foods*
7. *A Look at Each Vaccine: Hepatitis B Vaccine*

Research Papers

1. *Bt-Corn: What it is and How it Works*
2. *AquAdvantage Salmon—a pioneering application of biotechnology in aquaculture*
3. *A new specific reference gene based on growth hormone gene (GH1) used for detection and relative quantification of AquAdvantage® GM salmon (Salmo salar L.) in food products*
4. *Cry1Ac Expression and Control of the Eggplant Fruit and Shoot Borer (Leucinodes orbonalis Guenée)*
5. *Transgenic Cavendish bananas with resistance to Fusarium wilt tropical race 4*
6. *Characterization of Soybean Genetically Modified for Drought Tolerance in Field Conditions*

Videos

1. *Defending Corn*
2. *AquaBounty: GMO pioneer*
3. *Bt Brinjal, Beyond Boundaries*
4. *World-first Panama disease-resistant Cavendish bananas*
5. *Soybean Genetic Modification*

Products

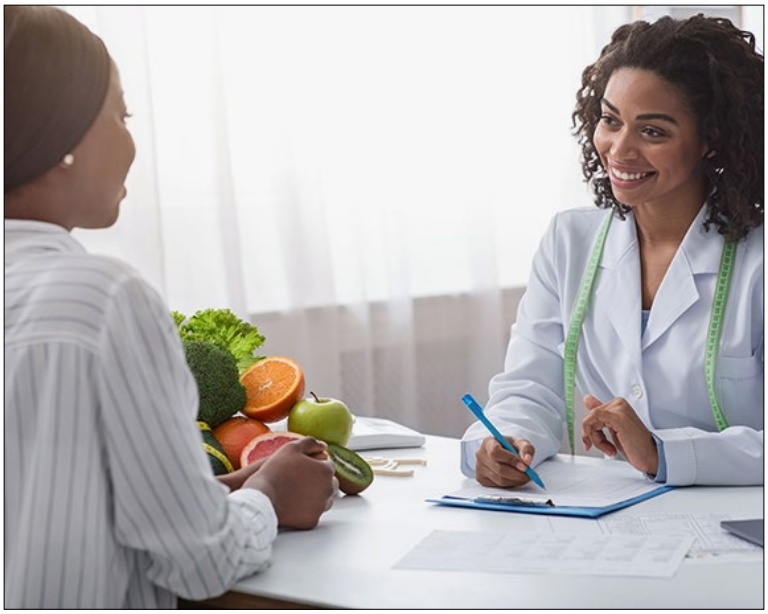
1. Corn—Resistant to insects
2. AquAdvantage Salmon
3. Bt Eggplant
4. GMO Cavendish bananas
5. GE Soy

FUTURELAB+

Nutrition Industry Packet

Directions

The group's expert for the Nutrition Industry should review the links provided, and chose a few to review to complete the Notice, Think, Wonder Capture Sheet. You should not review all the resources listed, just a few that seem most interesting.



News Article

1. *Is color additive that makes Impossible Burgers "bleed" safe?*
2. *GM Golden Rice could provide 30% to 50% of daily Vitamin A needed to combat deadly nutrient deficiency, study shows*
3. *How healthy is genetically modified soybean oil?*
4. *Scientists create rice variety with high folate stability*

Research Papers

1. *Safety Evaluation of Soy Leghemoglobin Protein Preparation Derived From Pichia pastoris, Intended for Use as a Flavor Catalyst in Plant-Based Meat*
2. *Golden Rice is an effective source of Vitamin A*
3. *Nutritionally enhanced food crops; progress and perspectives*
4. *Evaluating GM biofortified rice in areas with a high prevalence of folate deficiency*
5. *Biofortified Crops Generated by Breeding, Agronomy, and Transgenic Approaches Are Improving Lives of Millions of People around the World*
6. *New Genetically Engineered Tomatoes Have Enhanced Folate Content*

Videos

1. *Mission: Impossible (Burger)*
2. *Folic Acid*
3. *Regulating High Oleic Soybean Oil*
4. *No clear path for Golden Rice to reach consumers*

Products

1. Impossible Burger
2. Golden Rice (GR1)
3. Nutrient Rich Oil
4. Folic Acid-Rich Rice

FUTURELAB+

Food Retail Industry Packet

Directions

The group's expert for the Food Retail Industry should review the links provided, and chose a few to review to complete the Notice, Think, Wonder Capture Sheet. You should not review all the resources listed, just a few that seem most interesting.

News Article

1. *And Now California Develops a Square Tomato*
2. *Gene leads to longer shelf life for tomatoes, possibly other fruits*
3. *Sarah Browning: Apples, pears flourish in Nebraska*
4. *Square Tomato*
5. *East Texas Ag News: Questions answered about tomato disease identification*
6. *A raccoon rabies vaccine is being airdropped—again*

Research Papers

1. *Red to Brown: An Elevated Anthocyanin Response in Apple Drives Ethylene to Advance Maturity and Fruit Flesh Browning*
2. *The Genetic, Developmental, and Molecular Bases of Fruit Size and Shape Variation in Tomato*
3. *Overexpression of yeast spermidine synthase impacts ripening, senescence and decay symptoms in tomato*
4. *Induction of a protective immune response to rabies virus in sheep after oral immunization with transgenic maize, expressing the rabies virus glycoprotein*

Videos

1. *Our Beginning—The Arctic Advantage™*
2. *Detecting Plant Diseases in the Lab*
3. *Regulating High Oleic Soybean Oil*
4. *No clear path for Golden Rice to reach consumers*

Products

1. Apple—Resistant to browning
2. Tomato (UC-82)—Square shape
3. Tomato—More resistant to mold
4. Corn—antigen for rabies

FUTURELAB+

Career Exploration Capture Sheet

Directions

After your group has determined which careers are associated with the industry you have chosen to research, investigate those careers and complete the table below. For the pros and cons, think about what you would like or dislike about working in the career in your future—consider your soft skills and interests when deciding.

Industry

A Career Name

1	Facts	Average Education Needed	
		Average Salary	
		Average Work Hours	
2	Pros List two positive aspects of the career.		
3	Cons List two negatives of the career.		

Continues next page >

FUTURELAB+

Career Exploration Capture Sheet

Continued

B Career Name

1	Facts	Average Education Needed	
		Average Salary	
		Average Work Hours	
2	Pros List two positive aspects of the career.		
3	Cons List two negatives of the career.		

Continues next page >

FUTURELAB+

Career Exploration Capture Sheet

Continued

C Career Name

1	Facts	Average Education Needed	
		Average Salary	
		Average Work Hours	
2	Pros List two positive aspects of the career.		
3	Cons List two negatives of the career.		

Continues next page >

FUTURELAB+

Career Exploration Capture Sheet

Continued

D Career Name

1	Facts	Average Education Needed	
		Average Salary	
		Average Work Hours	
2	Pros List two positive aspects of the career.		
3	Cons List two negatives of the career.		

Continues next page >

FUTURELAB+

Notice, Think, Wonder Capture Sheet

Directions
From your industry's packet, chose four different products you learned about. Then, complete the steps listed below to explore and understand GE Products.

A–D	Enter the name of each product you choose onto one of the four capture sheets provided.
1	Notice: while you read and watch the different sources, write down what you notice about the product and its GE technology and the industry as a whole in the space provided. List at least three points per source.
2	Think: after you are finished reading the article or watching the video, write down what you think about the product and GE technology in the space provided.
3	Wonder: after you are finished reading the article or watching the video, write down a question that you wonder in the space provided. List at least one point per source.
4	Explain: after you complete steps 1–3 for two or three products, complete the final Step 4. Can you now answer any of your questions?

Continues next page >

FUTURELAB+

Notice, Think, Wonder Capture Sheet

Continued

Industry

A Product Name

1	Notice Address both the product and GE technology. List at least three points per source.	
2	Think Address both the product and GE technology.	
3	Wonder Think of at least one question per source.	
4	Explain Answer your own questions.	

Continues next page >

FUTURELAB+

Notice, Think, Wonder Capture Sheet

Continued

Industry

B Product Name

1	**Notice** Address both the product and GE technology. List at least three points per source.	
2	**Think** Address both the product and GE technology.	
3	**Wonder** Think of at least one question per source.	
4	**Explain** Answer your own questions.	

Continues next page >

FUTURELAB+

Notice, Think, Wonder Capture Sheet

Continued

Industry

C Product Name

1	Notice Address both the product and GE technology. List at least three points per source.	
2	Think Address both the product and GE technology.	
3	Wonder Think of at least one question per source.	
4	Explain Answer your own questions.	

Continues next page >

FUTURELAB+

Notice, Think, Wonder Capture Sheet

Continued

Industry

D Product Name

1	Notice Address both the product and GE technology. List at least three points per source.	
2	Think Address both the product and GE technology.	
3	Wonder Think of at least one question per source.	
4	Explain Answer your own questions.	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Medical Industry

Directions

Select at least four products within your industry to review.

Viral Vector Vaccine

Resource Type	Resource Title and Link	Summary
News Article	*COVID-19: How do viral vector vaccines work?*	Viral vector vaccines use a harmless virus to deliver a piece of genetic code (i.e. SARS-CoV-2 spike protein) from a pathogen to our cells to mimic an infection. Our cells transcribe the genetic code and present the spike protein on their cell surface. This prompts an immune response to produce antibodies and initiate a T cell response.
Informational Videos	*Using Viral Vector Vaccines for COVID-19 Vaccine*	The AstraZeneca COVID-19 adenovirus vector vaccine is based on a common cold that has been modified to include the SARS-CoV 19 spike protein. The adenovirus vector has been engineered to remove essential genes for viral replication so it can only act as a carrier.
	Viral Vector Vaccines	More than 40 vectors are used in the field of viral vectors for gene therapy and vaccines, with adenoviruses and modified vaccinia ankara viruses used most frequently. Vaccines are used to treat disease by encoding viral vectors, viral or bacterial processes, recombinant proteins, or mRNA. Viral vector vaccines are engineered to contain antigens from the pathogen to prime an immune response and provide further protection against that pathogen.
Primary Literature	*Viral vectors as vaccine platforms: from immunogenicity to impact*	
	New Vaccine Technologies to Combat Outbreak Situations	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Medical Industry

Continued

GM *Escherichia coli* bacteria (create insulin)

Resource Type	Resource Title and Link	Summary
News Article	*How did they make insulin from recombinant DNA?*	Recombinant DNA allows scientists to insert human genes into the genome of the common bacterium. Because the DNA of bacteria is a circular plasmid, scientists have engineered a plasmid with the genes encoding human insulin. In turn, the recombinant bacteria produce human insulin which can be harvested using protein purification techniques.
Informational Videos	*Insulin: A GMO Story*	Human insulin can be produced in bacteria by engineering its genome to encode the genes for human insulin. The FDA approved GMO insulin for use in October 1982. Prior to the discovery of GMO insulin, insulin was obtained from the pancreas of cattle or swine. GMO insulin is more similar to human insulin and can mitigate side effects from patients who could not tolerate insulin from cattle or swine.
Primary Literature	*Therapeutic insulins and their large-scale manufacture*	
	Expression and purification of recombinant human insulin from E. coli 20 strain	
	Human insulin from recombinant DNA technology	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Medical Industry

Continued

GM baker's yeast (create HepB Vaccine)

Resource Type	Resource Title and Link	Summary
News Article	*A Look at Each Vaccine: Hepatitis B Vaccine*	The hepatitis B vaccine is administered to prevent the severe liver disease in children or adults infected with hepatitis B virus. People are protected against hepatitis B virus infection by priming and immune response to a hepatitis B surface protein. The hepatitis B vaccine is produced by yeast cells, which produce many copies of the viral surface protein to make the vaccine.
Informational Videos	*Dr. Offit Addresses New Hepatitis B Vaccine for Adults*	In October 2017, the FDA approved the use of a novel hepatitis B vaccine in the US. This vaccine was later recommended, in February 2018, for use in people over the age of 18. The new hepatitis B vaccine is produced similarly using recombinant DNA technology to introduce the hepatitis B surface protein into yeast cells, but includes a novel adjuvant or additive to improve the efficacy of the vaccine. The new vaccine includes CpG motif, which are unique to bacterial DNA. The immune system recognizes these motifs as bacterial DNA and stimulates a stronger immune response, thereby increasing protection.
Primary Literature	*Overview of clinical studies with hepatitis B vaccine made by recombinant DNA*	
	Yeast-based vaccines: New perspective in vaccine development and application	
	Fermentation of recombinant yeast producing hepatitis B surface antigen	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Medical Industry

Continued

Edible Vaccines

Resource Type	Resource Title and Link	Summary
News Article	*Edible vaccines could soon be an alternative to needles thanks to UT researchers*	Researchers at the University of Texas in Austin have developed a new delivery method for vaccines through edible films. Researchers mixed vaccines with a sugar-based solution which traps vaccine components. This technology was initially developed for an Ebola vaccine to be cheap, stable at ambient temperatures, and not use needles.
	GMO tomato as edible COVID vaccine? Mexican scientists work to make it a reality	Researchers are working on modifications to edible plants and fruits to generate an immune response in the intestinal epithelium of animals after oral intake. Genetically modified crops used in the context of edible vaccines include potato, tomato, lettuce, papaya, carrot, rice, quinoa, alfalfa, banana, and algae. They have focused on hepatitis B, rotavirus, Norwalk virus, malaria, cholera, and autoimmune disease. Research from the Institute of Biotechnology of the Autonomous University of Neuvo Leon in Mexico has focused on developing an edible vaccine against SARS-CoV-2 that is expressed in tomatoes.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Medical Industry

Continued

GM mosquitoes (prevent the spread of malaria)

Resource Type	Resource Title and Link	Summary
News Article	*Genetically Modified Mosquitoes*	*Aedes aegypti* mosquitoes spread viruses like dengue, Zika, and chikungunya. *A. aegypti* mosquitoes can be genetically modified to control other mosquitoes in a community, with the intent to reduce disease transmission. Genetically modified mosquitoes have been produced to carry fluorescent marker genes (i.e. green fluorescent protein or GFP) that glow under special red light and a self-limiting gene to prevent female mosquito offspring from surviving into adulthood. The EPA has authorized use of genetically modified mosquitoes in Texas and Florida to evaluate the effectiveness of reducing *A. aegypti* mosquitoes in the area.
	750 Million GM Mosquitoes Will Be Released in the Florida Keys	A pilot program will release 750 million genetically modified mosquitoes into the Florida Keys in 2021 with the aim of reducing mosquito-borne illnesses like dengue and yellow fever. These mosquitoes are a modified *Aedes aegypti* species known as OX513A that contains a conditionally lethal genetic mutation to prevent offspring from reaching maturity. The mosquitoes were engineered by UK-based biotech firm Oxitec who've spent the last ten years developing GM mosquitoes in the Cayman Islands and Brazil.
Informational Videos	*See A Controversial Swarm Of Genetically Modified Mosquitoes In A Lab In Italy*	A group of scientists have been testing genetically modified mosquitoes as a new approach to eradicate pathogens transmitted by mosquitoes. Using the gene-editing technique CRISPR, they have designed a mutation to sterilize populations of malaria-transmitting mosquitoes in the wild. However, this technology is highly controversial because of the unintended consequences on the environment. This research is being conducted in Italy, where the lab is designed to mimic the natural environment in sub-Saharan Africa.
	Genetically Modified Mosquitoes | HHMI BioInteractive Video	In 2014, there was a spike of cases in newborn infants in Brazil affected by the Zika virus. The Zika virus is transmitted by mosquitoes and causes abnormally small heads. Mosquitoes are responsible for viral outbreaks. They have contributed to outbreaks of chikungunya and West Nile virus across the western hemisphere. Using genetic engineering, scientists are investigating the transmission characteristics of mosquitoes to develop a new strategy to prevent the spread of pathogens spread by mosquitoes. Despite these promising efforts, authorities have strict regulations for testing safety and efficacy.
Primary Literature	*Malaria Control with Transgenic Mosquitoes*	
	Perspectives of people in Mali toward genetically-modified mosquitoes for malaria control	
	Perceptions and recommendations by scientists for a potential release of genetically modified mosquitoes in Nigeria	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Directions

As a group, use one of the primary source links below to complete the assignment.

Corn—Resistant to insects

Resource Type	Resource Title and Link	Summary
News Article	*Use and Impact of Bt Maize*	In 1996, USA growers were introduced to commercial maize that was genetically engineered (GE) with resistance to European corn borer and other lepidopteran maize pests. In 2003 another GE maize was introduced that killed corn rootworm larvae (beetle grubs), especially larvae of the western corn rootworm, *Diabrotica virgifera virgifera*, another "billion dollar bug." These GE plants produce crystal (Cry) proteins or toxins derived from the soil bacterium, Bacillus thuringiensis (Bt), hence the common name "Bt maize." Bt maize has revolutionized pest control in a number of countries, but there are still questions about its use and impact.
	As Biotech Crops Lose Their Power, Scientists Push For New Restrictions	Genetically modified corn and cotton plants engineered to fend off insects are no longer offering the same protection from those bugs. Scientists say that the problem results from farmers overusing the crops, and are pushing for new regulations. Bt crops are losing their power. New strains of bollworms, rootworms, and other pests have emerged that are able to feed on Bt plants without dying. The current situation is complicated by the fact that biotech companies have deployed close to a dozen slightly different Bt genes, targeting a variety of insects. In many cases, the bugs have evolved resistance to some Bt proteins, but not others, and the prevalence of Bt resistant insects varies from place to place.
Informational Videos	*Defending Corn*	The Western Corn Rootworm has been termed the 'Billion Dollar Bug' for its ability to survive granular pesticides and sprayed insecticides. It has developed resistance to crop-rotation practices and even Bt corn. Initially Western Corn Rootworms were susceptible to Bt toxin engineered into hybrid corn plants, mitigating some of the crop destruction caused by this insect throughout the Midwest's Corn Belt which includes Iowa, Illinois, Nebraska, and Minnesota. After nearly a decade of effectiveness, Bt Corn has lost its ability to defend against this insect.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

AquAdvantage Salmon

Resource Type	Resource Title and Link	Summary
News Article	*Genetically Engineered Salmon: The Quest for a Super Fish*	In 2015, the FDA approved AquaBounty's GE salmon, AquAdvantage, becoming the first GE animal approved for human consumption in the United States. AquAdvantage salmon, a DNA mix of Atlantic salmon, Pacific king salmon, and Arctic ocean eelpout, grow twice as fast as wild salmon. In its 2015 decision, the FDA declared that it had completed its risk analysis, as required by the Federal Food, Drug and Cosmetic Act, and concluded that AquAdvantage salmon were safe for human consumption. In evaluating AquAdvantage salmon's potential environmental impact, the FDA judged it "highly unlikely" that the GE salmon would escape AquaBounty's landlocked facilities (a Canadian hatchery and an Indiana production facility for growing the imported eggs to market size fish) and, even if they did escape, deemed it unlikely that the GE salmon would survive and establish themselves in the wild.
	FDA OKs genetically modified salmon for human consumption	The FDA approved the first genetically modified salmon for human consumption despite a five year delay in approval during the Obama administration. The fish grows twice as fast as normal salmon, so it reaches market size more quickly. It has an added growth hormone from the Pacific Chinook salmon that allows the fish to produce growth hormone all year long. The engineers were able to keep the hormone active by using another gene from an eel-like fish called an ocean pout that acts like an "on" switch for the hormone. Typical Atlantic salmon produce the growth hormone for only part of the year.
Informational Videos	*Future of Food: This genetically engineered salmon may hit United States markets as early as 2020*	A third of global stocks are threatened by overfishing, causing aquaculture to gain popularity. In the United States, the majority of the salmon consumed is Atlantic salmon, but almost all of it is imported from ocean farms in Chile, Norway and Canada. A small company says its genetically engineered salmon can help meet the demand, as critics say it's a step in the wrong direction. NewsHour Weekend's Megan Thompson reports on the GE salmon. Aquabounty first applied for approval from the U.S. Food and Drug Administration in 1995. While it's been regulating genetically modified plants for more than 25 years, the FDA had never approved a genetically engineered animal as food before. Despite nearly 2 million comments to the FDA sent from protesters and nearly 80 retailers vowing not to sell it, the FDA approved AquAdvantage salmon, saying the product is "safe to eat," "has no significant impact on the environment" and it found "no biologically relevant differences" between GE salmon and other farm-raised salmon.
	FDA approves genetically modified salmon	AquAdvantage Salmon is engineered by the Massachusetts-based company AquaBounty. Ron Stotish, the company's CEO, said in a statement that the fish is a "game changer that brings healthy and nutritious food to consumers in an environmentally responsible manner without damaging the ocean and other marine habitats." The FDA said the fish "would not have significant environmental impact." The agency said the salmon can only be raised in land-based, contained hatchery tanks in two facilities in Canada and Panama, and that other facilities in the U.S. or elsewhere cannot breed the salmon for human consumption.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

Bt Eggplant

Resource Type	Resource Title and Link	Summary
News Article	*Bt Eggplant*	Eggplant is a staple food in India and other countries in South and Southeast Asia where it is called brinjal, along with over 30 Sanskrit names. In the Philippines, eggplant is known as talong and is the number one vegetable in terms of production area. Eggplant farmers suffer significant yield losses at 51-73 percent annually due to the Eggplant Fruit and Shoot Borer (FSB). To address this problem, many eggplant farmers in major eggplant producing areas in the Philippines and Bangladesh spray chemical insecticides every other day, or up to 80 times per growing season. Bt eggplant has been engineered to express the Bt gene, enabling it to produce the same protein that makes it resistant to FSB. When Bt protein is ingested by FSB larva, it is made soluble by the presence of enzyme and alkaline condition (pH of 9.5) of the gut. It then binds into another protein (receptor) present in the midgut, activating the toxin. The Bt toxin then punctures the gut, leaving the insect unable to eat and causing it to die within a few days.
	Study: Bt eggplant wins market and farmer acceptance in Bangladesh	Bt Eggplant has allowed farmers to achieve significantly higher yields and revenues in Bangladesh according to a study published in Frontiers in Bioengineering and Biotechnology. The four Bt eggplant varieties yielded on average 19.6 percent more than non-Bt varieties and earned growers 21.7 percent higher revenue. Significantly, 83 percent of Bt eggplant growers were satisfied with higher yields obtained and 80 percent were satisfied with the quality of fruit produced, compared to 59 percent of non-Bt eggplant growers. The findings of this data are based on a 2019 survey of Bt and non-Bt eggplant growers; the first year documentation of the economic benefits of Bt eggplant on the Bangladeshi market was available. Bt eggplant was developed by the Bangladesh Agricultural Research Institute (BARI) in conjunction with Mahyco, Cornell University and the United States Agency for International Development in an effort to stop the losses caused by eggplant fruit and shoot borer caterpillars, which cause up to 60 percent yield loss, and reduce pesticide use.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

Bt Eggplant continued

Resource Type	Resource Title and Link	Summary
Informational Videos	*Bt Brinjal, Beyond Boundaries*	Farmers from the Philippines, India, and Bangladesh grow eggplant and depend on it for their livelihood. There are almost eight million eggplant farmers in Bangladesh, fulfilling the demand of about 160 million people. Resource limitation, high production cost, climate change, pest attack, and diseases are some challenges faced by brinjal farmers in Bangladesh. These problems must be overcome in order to sell the grown crops at a good price. To protect their eggplant, farmers are compelled to spray pesticide 80 to 100 times in a single cropping season. Almost half of eggplant production cost goes to pesticides, and more than 47% farmers misuse the pesticide; this can adversely affect the soil, water, environment and biodiversity. The Bangladesh Agricultural Research Institute (BARI) developed FSB resistant Bt brinjal varieties to alleviate the challenges faced by Bangladeshi farmers yearly. Bangladesh made a historic step on October 30th, 2013 by releasing four genetically engineered eggplant varieties [BARI Bt brinjal 1 to 4] for commercial cultivation after its long-term research since 2005. As a public research institute, BARI provided seedlings and all necessary information to the farmers free of cost.
Primary Literature	*Field Performance of Bt Eggplants (Solanum melongena L.) in the Philippines: Cry1Ac Expression and Control of the Eggplant Fruit and Shoot Borer (Leucinodes orbonalis Guenée)*	
	Bt Eggplant Project in Bangladesh: History, Present Status, and Future Direction	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

GM Cavendish bananas

Resource Type	Resource Title and Link	Summary
News Article	*CRISPR might be the banana's only hope against a deadly fungus*	The Colombian government confirmed that a banana-killing fungus has invaded the Americas; the source of much of the world's banana supply. The invasion has given new urgency to efforts to create fruit that can withstand the scourge. A team in Australia has inserted a gene from wild bananas into the top commercial variety—known as the Cavendish—and are currently testing these modified bananas in field trials. Researchers are also turning to the powerful, precise gene-editing tool CRISPR to boost the Cavendish's resilience against the fungus, known as Fusarium Wilt Tropical Race 4 (TR4). So the only way to save the Cavendish may be to tweak its genome, according to Randy Ploetz, a plant pathologist at the University of Florida in Homestead.
	GM banana shows promise against deadly fungus strain	The fungal Panama disease has devastated banana crops in Asia, Africa, Australia, and is a major threat to the Americas. Transgenic bananas have been shown in a field trial to resist the deadly disease. In the 1950s, a soil-dwelling fungus destroyed Latin America's most popular banana variety, Gros Michel, before being replaced by the resistant Cavendish variety. The Cavendish banana variety makes up more than 40 percent of harvests worldwide. The fungus Fusarium Wilt Tropical Race 4 (TR4) targets Cavendish bananas and has devastated Southeast Asia, the Middle East, and Africa. TR4 is resistant to fungicides, which makes it especially difficult to control. James Dale and colleagues at Queensland University of Technology in Brisbane cloned a resistant gene named RGA2 from a type of wild banana into the Cavendish, creating six lines with varying numbers of the RGA2 copies. They also cloned Ced9, a nematode gene known to confer resistance to many kinds of plant-killing fungi.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

GM Cavendish bananas continued

Resource Type	Resource Title and Link	Summary
Informational Videos	*World-first Panama disease-resistant Cavendish bananas*	The Cavendish is the world's most popular banana, with global exports worth over $12 billion. The TR4 fungus infects the roots and infiltrates the vascular system of the plant, clogging it up. This leads to the death of the plant. Because the TR4 fungus is soil-borne, it can move relatively easily between plants. By engineering the Cavendish to express the resistance gene RGA2, they have shown resistance to TR4 fungus in field studies. These transgenic bananas were trialled for three years in the Northern Territory of Australia and produced high levels of resistance across multiple genetic lines encoding the RGA2 gene. Of the six transgenic Cavendish lines, four produced high levels of resistance. If these bananas were approved for consumption by regulatory agencies, they could alleviate the devastation caused by the TR4 fungal disease.
	The end of bananas as we know them?	Scientists in Honduras are developing new varieties of bananas resistant to the banana-killing fungus Tropical Race 4 (TR4), also known as Panama disease. There are no effective fungicides to control TR4, causing it to decimate banana plantations in Australia, Southeast Asia, the Middle East, and Africa. Luckily, TR4 has not been found in the Americas, which grow roughly 70 percent of the global banana supply. The Cavendish is grown in the Americas and is the most widely consumed banana globally. Ongoing research at the Honduran Foundation for Agricultural Research focuses on developing resistance crops through cross breeding. The Cavendish are seedless, which makes them desirable for consumption but difficult to breed. Through cross breeding, they are able to select for desirable traits from different banana varieties and introduce transgenes to confer resistance to TR4. They are additionally developing other banana varieties in the event that the Cavendish is wiped out entirely. They are developing varieties to be resistant to Black Sigatoka and TR4, useful for buyers, and have a long shelf life for global exports. However, it is important to consider the adaptive capabilities of the fungal disease so that genetic resistance is no longer effective.
Primary Literature	*Gene editing the phytoene desaturase alleles of Cavendish banana using CRISPR/Cas9*	
	Transgenic Cavendish bananas with resistance to Fusarium wilt tropical race 4	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Farming Industry

Continued

GM Soy

Resource Type	Resource Title and Link	Summary
News Article	*European Commission green light for new GM soybean: Is this good or bad news for our health and environment?*	The European Commission has authorized a genetically modified soybean for food and feed. The genetically modified soybean was engineered by Bayer and is known as "XtendFlex." The approval of this GMO was contingent on a favorable scientific assessment by the European Food Safety Authority (EFSA). The "XtendFlex" soybeans have been developed by the "high-yielding" Roundup Ready 2 Xtend soybean technology, which confers tolerance to glufosinate herbicides. The variety provides growers with additional flexibility to manage resistant weeds. Despite the fact that soybeans are not widely cultivated in the EU, but rather in the US, Brazil, and Argentina. The authorization of other GMO crops could benefit other members of the EU by making agriculture more sustainable.
	Beans and Biotech: Why Soybeans Are the Stars of Genetically Modified Foods	There are currently *ten GMO crops* approved for use in the U.S., as well as one animal product (salmon, although GMO salmon is not yet available for sale in stores). These foods have been modified through recombinant DNA technology. The majority of soybeans (more than 90 percent) grown in the U.S. are bioengineered. These beans typically have herbicide-resistant genes inserted into their genetic structure so that farmers can use herbicides to destroy invasive weeds without harming the soybean plant. These versatile beans may then be used for animal feed, pressed into soybean oil, or added as ingredients in foods like tofu. Due to the biotechnology that is used in soybeans, farmers often see an increased yield and lower loss from damage to the beans, which means more supply and more opportunities to feed people.
Informational Videos	*Soybean Genetic Modification*	Researchers at the University of Nebraska are genetically modifying corn, wheat, soygum, and soybeans to confer desirable traits and resistance. To genetically engineer soybeans, agrobacterium, a soil-based bacteria, is used to introduce new genetic information. Agrobacterium is unique in that it has the ability to transfer genetic material directly into plant cells and modify their genome. Using this mechanism, scientists can clone genes into agrobacterium using molecular cloning to create transgenic plants. Growing germinating seeds on culture plates allows them to engineer soybean varieties with great precision and manipulations to study the effects of genetic engineering on soybeans and other crops. One of the major challenges of creating new transgenic lines (this is true for most transgenic techniques) is inserting new genetic material so that it is heritable, meaning that the new genes are found in germline cells. Introducing new genetic information using this technique randomly integrates the transgenic DNA into the host's genome. If the transgenic DNA is integrated into somatic cells, the transgenic traits will not be heritable.
Primary Literature	*Seeds of Change: Intellectual Property Rights, Genetically Modified Soybeans and Seed Saving in the United States*	
	Characterization of Soybean Genetically Modified for Drought Tolerance in Field Conditions	
	Assessment of Genetically Modified Soybean in Relation to Natural Variation in the Soybean Seed Metabolome	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Nutrition Industry

Directions

As a group, use one of the primary source links below to complete the assignment.

Impossible Burger

Resource Type	Resource Title and Link	Summary
News Article	*Is color additive that makes Impossible Burgers "bleed" safe?*	Impossible Foods' plant-based burgers have an additive, soy leghemoglobin, which makes them appear to 'bleed' like real meat. Soy leghemoglobin is a heme colorant produced in genetically engineered yeast that required the approval of the Food and Drug Administration before being considered safe for consumption. The extent of testing has been called into question by the Center for Food Safety, which believes that there has not been enough safety testing for it to be considered safe for consumption. They believe that the additive was approved without long-term animal studies looking at the adverse effects, which may include cancer and reproductive impairment.
	Lawsuit challenges FDA approval of additive that makes Impossible Burger 'bleed'	The Center for Food Safety is challenging the FDA's approval of soy leghemoglobin, which has been used to make Impossible Foods' plant-based burger appear to bleed like real meat. The novel "heme" colorant is genetically engineered in yeast to produce a protein found in the roots of soybeans. In order to determine the safety of this additive, they must consider the long-term effects in animal studies. In a short-term rat trial, there were a number of adverse effects, including disruption of reproductive cycles and reduced uterine weights in females and biomarker of anemia, and reduced clotting ability and kidney problems. Yet the FDA has dismissed these concerns and, following rigorous safety testing, they approved the use of soy leghemoglobin for consumption. Today, Impossible Foods' products containing GE heme can be found in supermarkets and restaurants across the country.
Informational Videos	*The Impossible Burger: Inside the Strange Science of the Fake Meat That 'Bleeds'*	Impossible Foods has used genetic engineering to create a plant-based burger that mimics the taste and texture of a burger made with real meat. In animal tissue, there is naturally-occurring heme in myoglobin proteins found in muscle tissue. When you cook a burger, the heme is released from myoglobin and catalyzes a series of reactions that release chemical compounds that give both the smell and flavor characteristic of meat. Soy leghemoglobin is a chemical compound naturally found in the root of soybeans that resembles the heme molecule in myoglobin, yet it is not produced in high enough quantities to use as a food additive. By engineering yeast cells to produce leghemoglobin, they have created a plant based burger that resembles the taste and texture of a meat burger. Using techniques including gas chromatography mass spectrometry, they can better characterize the flavor profiles of meat. This data ultimately allows them to better engineer a plant-based burger using homologous compounds found in plants. Heme is not the only additive in an Impossible Burger; it also contains wheat protein for texture and coconut as a replacement for fat.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Nutrition Industry

Continued

Golden Rice (GR_1)

Resource Type	Resource Title and Link	Summary
News Article	*GM Golden Rice could provide 30% to 50% of daily Vitamin A needed to combat deadly nutrient deficiency, study shows; Development and characterization of GR2E Golden Rice introgression lines*	Scientists at the International Rice Research Institute, Philippine Rice Research Institute, and Bangladesh Rice Research Institute have shown that Golden Rice produces a significant amount of carotenoids in the milled grain. Researchers used marker-assisted backcross breeding to introduce the GR2E trait into three local rice varieties. They tested these introgression lines on confined fields to evaluate their agronomic performance and expression of beta carotene, vitamin-A precursor. The best performing lines were found to supply 30 to 50 percent of the daily average requirement of Vitamin A.
Informational Videos	*GMO debate grows over Golden Rice in the Philippines*	Vitamin A deficiency (VAD) is a deadly threat to kids and pregnant mothers in developing countries around the world. Researchers have added Vitamin A in rice to lessen the effects of VAD in these populations. Each year, over a half-million children and a few hundred thousand women go blind or die from a lack of Vitamin A. The best sources of Vitamin A, meats and leafy vegetables, are expensive and often unavailable. Scientists at the International Rice Research Institute are taking some aspects from corn, which produces beta carotene, and introducing them into rice using genetic engineering. In turn, this rice variety will contain beta carotene. The human body converts beta carotene into Vitamin A, which plays a crucial role in vision. Golden Rice was first created in the late 1990s by agribusiness corporation Syngenta, but was turned over to a nonprofit organization where it has been further developed. There is an additional black rice that has small amounts of Vitamin A made by the Farmer Scientist Partnership For Development, also known as MASIPAG.
	The Philippines has rated 'Golden Rice' safe, but farmers might not plant it	Food fortification by adding minerals and vitamins to commonly-eaten foods can help end micronutrient malnutrition. Biofortification was first implemented in common foods in the early 20th century when scientists realized that there were common diseases caused by not enough vitamin and mineral consumption. As a result, these conditions became far less common by adding nutrients to salt, milk, and margarine. In the 1940s, iron and B vitamins were added to corn and wheat flour in an attempt to keep soldiers healthy. Rice is currently being biofortified to produce beta carotene, which the human body can convert into Vitamin A. Golden Rice was engineered by plant scientist Ingo Potrykus who claimed that "Vitamin A deficiency occurs where rice is a major staple food." White grains of rice contain no beta carotene. Genetically modifying rice to contain beta carotene is at best a band-aid for extreme cases of Vitamin A deficiency, not a corrective for the widespread problem.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Nutrition Industry

Continued

Nutrient Rich Oil

Resource Type	Resource Title and Link	Summary
News Article	*How healthy is genetically modified soybean oil?*	Soybean oil accounts for more than 90 percent of all the seed oil production in the United States. Genetically modified soybean oil from the seeds of GM soybean plants was recently introduced into the food supply on the condition that it is healthier than conventional soybean oil. Scientists at the University of California, Riverside and their colleagues at UC Davis compared the effects of both oils in experiments performed in the lab on mice. They found that the GM soybean oil was equally as unhealthy as regular soybean oil in that it induces obesity, diabetes, and fatty liver. Yet, the difference is that GM soybean oil does not cause insulin resistance, or the inability to use the hormone insulin.
Informational Videos	*The Latest Gene-Edited Food Is A Soybean Oil That Comes With Zero Trans Fat*	Minnesota-based Calyxt, Inc. announced the first commercial sale of genetically modified soybean oil, touting its new high oleic oil as a healthier alternative to soybean oil which contains trans fat. According to their CEO Jim Blome, Calyxt's genetically modified soybean oil contains "approximately 80 percent oleic acid and up to 20 percent less saturated fatty acids compared to conventional soybean oil." Their genetically modified soybean oil isn't available in grocery stores, but is being marketed for the food service industry where companies are eager to find healthier alternatives for frying and shelf stability without trans fats. Their technology relies on TALEN, or "transcription activator-like effector nuclease" to engineer high oleic soybeans.
Primary Literature	*Nutritionally Improved Agricultural Crops*	
	Nutritionally enhanced food crops; progress and perspectives	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Nutrition Industry

Continued

Folic Acid-Rich Beans

Resource Type	Resource Title and Link	Summary
News Article	*Scientists create rice variety with high folate stability*	Researchers from Ghent University have stabilized folates in biofortified rice to prevent long term storage degradation. The human body is unable to make vitamin B9; better known as folate. Adults need approximately 400 micrograms of folates per day to remain healthy, a number which is increased to 600 micrograms for pregnant women. Folates are abundant in green leafy vegetables (folium is Latin for leaf), such as spinach and legumes (e.g. beans). Most staple crops, such as rice and other cereals, contain very low amounts of this vitamin. Vitamins are unstable molecules that degrade easily upon contact with oxygen, light, humidity, increased temperatures and changes in acidity. For this reason, it is important to consume food products, such as vegetables and fruit, as fresh as possible. A lot of vitamins get lost, not only during food processing and preparation, but also during storage. A research team from Ghent University in Belgium reported the development of a first generation of rice lines with 100-fold higher folate levels. This was achieved through metabolic engineering of the biosynthesis pathways of the plant compound. The folate content in these rice lines degrades after half a year.
	Folic Acid	Folic acid is a B vitamin our bodies use to make new cells in skin, hair, and nails. During early development, folic acid helps form the neural tube and has been implicated in major birth defects like baby's brain (anencephaly) and spine (spina bifida). It is recommended that all women of reproductive age should take 400 mcg of folic acid each day to prevent some birth defects. Folic acid is ideal for biofortification because it is more heat-stable than types of natural food folate, where heat and light can easily break down their structure. Folic acid is better suited for food fortification because many fortified products, like bread and pasta, are cooked. In addition to eating foods with folate from a varied diet, women can get folic acid from taking vitamins with folic acid in them, eating fortified foods, or a combination of both.
Primary Literature	*Evaluating GM biofortified rice in areas with a high prevalence of folate deficiency*	
	Biofortified Crops Generated by Breeding, Agronomy, and Transgenic Approaches Are Improving Lives of Millions of People around the World	
	New Genetically Engineered Tomatoes Have Enhanced Folate Content	

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Nutrition Industry

Continued

Apple—Resistant to browning

Resource Type	Resource Title and Link	Summary
News Article	*Genetically modified apple reaches US stores, but will consumers bite?*	The "Arctic apple" is a genetically modified apple that has been modified to prevent their flesh from browning when exposed to air. It was developed by Okanagan Specialty Fruits in Summerland, Canada, and was first planted in 2003. Okanagan co-founder Neal Carter used findings from researchers at the Commonwealth Scientific and Industrial Research Organisation who had deleted the gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives. A major obstacle in the widespread use of GMOs is the US regulatory process. US regulators assessed the Arctic apple for five years before approving it for sale, yet the non-browning GM potato developed by J.R. Simplot spent two years in review.
Informational Videos	*The first GMO non-browning apples will go on sale in the US next month*	The Arctic Apple developed by Okanagan Specialty Fruits was approved by the USDA in 2015 with a first harvest collected in fall 2016. The apple has been modified to brown less quickly by knocking out the gene that encodes the enzyme polyphenol oxidase or PPO. In a wild-type ("normal") apple, when it is sliced or bruised, PPO reacts with polyphenolic compounds that produce the browning effect. This enzyme is believed to be an evolutionary defense mechanism used to deter insects. By suppressing PPO, Arctic Apples brown at a slower rate, taking three weeks to fully oxidize.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Food Retail Industry

Directions

As a group, use one of the primary source links below to complete the assignment.

Tomato (UC-82)—Square Shape

Resource Type	Resource Title and Link	Summary
News Article	*A common genetic mechanism underlies morphological diversity in fruits and other plant organs*	One of the most commonly utilized tomato fruit shape genes is OVATE, the founding member of the OVATE Family Protein (OFP) class. Mutations in this gene create an elongated fruit, yet the extent depends on the genetic background. To determine the role of OFPs in fruit morphology, they identified interacting proteins using the yeast-two-hybrid (Y2H) approach. Through creating mutations to OVATE, they were able to identify important residues for OVATE protein to protein interactions.
	Square Tomato	To prevent tomatoes from rolling off conveyor belts, Gorde "Jack" C. Hanna at UC Davis developed the square tomato "cultivar VF-145." Despite not being exactly square in shape, they accomplished their goal to enable more efficient packing by making a "less round" tomato. This tomato is also more hardy than regular ones, and can withstand being picked by machine, making it even more cost efficient.
Informational Videos	*Could Genetics Grow a Square Tomato?*	The diversity in tomato varieties seen commonly in grocery stores is a product of human selection of useful mutations found in fruits and vegetables over the course of generations. Some of these mutations include better yields, new shapes, and better taste. The selective breeding of tomatoes has been greatly improved by genetic mapping. Using this information, they can screen seedlings to look for genes encoding heritable traits. This technique is known as marker-assisted selection. In a paper published in Nature Communications, Dr. Van Der Knaap at the University of Georgia identified two families of genes that determine whether a fruit is round or long. The families of genes she discovered are implicated in the cell division process, which divide either horizontally or vertically. The work of her and her colleagues discovered the gene OVATE which instructs cells to divide in a vertical manner. The expression of this gene is implicated in the overall shape of the tomato. They additionally discovered a family of genes called TRMs which interact with the OVATE proteins directly.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Food Retail Industry

Continued

Tomato—More resistant to mold

Resource Type	Resource Title and Link	Summary
News Article	*Fraser Valley researcher asking home gardeners help battle potato blight*	Canada's potato blight is caused by a water-based mold called Phytophthora infestans causing the destruction of mass home gardens and commercial fields. Blight develops in wet conditions when the weather is between 15°C and 25°C. As a result, farmers are applying fungicide more regularly which will drive up the cost of production. In fact, this pathogen is capable of mutating similar to COVID and developing resistance against fungicides, like metalaxyl. Tomatoes are also susceptible to late blight. There are multiple resistant varieties of tomatoes including Mountain Mist, Defiant PHR, Mountain Merit, and Iron Lady.
	East Texas Ag News: Questions answered about tomato disease identification	Common diseases that affect tomatoes in Texas are fungus, bacteria, and viral diseases in addition to nematodes and physiological disorders. Fungal issues are the most prominent issue and include Late blight, Early blight, Gray leaf spot, Leaf-mold, Buckeye rot, Nailhead spot, Anthracnose, Fusarium wilt, Verticillium wilt, Gray mold, and Botryosphaeria mold. Hybrid tomatoes are often listed with their resistant varieties on the seed packet with "V", "F", "N" to indicate which pathogens they are resistant to.

Continues next page >

FUTURELAB+

Industry Packet Resources Capture Sheet

Food Retail Industry

Continued

Corn—Antigen for rabies

Resource Type	Resource Title and Link	Summary
News Article	*A raccoon rabies vaccine is being airdropped—again*	The inter-agency wildlife rabies prevention program is dropping oral vaccination packets throughout Western Pennsylvania. The smelly bait packets are distributed to prime raccoon habitats and once eaten, will develop immunity to the rabies virus in raccoons. The rabies virus is transmitted through saliva or scratches of an infected animal. It attaches itself to the central nervous system where it can cause dementia and coma if not treated. It infiltrates the salivary glands causing foaming of the mouth and transmission through bites. Without treatment, death occurs in 99 percent of cases. The strategy is to create vaccination zones where rabies is geographically eliminated. Unable to spread through the zones, it would theoretically become a minor risk.
	Rabies vaccine bait arriving for area raccoons	The number of rabid raccoons is declining in Southwestern Pennsylvania through oral vaccination administration. Oral vaccine baits, the size of ketchup packets, will be dropped by helicopter across Southwestern Pennsylvania with aerial delivery allowing them to distribute oral vaccines in remote areas not easily accessible to humans. The packets contain fish oil and odor used to attract raccoons and are intended to protect people and their pets from contracting rabies.
Informational Videos	*Rabies*	Rabies is a virus that infects wildlife in the United States, especially bats, raccoons, skunks and foxes. It can spread to people and pets when they are bitten or scratched by a rabid animal. Without treatment, rabies almost always causes death. However, rabies is 100 percent preventable with post-exposure prophylaxis (PEP) that includes rabies vaccine and medications to fight infection, as long as people get PEP before symptoms start.

Continues next page >

FUTURELAB+

Career Cards

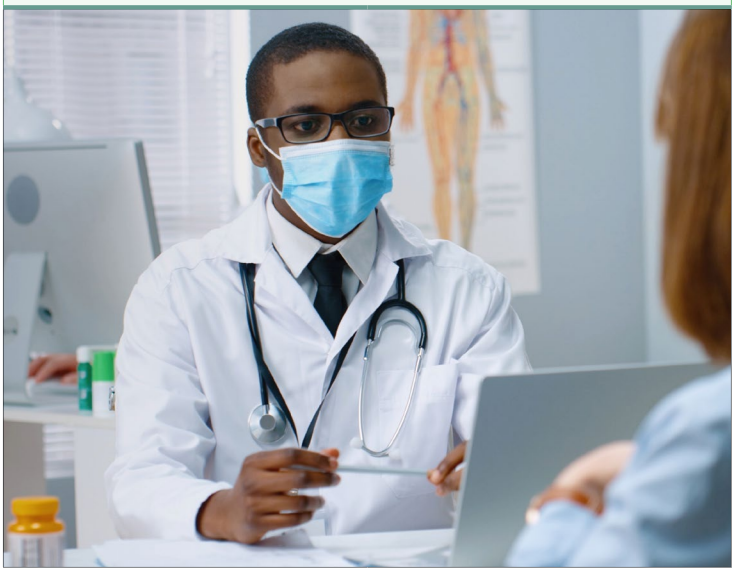
Directions
As a group, sort these careers into the four industries (Medicine, Farming, Nutrition, and Food Retail) with which they are likely associated.

Clinical Research Doctor

Farmer

Nutritionist

Nurse



Continues next page >

FUTURELAB+

Career Cards

Continued

Plant Geneticist

Agricultural Worker

Grocery Store Buyer

Restaurant Owner

Continues next page >

FUTURELAB+

Career Cards

Continued

Senior Bioprocess Technician

Stocker

Research and Development Scientist

Soil Analyst

Continues next page >

FUTURELAB+

Career Cards

Continued

Cafeteria Food Services Worker

Farmers Market Vendor

Homeopathic Health Practitioner

Food Bank Employee

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Directions
Now work to identify which industries are working to solve that challenge and how they are working to solve it. Does the challenge affect your community? Use your best knowledge from this unit to complete the table.

1. Discover. Use research artifacts provided by your teacher to explore more about Golden Rice.

A	Food Deserts	The Food Empowerment Project defines *Food Deserts* as "geographic areas where residents' access to affordable, healthy food options (especially fresh fruits and vegetables) is restricted or nonexistent due to the	absence of grocery stores within convenient traveling distance. For instance, about 2.3 million people (or 2.2 percent of all United States households) live more than one mile away from a supermarket and do not own a car."
1	What industries are working to solve it?		
2	How are they currently working to solve it? Provide at least one example.		
3	Do you think this challenge affects your community? Explain.		

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

B Cost of Prescription Drugs

In March of 2019, in *Do Prescription Drugs Have to be So Expensive?*, The Atlantic reported that "many drugs cost more than $120,000 a year. A few are even closing in on one million dollars. The Department of Health and Human Services estimates that Americans spent more than $460 billion on drugs—16.7 percent of total health-care spending—in 2016, the last year for which there is definitive data. On average, citizens of other rich countries spend 56 percent of what Americans spend on the exact same drug."

1	What industries are working to solve it?	
2	How are they currently working to solve it? Provide at least one example.	
3	Do you think this challenge affects your community? Explain.	

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

C	Education Around Healthy Nutrition	Health Journal (***Nutrition quality of food purchases varies by household income***) found that "lower household income has been consistently associated with poorer diet	quality. Household food purchases may be an important intervention target to improve diet quality among low income populations."
1	What industries are working to solve it?		
2	How are they currently working to solve it? Provide at least one example.		
3	Do you think this challenge affects your community? Explain.		

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

D	Obesity	According to the National Institute of Diabetes and Digestive and Kidney Diseases (*Overweight & Obesity Statistics*), the "factors that may contribute to weight gain among adults and youth include genes, eating habits, physical inactivity, TV, computer, phone, and other screen time, sleep habits, medical conditions or medications, and where and how people live, including their access to healthy foods and safe places to be active."	
1	What industries are working to solve it?		
2	How are they currently working to solve it? Provide at least one example.		
3	Do you think this challenge affects your community? Explain.		

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

E	Climate Change	According to the United States Environmental Protection Agency in *Climate Impacts on Agriculture and Food Supply*, "agriculture and fisheries are highly dependent on the climate. Warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past."	
1	What industries are working to solve it?		
2	How are they currently working to solve it? Provide at least one example.		
3	Do you think this challenge affects your community? Explain.		

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

2. As a class, identify four local community challenges to fill in these last boxes.

A

1	What industries are working to solve it?	
2	How are they currently working to solve it? Provide at least one example.	
3	Do you think this challenge affects your community? Explain.	

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

B

1	What industries are working to solve it?	
2	How are they currently working to solve it? Provide at least one example.	
3	Do you think this challenge affects your community? Explain.	

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

C

1	What industries are working to solve it?	
2	How are they currently working to solve it? Provide at least one example.	
3	Do you think this challenge affects your community? Explain.	

Continues next page >

FUTURELAB+

Community Challenges Capture Sheet

Continued

D

1	What industries are working to solve it?	
2	How are they currently working to solve it? Provide at least one example.	
3	Do you think this challenge affects your community? Explain.	

Continues next page >

FUTURELAB+

Concept Map Capture Sheet

Directions

Connect industries to products and community challenges.

1. Draw a line connecting each industry to its associated products. Then, fill in the adjacent box with the challenge the product was designed to solve.

Industry	GM Product	The Challenge Solved
Medicine Medical Advancements and Vaccines	Cavendish Bananas	
	GM Tomatoes	
	GM Mosquitoes	
	GM Beans	
Farming Sustainable Practices and Crop Production	Bt Corn	
	AquAdvantage Salmon	
	GE Soy	
	GE Baker's Yeast	
Nutrition Wellness and Meat Protein	Bt Eggplants	
	Golden Rice	
	E. Coli Bacteria	
	Impossible Burger	
Food Retail Food Storage and Shelf Life	Vaccines	
	Nutrient Rich Oil	
	GE Apples	

Continues next page >

FUTURELAB+

Concept Map Capture Sheet

Continued

2. Pick five products and explain how they could be used in your local community to make a positive impact.