**Key:** Yellow highlight = required component

# Plant Plague!

**Subject Area(s)** **Biology and Data Analysis and Probability**

**Associated Unit** **GMO & Microbial life**

**Lesson Title** **Plant Plague!**

**Header**


**Image 1**

**ADA Description:** An aerial view of crop fields, with a prompt written over the top saying: "You are a farmer who has decided to buy GMO crops this year!"

**Source/Rights:** aerial view of crop fields retrieved from © GettyImages.

high school level, recommend using the "open choice" pages.)

**Time Required:** 90 minutes (2 days of 45 minutes each) (Can alter the research requirements to fit as needed)

**Summary:** **Students explore the causes, effects, and implications of microbial outbreaks in GMO crops in the United States.**

**Students will learn effective research practices and how to find credible sources when researching background information and potential solutions to the problem. Students will research engineering practices to formulate potential alterations to crop genomes as methods to protect against various pathogenic infections.**

**Engineering Connection:** **Engineers must solve the problems that face society today by applying themselves creatively and scientifically to the issue at hand. Students in this lesson will have to research effectively, analyze the data, and develop a plan of action for reducing the incidents of crop plagues.**

**Engineering Category** = 2

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

**Keywords:** **Genetically Modified Organism (GMO), Names of differing crop pathogens, Pathogen, Infection, Cross-Contamination, Microbe, Identify, Influence desired traits, Modifications, Engineering Practices**

**Educational Standards** (List 2-4)
State STEM Standards & NGSS Standards

***POWER STANDARD:***

***MS-LS4-5.***

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

***Additional Standards:***

***MS-LS3-2.***

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

***MS-LS1-5.***:

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (Bacteria can cause substantial growth problems in the GMO)

ITEEA Standards:

1. S11416BA
**Description**
Technology and Society
Students will develop an understanding of the cultural, social, economic, and political effects of technology.

3. S114170D
**Description**
Technology and Society
Students will develop an understanding of the cultural, social, economic, and political effects of technology.
In order to recognize the changes in society caused by the use of technology, students should learn that:
Technology, by itself, is neither good nor bad, but decisions about the use of products and systems can result in desirable or undesirable consequences.

**Pre-Requisite Knowledge**

## Learning Objectives

After this lesson, students should be able to:

- **Identify reasons for pathogenic spread within same species and differing species of crops.**
- **Explain how GMOs are different from selected breeding program organisms.**
- **Develop a plan for reducing the incidents of pathogenic attack and spread using research and engineering planning practices.**
- **Support conclusions with well documented research from the scientific community.**

## *Prior to printing:*

- Please decide what student pages you need:
    - Included are duplicates of pages, some have a blank area for students to fill in if you are picking new microbes and some are prefilled in with the general examples.
    - Additionally, the pages with fields are offered in 2 varieties based on the scaffolding needs of your students.
    - While the pages are in PowerPoint, they are set to print on traditional 8.5x11 inch pages.
- The last 2 pages of this document for teachers pages are two variants: one is blank for choosing your own microbes, and one with the matching microbes pre-filled in to match the pre-filled student variant of pages.

### Introduction / Motivation

- Do an informal poll of students: Who is part of FFA? Who is part of 4H? Who lives on a ranch or farm and grows crops? Who eats: __<insert some fresh produce then try again with processed foods stemming from one of the crops (ex: sugar beets make molasses)>_? Who has a printer at home: raise your hands; leave your hands up if you know it uses toner? Who has picked up a newspaper lately? <Potentially bring in a copy of the local newspaper, you could even go to the paper and ask for an ingredients list of their ink…>
- Then have a discussion about how the different crops in the activity have a variety of uses and use this as a chance for students to assess if they are part of the agricultural industry in Wyoming.

### Lesson Background & Concepts for Teachers

This lesson is a cross-disciplinary lesson which bridges the gap between Biology classes and the local application of agriculture along with 7$^{th}$ grade civics classes.

This lesson could be used as an endcap for the 5E model: either as an engage in the start of the unit or you could add in different end product requirements as an evaluate lesson. Potential changes could include: a formal scientific paper presenting the students' findings, or a mini-project that displays their possible alterations to the genome of their crop as though they are selling to the local agriculture community.

Students need to already be familiar with DNA, the passage of traits through DNA to offspring, and the idea that sexual reproduction results in genetically different offspring.

Vocabulary / Definitions

| Word | Definition |
|---|---|
| **Genetically Modified Organism (GMO)** | An organism whose genome has been engineered in the laboratory in order to express a desired trait(s). |
| **Names of differing crop pathogens** | <can change based on your choices> |
| **Pathogen** | Infectious agent |
| **Infection** | Micro-agent entering the body resulting in the activation of immune reactions |
| **Cross-Contamination** | Infection of different organisms by the same pathogen |
| **Microbe** | Bacterium, virus, or single cell fungi |
| **Desired Traits** | A phenotype required for a particular reason |
| **Modifications** | Alterations made to a genome, in a lab setting, having an effect on the entire organism |
| **Engineering Practices** | Planning, implementing, and revision of in lab methods of altering genomes |

**Associated Activities:**

If additional lessons or activities for early finishers are required PBS provides an additional activity:

Full lesson:

https://wyoming.pbslearningmedia.org/resource/tdc02.sci.life.gen.lp_bioengfood/bioengineered-foods/

From above lesson directly pertinent to this lesson:
https://wyoming.pbslearningmedia.org/resource/tdc02.sci.life.gen.engineeracrop/engineer-a-crop-transgenic-manipulation/

Time Frame:

| |
|---|
| Day One<br><br>Pass out student pages:<br>1. Instructions<br>2. Fields<br>3. Crop research graphic organizer<br>Research |
| Day Two<br><br>Pass out student pages:<br>1. Microbe research graphic organizer<br>2. Lab Questions<br>Research<br>Complete lab questions |

**Lesson Closure: The close of the lesson will be the final presentation. Look for the suggested variations to the lesson as the lesson extension activity.**

## Assessment

**Pre-Lesson Assessment**
*Descriptive Title:* Formative assessment during discussion to guide the teacher to clarifying any misconceptions.

**Lesson Summary Assessment**
*Descriptive Title:* Lab/Activity answers presented in a potential of variety of ways.

## References

Dewey, C. (2018, 04, 30). Why E. coli keeps getting into our lettuce. *The Washington Post.* Retrieved from https://www.washingtonpost.com/news/wonk/wp/2018/04/26/why-e-coli-keeps-getting-into-our-lettuce/?noredirect=on&utm_term=.2df1832ae000

**Contributors: Caitlin Person**

**Supporting Program: University of Wyoming teacher education program**

**Classroom Testing Information: Not tested in any classrooms yet.**

# Teacher Resources

## Crop Planting: Teacher's information

1. Print the "crop selection" page for your reference (recommended one page per block).
2. Assign a random number (1-4) to each crop type on the crop selection page, (do NOT show the students the numbers yet).
3. As you assign the crops a number ask students to number their fields 1-5 in any direction they wish (an example being in a clockwise direction spiraling inwards…).
4. After steps 2 & 3 are accomplished show the students your crop number assignment. Students will place the crop name in the field by matching the number you rolled and their field. (ex: corn received #1 for your random number generator, so in field #1 they write "corn").
5. The 5th field will be the students' choice of crop from those listed.
6. Following the assignment of crops to fields the students will do research about the potential GMO alterations of their crop choices and provide a written review of the alterations to the genetically modified crops.
    A. The requirements of the research and how the students present the information is at your discretion.

Free random number generator:

https://www.random.org

## INFECTION!: Teacher's information

1. Use 1 of 2 options for infectious agents and the research options:
    A. You can potentially use https://datacorral.uwyo.edu data discovery tool to find the current year's crop microbe infection and rate within the state of Wyoming (due to the fluctuating nature of pathogens it is important to get the most current real-world data).
        - If you are located elsewhere, please provide crop and microbe options relevant to your local.
    B. An example included is a copy of generic microbial infectious agents for students to research listed on the example page.
        - The goal is to get students to understand that even with genetic modification (research of how this is achieved for each of the crops mentioned done by students) infection is still a potential problem for GMO crops, and even between different types of crops.
2. HOW THE DESEASES SPREAD:
    A. As the teacher: on the diseases chart for the class number the potential diseases you have provided 1-4. Reuse the appropriate numeral for the potential cross contamination (ex.: E. coli in Soybeans is "1" and again alfalfa is also "1").

- If you provide recent data about infectious agents, try to look for agents that cross contaminate throughout numerous crop types, due to needing the infection vector.

B. STARTING in the field the student labeled #1:

- Use a random number generator 1-4:
- *IF* the number corresponds to an infectious agent (see your crop assignment sheet) that *can* attack the crop: ***INFECTION***!
    - **IF INFECTED**: Look at all fields directly next to the infected field, and any that can be cross contaminated receive the infection, then radiate out from any infected fields from there and continue infecting outward through the farmers' fields.
    - **IF students' research indicate the GMO has a resistance to the infectious agent: THAT FIELD gets a "ROLL OFF":**
- Use the random number generator that has been used: even number= safe; odd number= infected (this indicates the fact the resistance is not 100% effective against all pathogens
    - <if you don't want a 50% chance you can alter this how you want for probability>).
- Do this process 5 times: once for each field # (1-5)
    - Some fields will not receive infections, and some will receive multiple potential cross contaminations.

3. Ask students to research what pathogens could or could not infect their GMO crops:

A. After this round of research the students need to then compare their infected fields with the rest of the farmers (classmates) and do the formal lab data analysis.

## KEY

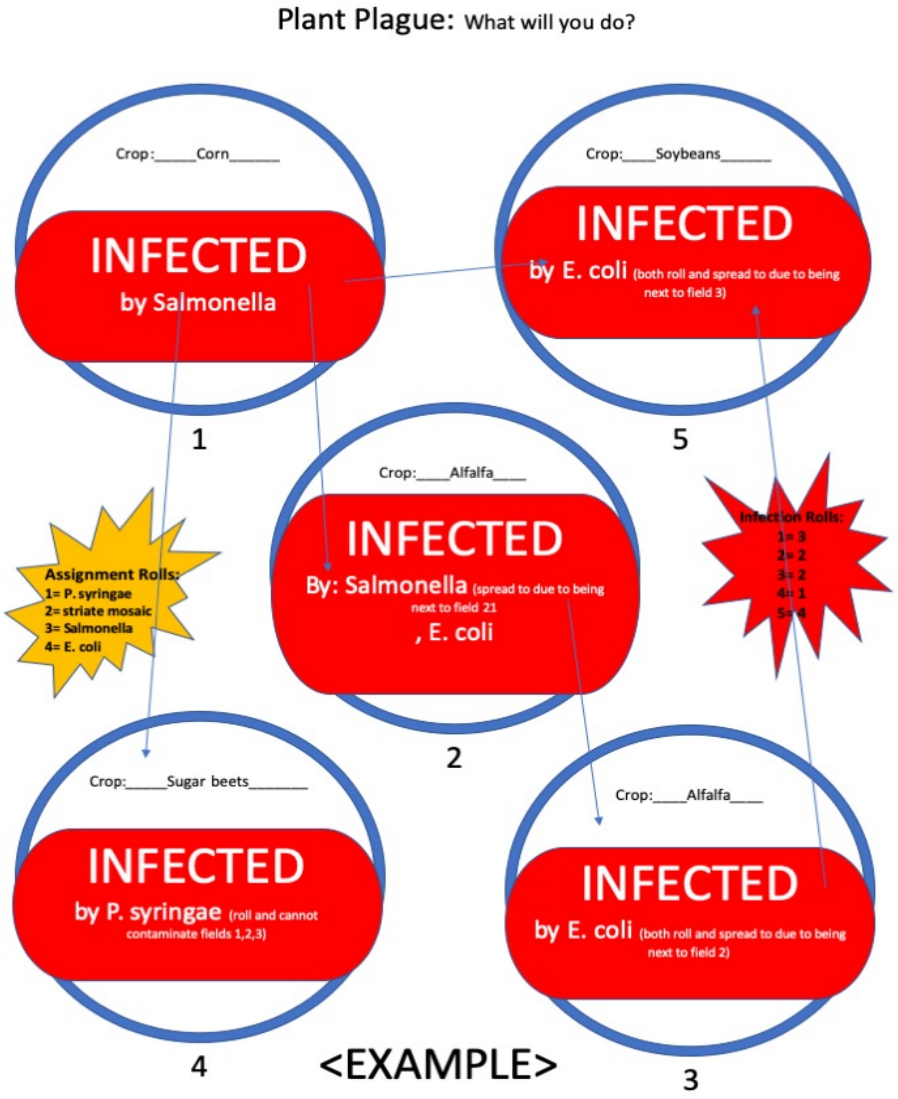
Answers will vary based on the student research choices and the random assignments of numbers.

Resources:

*Transmission of Escherichia coli O157:H7 from Contaminated Manure and Irrigation Water to Lettuce Plant Tissue and Its Subsequent Internalization. Appl Environ Microbiol. 2002 Jan; 68(1): 397–400.
*Front Microbiol. 2019; 10: 967. Published online 2019 May 15. Salmonella Establishment in Agricultural Soil and Colonization of Crop Plants Depend on Soil Type and Plant Species
*Viruses and Virus Diseases of Poaceae (Gramineae), By Hervé Lapierre, Pierre-A. Signoret. Pg 587.
* https://datacorral.uwyo.edu data discovery tool.

*4-column Research Table As Inspired By Natgeoed.Org.

*Free random number generator. https://www.random.org




| Plant Plague: What will you do? | 4-Column Research Chart | | Research graphic orginizer: include your resources |
|---|---|---|---|
| SOYBEANS | CORN | ALFALFA | SUGAR BEETS |
| | | | |

| Plant Plague: What will you do? | 4-Column Research Chart | | Research graphic orginizer: include your resources |
|---|---|---|---|
| Pseudomonas syringae | Escherichia coli | American wheat striate (wheat striate mosaic) | Salmonella |
| | | | |

**Examples of charts and fields:**

| Crop | Microbe | (random) # | How many fields were infected? |
|---|---|---|---|
| Sov Beans | Pseudomonas syringae | 1 | |
| | Escherichia coli | 4 | |
| Corn | American wheat striate (wheat striate mosaic) | 2 | |
| | Salmonella | 3 | |
| Alfalfa | Escherichia coli | 4 | |
| | Salmonella | 3 | |
| Sugar Beets | Pseudomonas syringae | 1 | |
| | American wheat striate (wheat striate mosaic) | 2 | |

Plant Plague: What will you do?

# Crop Selection

_____ Soybeans 

_____ Corn 

_____ Alfalfa 

_____ Sugar Beets 

| Crop | Microbe | (random) # | How many fields were infected? |
|---|---|---|---|
| Soy Beans | | | |
| | | | |
| Corn | | | |
| | | | |
| Alfalfa | | | |
| | | | |
| Sugar Beets | | | |
| | | | |

Plant Plague: What will you do?

# Crop Selection

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_____ Corn 

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| Soy Beans | Pseudomonas syringae | | |
| | Escherichia coli | | |
| Corn | American wheat striate (wheat striate mosaic) | | |
| | Salmonella | | |
| Alfalfa | Escherichia coli | | |
| | Salmonella | | |
| Sugar Beets | Pseudomonas syringae | | |
| | American wheat striate (wheat striate mosaic) | | |