Grades 9-10th

Genetics and Heredity: Genetically Modified Foods

LESSON OVERVIEW

Lesson developed by Jal Raval and Raquel Vigil

SYNOPSIS

This lesson is designed to introduce students to the debates regarding Genetically Modified Organisms (GMO's). Students will read texts on GMO's and discuss pros and cons. Lastly, students will write an essay arguing for one or against one side of the debate. This lesson was developed with English Language Learners in mind.

LEARNING OUTCOME(S)

Genetics 7: Explain how an organism be genetically modified for a particular use.
Genetics 8: Identify the pros and cons of GMO's products to people and environment.

ESSENTIAL QUESTION(S)

1. What are genetically modified foods? Is it really harmful?
2. What are some criticisms against GM foods?
3. How do I identify the important and relevant details in a piece of informational text?
4. How do I use evidence from an informational text to develop an argumentative claim?

LITERACY AND LANGUAGE OBJECTIVE(S)

Language objectives clarifies how students will learn and/or demonstrate the content knowledge by reading, speaking, writing, or listening.

This lesson emphasizes: **Language Outcome 5-** Write an argumentative essay supported by textual evidence.

LITERACY: KEY VOCABULARY

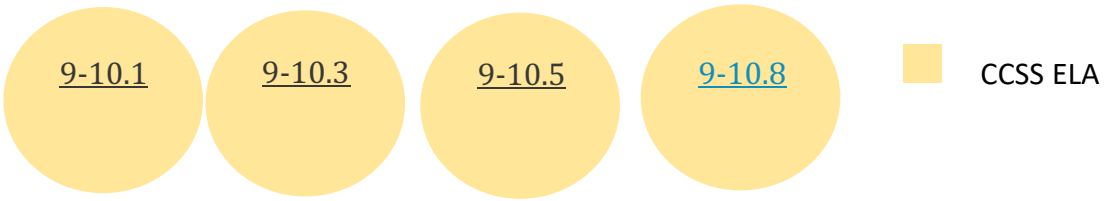
We recommend pre-teaching key vocabulary terms before the lesson begins or having a vocabulary guided worksheet for students.

The bolded vocabulary terms are covered in the structured worksheets for the readings.

Word	Definition
Agribusiness	A business that earns most or all of its revenues, or money, from agriculture.
Allergy	A medical condition that causes someone to become sick after eating, touching, or breathing something that is harmless to most people.
Argumentative	Given to expressing divergent or opposite views.
Bioethics	The study of the ethical and moral implications of new biological discoveries and biomedical advances.
Breeding	To produce by mating; propagate sexually; reproduce; give birth to; hatch.
Claim	State or assert that something is the case, typically without providing evidence or proof.
Counterclaim	A claim made to rebut a previous claim.
Criticism	The expression of disapproval of someone or something based on perceived faults or mistakes
Genetically Modified Organism	An organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination
Harmful	Something that causes damage or is able to be hurtful.
Hazard	A danger or risk.
Herbicide	A chemical used to destroy plants or stop plant growth.
Inserting / Inserted	to put or place in; to put (something) in something
Labeled / Labeling	An item used to identify something or someone, as a small piece of paper or cloth attached to an article to designate its origin, owner, contents, use, etc.
Mating	The action of animals coming together to breed; copulation; the act of pairing a male and female for reproductive purposes.
Modified	Make partial or minor changes to (something), typically so as to improve it or to make it less extreme.
Mortality	Death.
Pest	A destructive insect or other animal that attacks crops, food, livestock, etc.
Pesticide	A chemical that is used to kill animals or insects that damage plants or crops.
Pollen	The fertilizing element of flowering plants, consisting of fine, powdery, yellowish grains or spores, sometimes in masses.
Predictable	Able to say or estimate that a specified thing will happen in the future or will be a consequence of something.

Profit	Money that is made in a business after all the costs and expenses are paid; A financial gain.
Offspring	A person's child; the young of an animal or plant.
Released	Allow (something) to move, act, or flow freely; to set free; to allow to escape
Risky	Full of the possibility of danger, failure, or loss.
Traits	Physical attributes of an organism such as hair color, leaf shape, size, etc.
Tolerance/Tolerant	(of a plant, animal, or machine) Able to endure or survive (specified conditions or treatment).

STANDARDS



English Language Arts Standards Reading: Informational Text » Grade 9-10

MINDFUL PRACTICES

For suggestions for mindfulness activities, please see the *MYCEF Mindful Activities Sheet* located on the MCEF website. For this activity, we suggest the mindful journaling exercise; examining a plant.

ASSESSMENTS

Performance Task:	Other Evidence:
Students will write an argumentative essay	- Structured worksheets for reading - Talk-pair-share - Large discussions

Genetics and Heredity: Genetically Modified Foods

TEACHER GUIDE

LESSON PLAN

Prior Knowledge/Anticipated Misconceptions	We recommend reading the main texts in their entirety to familiarize yourself with the content. See references for links to full text. **Teacher Reflections:** 1. Flexible pairs to assure appropriate peer editing by analyzing more relevant and accurate evidence (data). 2. For students who need more of a challenge, have students explain how/why they prioritized evidence. 3. An oral or graphic explanation could be kinesthetic (3 students hold cards, each with a term, and determine among themselves what the relationship is among them: the PROMPT connects the ***TEXTS*** to the ***CLAIM, EVIDENCE AND COUNTERCLAIM***).
Materials	**Student Readings and Worksheets For:** - Genetically Modified Foods by Deborah B. Whitman - Positive Arguments for Genetically Modified Organisms by Doris Lin **Teacher Readings** - Positive Arguments for Genetically Modified Organisms by Doris Lin [Original text]

Lesson Procedures	**<u>Activation Activity:</u>**
	• Introduce the Essential Questions to the class:
	  • What are genetically modified foods? Is it really harmful?
	  • What are some criticisms against GM foods?
	  • How do I identify the important and relevant details in a piece of informational text?
	  • How do I use evidence from an informational text to develop an argumentative claim?
	• Students will watch a brief clip from Scientific America about GMO's. (5 minutes). http://www.scientificamerican.com/article/gmo-what-is-genetically-modified-food-video/
	• Debrief Video

	<u>Reading Text One:</u> • Introduce reading *Genetically Modified Foods* by Deborah B. Whitman

	• Set a purpose for reading/listening. • Modeling active reading. **Reading Text Two:** • Review students' responses to the text. • Instruct students to read *Positive Arguments For Genetically Modified Organisms* by Doris Lin independently. • Tell students to read and fill out worksheet in paired/small group
	Review of Concepts and Vocabulary: • Use the following assessment prompts to review vocabulary for students. **Assessment Prompt (AP) #1:** Identify and distinguish between important/interesting information about the texts. **Assessment Prompt #2:** Summarize relevant information. **Assessment Prompt #3:** Identify and prioritize necessary relevant information. **Assessment Prompt #4**: Choose a sentence and identify and justify textual evidence for that choice. **Assessment Prompt #5:** Explain connections between claims, warrants, and evidence to support sentence choice (position).
	Performance Task: • Instruct students that they will be writing an essay choosing and defending a position around GMO's.
	Wrap Up: • End lesson by instructing students to fill out the exit ticket for the lesson, attached below.

REFERENCES

Lin, D. (2019, May 24). The Pros and Cons of GMOs: Genetically Modified Organisms From a Vegan Perspective. *ThoughtCo.* Retrieved from https://www.thoughtco.com/genetically-modified-organisms-pros-and-cons-127662. Accessed September 13, 2019.

Scientific America (2013, September 1). *What Is a Genetically Modified Food? [Video].* Retrieved from https://www.scientificamerican.com/article/gmo-what-is-genetically-modified-food-video/. Accessed September 13, 2019.

Whitman, D. B. (2000, April). Genetically Modified Foods: Harmful or Helpful?. Retrieved from http://artsci.ucla.edu/biotech177/reading/GMO_Harm_or_Help.pdf. Accessed September 13, 2019.

Genetics and Heredity: Genetically Modified Organisms

STUDENT READING AND WORKSHEET

Directions: Read the excerpts *Genetically Modified Foods* by Deborah B. Whitman answer the questions.

1. If a food is **'harmful*'**, is it 'SAFE' or 'DANGEROUS'? _____

What are genetically-modified foods?

The term **'GM foods'** or '**GMOs'** (**genetically-modified[i] organisms**) is most commonly used to refer to crop plants created for human or animal consumption using the latest molecular biology techniques.

2. What does **'GMO'** stand for?

G _____

M _____

O _____

3. What does **'modified*'** mean?

_____

4. What has been modified*? How? _____

_____

_____

These plants have been **modified*** in the laboratory to enhance desired traits such as increased resistance to herbicides* or improved nutritional content.

5. Have these plants been modified* 'IN NATURE' or 'IN THE LABORATORY'? _____

_____

6. What are **<u>two</u> reasons** why these plants have been modified*?

a. _____

b. _____

Genetic engineering, on the other hand, can create plants with the exact desired trait very rapidly and with great accuracy. For example, plant geneticists can isolate a <u>gene</u> responsible for drought tolerance* and insert that gene into a different plant. The new genetically-modified* plant will gain drought tolerance* as well.

7. What is the **benefit** of genetic engineering? _____

_____

_____

8. How do geneticists genetically engineer a plant? _____

_____

_____

<u>What are some of the criticisms* against GM foods?</u>

Environmental activists, religious organizations, public interest groups, professional associations and other scientists and government officials have all raised concerns about GM foods. They have criticized agribusiness for pursuing profit without concern for potential hazards. They have criticized the government for failing to exercise adequate regulatory insight. It seems that everyone has strong opinion about GM foods. Even the Vatican and the Prince of Wales have expressed their opinions. Most concerns about GM foods fall into three categories: environmental hazards, human health risks, and economic concerns.

9. Does **'criticism* against'** mean to 'SUPPORT' or 'NOT SUPPORT'? _____

10. Who has raised concerns about GM foods?

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

11. According to this paragraph, is **agribusiness*** concerned with 'PROFIT' or 'POTENTIAL HAZARDS'? ___

_____

12. What is **'profit'***? _____

_____

13. What does **'hazard'*** mean? _____

_____

14. What are the **three categories** of concerns about GM foods?

a. _____

b. _____

c. _____

ENVIRONMENTAL HAZARDS

ENVIRONMENTAL HAZARD 1: Unintended harm to other organisms

Last year a laboratory study was published in Nature showing that pollen from B.t. corn caused high mortality rates in monarch butterfly caterpillars. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from B.t. corn is blown by the wind onto milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish. Although the Nature study was not conducted under natural field conditions, the results seemed to support this viewpoint. Unfortunately, B.t. toxins kill many species of insect larvae indiscriminately; it is not possible to design a B.t. toxin that would only kill crop-damaging pests and remain harmless to all other insects.

15. What does **pollen from B.t. corn** cause in monarch butterfly caterpillars? _____

_____

16. If there is a '**high mortality* rate'** in monarch butterfly caterpillars, does this mean that they are 'SURVIVING' or 'DYING'? _____

17. 'MILKWEED PLANTS' or 'CORN'? What do monarch caterpillars consume?

18. What is fear about B.t. corn pollen, neighboring fields, and caterpillars? _____

19. 'TRUE' or 'FALSE'? It is possible to design a B.t. toxin that only kills crop-damaging pests* and remains harmless to all other insects. _____

20. What is a **'pest'*** ? _____

ENVIRONMENTAL HAZARD 2: Reduced effectiveness of pesticides

Just as some populations of mosquitoes developed resistance to the now-banned pesticide* DDT, many people are concerned that insects will become resistant to B.t. or other crops that have been genetically-modified* to produce their own pesticides*.

21. If 'cide' means 'kill' in Latin, what is a **'pesticide*'**? _____

22. What happened to some populations of mosquitoes? _____

_____

_____

23. If the pesticide* DDT was **banned**, is it 'LEGAL' or 'ILLEGAL'? _____

24. What are people concerned will happen to insects if crops have been genetically-modified* to produce their own pesticides*? _____

_____

_____

ENVIRONMENTAL HAZARD 3: Gene transfer to non-target species

Another concern is that crop plants engineered for herbicide* tolerance* and weeds will cross-breed, resulting in the transfer of the herbicide* resistance* genes from the crops into the weeds. These "superweeds" would then be herbicide* tolerant* as well. Other introduced genes may cross over into non-modified crops planted next to GM crops. The farmers claim that their unmodified crops were cross-pollinated from someone else's GM crops planted a field or two away. More investigation is needed to resolve this issue.

25. What is a concern about crop plants engineered for herbicide* tolerance*? _____

_____

_____

_____

26. What are 'superweeds'? _____

_____

_____

27. What does it mean if weeds are **'tolerant*'** of herbicide*? _____

_____

_____

28. What might happen with some introduced genes? _____

_____

_____

29. What do farmers claim happened to their unmodified crops? _____

_____

_____

30. Does **'unmodified'** mean 'CHANGED' or 'NOT CHANGED'? _____

31. What is needed to resolve the issue of GM crops cross-pollinating unmodified crops located in nearby fields? _____

HUMAN HEALTH RISKS

HUMAN HEALTH RISK 1: Allergenicity

Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new **allergen** or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of their fear of causing unexpected allergic reactions.

32. What have many children in the US and Europe developed? _____

_____

_____

33. What is an **'allergy'*** ? _____

_____

_____

34. What might "introducing a gene into a plant' cause in some individuals? _____

_____

_____

35. Why was a proposal to incorporate a gene from Brazil nuts into soybeans abandoned? _____

_____

_____

HUMAN HEALTH RISK 2: Unknown effects on human health

There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. A recent article published in Lancet examined the effects of GM potatoes on the digestive tract in rats. This study claimed that there were appreciable differences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes.

36. What is the growing concern about introducing foreign genes into food plants? _____

_____

_____

37. 'POSITIVE' or 'NEGATIVE'? Growing numbers of people think that GM foods will have a _____ _____ impact on human health.

38. What did a study of rats fed GM potatoes and rats fed unmodified potatoes claim? _____

_____

_____

_____

39. Does an '**appreciable* difference'** mean a 'BIG DIFFERENCE' or a 'SMALL DIFFERENCE'? _____

_____

Vocabulary

A

Agribusiness: A business that earns most or all of its revenues, or money, from agriculture.

Allergy: A medical condition that causes someone to become sick after eating, touching, or breathing something that is harmless to most people.

Appreciable: Large or important enough to be noticed.

C

Criticism: The expression of disapproval of someone or something based on perceived faults or mistakes.

H

Harmful: Something that causes damage or is able to be hurtful.

Hazard: A danger or risk.

Herbicide: A chemical used to destroy plants or stop plant growth.

M

Modified: Changed somewhat the form or qualities; Altered.

Mortality: Death.

P

Pest: A destructive insect or other animal that attacks crops, food, livestock, etc.

Pesticide: A chemical that is used to kill animals or insects that damage plants or crops.

Pollen: The fertilizing element of flowering plants, consisting of fine, powdery, yellowish grains or spores, sometimes in masses.

Profit: Money that is made in a business after all the costs and expenses are paid; A financial gain.

T

Tolerance / Tolerant: (of a plant, animal, or machine) Able to endure or survive (specified conditions or treatment

Genetics and Heredity: Genetically Modified Organisms

STUDENT READING AND WORKSHEET

Name: _____ Class: ___ Date: _____

Directions: Read the excerpts from *Positive Arguments For Genetically Modified Organisms* by Doris Lin and answer the questions.

If you're confused about the pros and cons of genetically modified organisms (GMOs) you're not alone. This relatively new technology is riddled with bioethics* questions, and the arguments for and against GMOs are difficult to weigh because it's hard to know the risks* until something goes wrong.

1. '***Positive' or 'Negative'?*** **'**Pros' are _____ things.

2. ***'Positive' or 'Negative'?*** 'Cons' are _____ things.

3. ***'Old' or 'New'?*** Creating GMOs is _____ technology.

4. ***'Few' or 'Many'?*** There are _____ bioethics questions about GMOs.

5. **'Bioethics'** means _____

_____

6. ***'True' or 'False'?*** We know all of the risks of GMOs? _____

What Is a Genetically Modified Organism or GMO?

The legal definition of a genetically modified organism in the European Union is "an organism, with the exception of human beings, in which the genetic material has been altered* in a way that does

not occur naturally by mating and/or natural recombination*." It is illegal* in the EU to deliberately* release a GMO into the environment, and food items containing more than 1% GMOs must be labeled*.

7. ***'True' or 'False'?*** According to the European Union, the genetic material of a GMO has been altered by mating and/or natural recombination. _____

8. In the EU, it is _____ to deliberately _____ a GMO into the _____.

9. **'Release'** means _____

_____

10. Food items containing _____ GMOs must be _____.

11. **'Labeled'** means _____

_____

This alteration* of the genes usually entails inserting* genetic material in to an organism in a laboratory without natural mating*, breeding* or reproduction. Instead of breeding* two plants or animals together to bring out certain traits* in the offspring*, the plant, animal or microbe has DNA from another organism inserted.

12. What does the alteration of genes usually entail? _____

_____

_____

13. **'Inserting'** means _____

_____

14. '***In nature' or 'In the laboratory'?*** Where does the alteration of genes for GMOs take place? _____

_____

15. **'Mating'** means _____

_____

16. **'Breeding'** means _____

_____

17. **''Traits'** means _____

_____

_____

18. **'Offspring'** means _____

_____

_____

19. ***'Natural mating, breeding or reproduction' or 'Having DNA from another organism inserted'?*** The alteration of genes in GMOs entails _____

_____

_____

Creating GMOs is one type of genetic engineering. A transgenic organism is a GMO that contains DNA from another species. A cisgenic organism is a GMO that contains DNA from a member of the same species, and is generally regarded as the less risky type of GMO.

20. One type of GMO is _____.

21. ***'DNA from the same species' or 'DNA from another species'?*** A transgenic organism is a GMO that contains _____

_____.

22. '***DNA from the same species' or 'DNA from another species'?*** A cisgenic organism is a GMO that contains _____.

23. **'Risky'** means _____

_____

24. '***Transgenic organism' or 'Cisgenic organism'?*** Which organism is regarded as the less risky type of GMO? _____.

GMOs have been used in various ways, including creating mice with certain traits for the purposes of vivisection, but the GMO debate is centered on food products for direct human consumption and on food for livestock.

25. The GMO debate is centered on _____

_____

Am I Eating GMOs?

If you live in the United States, you are most likely eating GMOs and/or livestock who were fed GMOs. Eighty-eight percent of the corn grown in the U.S. has been genetically modified to be herbicide-resistant and/or insect-resistant. Ninety-four percent of the soy grown in the U.S. has been genetically modified to resist herbicides.

26. '***True' or 'False'?*** If you live in the United States, you probably do not eat GMOs.

_____

27. What percentage of corn grown in the U.S. has been genetically modified?

_____

28. Why has eighty-eight percent of the corn grown in the U.S. been genetically modified? _____

_____

_____

29. What percentage of soy grown in the U.S. has been genetically modified?

_____

30. Why has ninety-four percent of the soy grown in the U.S. been modified? _____

_____

_____

One of the biggest controversies surrounding GMOs is labeling. Unlike other controversial foods like veal, trans fats, MSG or artificial sweeteners, GMO ingredients in food are rarely, if ever, identified on the label. GMO opponents advocate a labeling requirement so that consumers can decide for themselves whether to consume GMO products.

31. What is one of the biggest controversies surrounding GMOs?

_____

32. ***'Often' or 'Rarely'?*** GMO ingredients are _____ identified on the label.

33. What do GMO opponents advocate? _____

_____

_____

34. ***'Support GMOs' or 'Do not support GMOs'?*** GMO advocates are people who

_____

_____

35. ***'True' or 'False'?*** GMO opponents do not think it is important for consumers to decide whether to consume GMO products. _____

Pros – Arguments for Genetically Modified Organisms (GMOs)

- GMO technology can develop crops with higher yield, with less fertilizer, less pesticides, and more nutrients.

36. What are the four benefits of developing crops with GMO technology?

a. _____

b. _____

c. _____

d. _____

37. ***'More' or 'Less'?*** 'Higher yield' means crops produce _____ food.

38. ***'Healthier' or 'Less Healthy'?*** Crops with more nutrients are _____

_____.

- Traditional breeding can be very slow because it might take several generations before the desired trait is sufficiently brought out and the offspring must reach sexual maturity before they can be bred. With GMO technology, the desired genotype can be created instantly in the current generation.

39. ***'Instantly in the current generation' or 'In several generations'?*** How long does it take in traditional breeding for a desired trait to be brought out? _____

_____

40. **'Instantly in the current generation' or 'In several generations'?** With GMO technology, when can the desired genotype be created? _____

_____

- In some ways, GMO technology is more predictable than traditional breeding, in which thousands of genes from each parent are transferred randomly to the offspring. Genetic engineering moves discrete genes or blocks of genes at a time.

41. ***'GMO technology' or 'Traditional breeding'?*** Which is more predictable?

_____

42. **'Predictable'** means _____

_____

- GMOs may not be natural, but not everything natural is good for us, and not everything unnatural is bad for us. Poisonous mushrooms are natural, but we shouldn't eat them. Washing our food before eating it is not natural, but is healthier for us.

43. ***'True' or 'False'?*** GMOs are natural. _____

44. ***'True' or 'False'?*** Everything natural is good for us. _____

44. One example of something natural that is not good for us is _____

_____.

45. ***'True' or 'False'?*** Everything unnatural is bad for us. _____

- GMOs have been on the market since 1996, so if all GMOs were an immediate health threat, we would know it by now.

46. Since what year have GMOs been on the market? _____.

47. '***True' or 'False'?*** GMOs are an immediate health threat. _____.____

Vocabulary

B

Bioethics: The study of the ethical and moral implications of new biological discoveries and biomedical advances.

Breeding: To produce by mating; propagate sexually; reproduce; give birth to; hatch.

I

Inserting / Inserted: to put or place in; to put (something) in something

L

Labeled / Labeling: An item used to identify something or someone, as a small piece of paper or cloth attached to an article to designate its origin, owner, contents, use, ...

M

Mating: The action of animals coming together to breed; copulation; the act of pairing a male and female for reproductive purposes.

O

Offspring: A person's child; the young of an animal or plant.

P

Predictable: Able to say or estimate that a specified thing will happen in the future or will be a consequence of something.

R

Released: Allow (something) to move, act, or flow freely; to set free; to allow to escape

Risky: Full of the possibility of danger, failure, or loss.

T

Traits: Physical attributes of an organism such as hair color, leaf shape, size, etc.

EXIT TICKET
Genetically Modified Organism (GMO Reading)
STUDENT WORKSHEET

Name: _____ Class: ___ Date: _____

Genetically Modified Organism (GMO Reading)

Outcome	H	P	C	N
Genetics 7: I am able to explain how an organism be genetically modified for a particular use.				
Genetics 8: I am able to Identify the pros and cons of GMO's products to people and environment.				
Language 2: I am able to find the main idea of a text.				

_____

Reflection: Today I learned that:

_____

_____

_____

_____

I want to know more about:

_____

_____

_____

_____