

GMO Mosquitoes: How Biotechnology Can Fight Mosquito Borne Illnesses

Unit: Biotechnology and Genetically Modified Mosquitoes	Utah SEEd Standard / NGSS Performance Expectation: Standard Bio 3.5 Evaluate design solutions where biotechnology was used to identify and/or modify genes in order to solve (effect) a problem. <i>Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.</i> Emphasize arguments that focus on how effective the solution was at meeting the desired outcome. (LS3.B, ETS1.A, ETS1.B, ETS1.C)	Time: 2 (70-minute) class periods for instruction 1-day Assessment
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Access to all material for this lesson: <https://byu.box.com/s/zd9nroo0mva9ej9z2syhz57fbse9z9fi>

Anchor Phenomenon	Mosquitoes and the spread of disease
Driving Question(s)	How can biotechnology solve a problem? How effective is using biotechnology to solve a problem? Can using biotechnology have unintended consequences? →→→ JURASSIC PARK
Performance Task	Students will form an opinion based on an evaluation of using biotechnology to genetically modify an organism.






Lesson Summary:



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1. Students will evaluate design solutions where biotechnology was used to identify and/or modify genes to solve a problem (GMO Mosquitoes and the Zika Virus).
 - a. Students are taught about Mosquitoes and the spread of disease.
 - b. Students learn how a Mosquito has been genetically engineered to stop the spread of disease.
2. Students will be able to recognize the use of biotechnology within their lives and the world around them through the lens of genetically modified mosquitoes.

	Time	Guiding Question / Learning Objective	How are students answering the guiding question or meeting the learning objective?
 Engage	Day1 15-20 min	Read Objectives Rank 7 Deadliest Animals	Objectives introduce the phenomenon of the spread of disease by Mosquitoes, leading students to the need for genetically modified mosquitoes.
 Explore	Day1 20-30 min	Students explore how mosquitoes spread disease through viruses and what methods are used to avoid or minimize mosquito interactions. Video: Mosquito - Deadliest Creature in the World	Students recognize that disease spread by Mosquitoes is a problem that can be addressed.
 Explain	Day1 10-15	Students focus on Zika Virus and what one company (Oxitec) has done to create a genetically modified Mosquito. Video: Genetically Modified Mosquitoes	Students learn about genetic engineering. Talk about the ethics of Biotechnology
 Elaborate	Day 2	Students begin to answer the question of how GMOs can be used and to identify potential benefits and/or potential drawbacks.	Students learn about the use of biotechnology in the world around them and evaluate the solution
 Evaluate	Day 3	Students are given an assessment to understand genetically modified organisms through genetic engineering and selective breeding. They are also introduced to bioethics through the movie Jurassic Park (video clip) .	Students should be able to form their own opinion about the use of genetically modified mosquitoes to treat disease.

Three Dimensions Focused on in This Lesson		
<p>Disciplinary Core Idea: NGSS Appendix E</p> <p>Utah SEEd Standard Bio 3.5</p> <p>Evaluate design solutions where biotechnology was used to identify and/or modify genes in order to solve (effect) a problem. <i>Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.</i> Emphasize arguments that focus on how effective the solution was at meeting the desired outcome. (LS3.B, ETS1.A, ETS1.B, ETS1.C)</p>	<p>Science and Engineering Practices: NGSS Appendix F</p> <p>Designing Solutions</p> <p>Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p>	<p>Crosscutting Concept: NGSS Appendix G</p> <p>Cause and Effect</p> <p>Students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.</p>
<p>Learning Objectives</p> <ol style="list-style-type: none"> Students will evaluate design solutions where biotechnology was used to identify and/or modify genes to solve a problem (GMO Mosquitoes and the Zika Virus). Students will be able to recognize the use of biotechnology within their lives and the world around them through the lens of genetically modified mosquitoes. 		
Related Knowledge and Skills from Prior Grades		
<p>Disciplinary Core Idea: NGSS Appendix E</p>	<p>Science and Engineering Practices: NGSS Appendix F</p>	<p>Crosscutting Concept: NGSS Appendix G</p>



<p>Grade 7 Utah SEEd Standard Bio 7.4.4</p> <p>Obtain, evaluate, and communicate information about the technologies that have changed the way humans affect the inheritance of desired traits in organisms. Analyze data from tests or simulations to determine the best solution to achieve success in cultivating selected desired traits in organisms. Examples could include artificial selection, genetic modification, animal husbandry, or gene therapy. (LS4.B, ETS1.A, ETS1.B, ETS1.C)</p>	<p>Grades 6-8</p> <p>Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system.</p>	<p>Grades 6-8</p> <p>Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability</p>
<p>Connections to Mathematics and ELA/Literacy Standards</p>		
<p>ELA/Literacy Standards:</p> <ul style="list-style-type: none"> ● RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. ● RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. ● RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. 		<p>Mathematics Standards:</p> <ul style="list-style-type: none"> ● MP.2: Reason abstractly and quantitatively. ● MP.4: Model with mathematics.

Materials	
Handouts	Other Resources (videos)
<ul style="list-style-type: none"> – Deadliest Animals in the World – GMO Mosquito Mark It Up (Student worksheet and article) – Student Assessment <p>Teacher Resources</p> <ul style="list-style-type: none"> – PowerPoint: Biotechnology – West Nile Alternative Files – Teacher Rubric 	<ul style="list-style-type: none"> – Mosquitoes – Genetically Modified Mosquitoes – Agricultural biotechnology – Selective plant breeding – Jurassic Park – Florida and Genetically Modify Mosquitoes – Ted Ed – The Loathsome Lethal Mosquito

ENGAGE	
<ul style="list-style-type: none"> – Start by reading the objectives to the class to help steer the students toward the intended goals of the lesson. – Top 7 deadliest animals in the world <ul style="list-style-type: none"> • Show students the slide with the deadliest animals in the world. Either specify that all animals are on the slide or let students use their imaginations. Have students write their predictions on the Deadliest Animals in the World handout. – After giving the students 3-5 minutes to write their predictions, show them the results on the next slide. Names of animals that may be unfamiliar are listed in the notes section of the slide. – Mosquitoes are the deadliest animal. At this point, discuss that the mosquito is the deadliest animal because it spreads viruses that cause disease. Something worth observing with the students is how many of “the deadliest” animals are because of the diseases they spread. 	<p>Teacher Tips</p> <ul style="list-style-type: none"> -Engage section will take about 10 minutes -Slide 3 places animals from least to most deadliest

EXPLORE

- Teacher asks: *“Now we have seen that mosquitoes can pass viruses; does anyone know how that happens?”*
- After this discussion, show students the video [Mosquito - Deadliest Creature in the World](#). (Turn on Closed Captioned for ELL/ and hard of hearing students). Before starting the video, have students use the backside of the ‘Deadliest Animals in the World’ handout to create a KWL chart.
 1. In the **K** column, students will record things they already **K**new about mosquitoes and diseases.
 2. In the **W** column, students will record **W**hat they want to know more about mosquitoes and diseases.
 3. In the **L** column, students will record things they **L**earned about mosquitoes and disease.
- After the video, do a think-pair-share to discuss what students recorded on their KWL chart.
- Teacher asks: *“How can we help lessen the impact of mosquito-transmitted diseases? How can we avoid or minimize mosquito interactions?”*
- Present the slide that highlights different mitigation and avoidance techniques.
 - Teacher asks: *“Which strategies and methods do you use? What are the benefits and drawbacks of some of the strategies on the list?”*
 - Teacher asks: *“What are other potential solutions to mosquito problems?”*

Teacher Tips

During this section, there will be a need to explain the following concepts and terms:

- Invasive Species
- West Nile Virus
- Zika Virus
- Euthanize
- Progeny
- Extrapolate
- Eradicated
- Hindrance
- Zoonotic

BEFORE PLAYING THE VIDEO, GIVE A CONTENT WARNING; THE VIDEO HAS THE POTENTIAL TO TRIGGER PHOBIAS!



EXPLAIN

- Present the slide on the Zika Virus. Use this slide to highlight the Zika Virus symptoms and introduce the concept of genetically modified mosquitoes.
- Show students the video [Genetically Modified Mosquitoes](#). Before starting the video, instruct students to add to the KWL charts they used previously.
 1. In the **K** column, students will record things they already **K**new about Genetically Modified Organisms.
 2. In the **W** column, students will record **W**hat more they want to know about Genetically Modified Organisms.
 3. In the **L** column, students will record things they **L**earned about Genetically Modified Organisms.
- After the video, do a think-pair-share to discuss what students recorded on their KWL charts.

Teacher Tips

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ELABORATE

- Hand out the “[GMO Mosquito Mark It Up](#)” packet.
- Introduce the reading to the students and explain the process of highlighting potential benefits in one color and potential drawbacks in another.
 - Show the table (page 1) and explain the different boxes.
- After students have read and marked their article, have them share what they recorded with a partner. Discuss student ideas as a class.
- After discussing what students identified, have students complete the final evaluation question on the 2nd page.

Teacher Tips

[Audio link to the “Mark It Up!” article if needed](#)

EVALUATE

- Hand out the [student assessment](#), which is organized into two parts:
 - **STIMULUS – Reading 1: Roundup Ready Crops.** This reading is about Roundup Ready Crops and is used to stimulate student thinking. The purpose is to give students an example of a GMO currently in use, some history of the GMO, and the benefits and potential environmental impacts of using a GMO crop.
 - After students have read the article, have them answer questions 1-6.
 - **APPLICATION – Reading 2: Types of Biotechnology.** This reading will compare two different methods of genetic modification.
 - a. The first method discussed is genetic modification by genetic engineering. Have students watch the video and then read the information. Students should recognize that “Golden Rice” is an example of genetic engineering.
 - b. The second method discussed is genetic modification by selective breeding. Have students watch the video and then read the information. Ensure students recognize that “Wheat” is an example of selective breeding.
- After students have read this, have them answer questions 7 and 8.
- End class by showing the students the slide BIOETHICS. Ask students: “*Just because we can do something, should we?*” Show students the [Jurassic Park](#) clip.

Teacher Tips

A copy of the assessment is in CANVAS. Search for it in COMMONS using the name ‘Bryan Holder’ with a thumbnail that looks like this:



Video: [Agricultural biotechnology](#)

Video: [Selective plant breeding](#)

Video: [Jurassic Park](#)

POSSIBLE EXTENSION / ALTERNATIVE ADAPTATIONS

Extensions:

Video: [Florida and Genetically Modify Mosquitoes](#)

Video: [Ted Ed – The Loathsome Lethal Mosquito](#)

Articles for additional background. These articles can be used to help you as a teacher gain additional knowledge or can be given to a student as well.

- [First Genetically Modified Mosquitoes Released in US](#)
- [Study on DNA Spread By Genetically Modified Mosquitoes Prompts Backlash](#)

Alterations:

[Audio Link for the “Mark It Up!” Assessment](#)

West Nile Alternatives. If you would like to make a connection on how mosquitoes spread disease in Utah, you can use the following resources:

- [‘Utah Horses Die from West Nile’](#)



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This lesson was developed by Jens Andreasen, Bryan Holder, Kelly Peterson, & Thomas Wilder