BEATING MOSQUITOS AT THEIR OWN GAME

TGR FOUNDATION

HIGH SCHOOL

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BEATING MOSQUITOS AT THEIR OWN GAME

LESSON OVERVIEW:

Students will investigate how humans can influence the characteristics of organisms in order to ultimately take a stance on the best way to combat an outbreak of Zika-infected mosquitos in their community. Students will begin by investigating mosquito-borne disease transmission. Next, they will consider how scientists are effectively using mosquitos as model organisms to study disease progression and to test treatments. Students will then develop an understanding of how scientists are using Geographic Information Systems (GIS) mapping to study mosquito locations. Once students have sufficient background knowledge, they will move on to explore how scientists modify mosquitos using various methods to combat the spread of disease. Students will then compare remediation efforts to the use of genetically modified organisms (GMOs). They will use this information to ultimately develop a stance on GMOs and come to their own conclusion on the best way to combat their community's mosquito outbreak.

The accompanying presentation was created with PowerPoint so that it can be used in a variety of classrooms. If you are using a laptop with an LCD projector, simply progress through the PowerPoint by clicking to advance. All interactiveaspects of the presentation are activated by a click. This includes images, text boxes, answers and links to outside videos, which will appear in your web browser. If you are using an interactive whiteboard, tap on each slide with your finger or stylus to use the interactive features of the presentation. There will be information on how to proceed in the notes section of each slide.

THIS LESSON FOCUSES ON:

ENGINEERING DESIGN PROCESS	21ST CENTURY SKILLS
• Defining the Problem	• Collaboration
• Designing Solutions	• Communication
• Creating or Prototyping	• Critical Thinking
• Refine or Improve	• Creativity
• Communicating Results	

SUGGESTED TIME

4 class sessions (45-50 minutes each)

GRADE LEVELS

9-12

CONTENT AREAS

- Heredity
- Genetics
- Ethics

ESSENTIAL QUESTIONS

1. How can humans influence the characteristics of organisms?
2. How can you model the spread of infectious disease?
3. How are scientists using mosquito models to examine human diseases?

4. How do researchers use GIS Mapping and computer-based simulation models as tools for investigating mosqui to-borne diseases?
5. What role does biotechnology have in the control and prevention of mosquito-borne diseases?
6. What are the advantages and disadvantages of genetic modification vs. novel biological control mechanisms?

HAVE YOU EVER WONDERED…

What is Zika and what are the symptoms of Zika?

Zika virus is a mosquito-borne flavivirus that was first identified in Uganda in 1947 in monkeys. It was later identified in humans in 1952 in Uganda and the United Republic of Tanzania.

Many people who are infected with Zika don't actually know they are infected. Others may have mild symptoms. Symptoms can include a rash, fever, headache, joint pain, muscle pain, itching or pain behind the eyes. However, the biggest risk comes with pregnancy. Pregnant women who have Zika, even if they show no symptoms, can spread Zika to their developing child. A fetus exposed to Zika is at risk of developing birth defects.[1]

When did the Aedes aegypti mosquito come to America?

The Aedes aegypti mosquito likely came to America from West Africa, aboard ships of the slave trade. Eventually, the mosquito spread across America to parts where it could easily live. For hundreds of years, this mosquito carried other diseases like yellow fever, dengue and malaria. In fact, the mosquito helped America win its independence. The British troops grew so sick from malaria that the American and French armies were able to easily surround them, forcing Britain's General Cornwallis to surrender![2]

How can you protect yourself against Zika?

There is no existing vaccine for the Zika virus, though scientists are trying to create one. Other than avoiding going to regions where the Zika virus is highly transmitted, people can try to avoid mosquito bites by using insect repellent, wearing pants and long sleeves and sleeping in screened-in rooms.3

MAKE CONNECTIONS!

This section captures how this activity connects to different parts of our lives and frames the reason for learning.

HOW DOES THIS CONNECT TO STUDENTS?	HOW DOES THIS CONNECT TO CAREERS?	HOW DOES THIS CONNECT TO OUR WORLD?
Over 6,000 cases of Zika have been reported in the United States since 2018.4 While the majority of these cases were in travelers who were returning from other infected areas, a small number of these cases were acquired in the southern United States. It's therefore important for students to be aware of this disease—both for travel and at home—as well as to understand different ways that scientists are combatting its spread!	**Epidemiologists** study the patterns, causes and effects of diseases—particularly epidemic diseases (diseases that affect many people at once) in order to suggest prevention and treatment. Epidemiologists can be medical doctors, but a medical license is not a career requirement. **Entomologists** are scientists who study insects. Medical entomologists specifically study how insects affect people's health, and they may focus on a particular insect and the effects it has on society. **Pest Control Worker:** To prevent health problems and damage to property, pest control workers remove pests. Traditionally accomplished with chemical sprays, there is a growing effort to provide green pest management to control pests with environmentally-friendly methods.	Zika exists in countries in Africa, Asia, the Caribbean, Central America, North America, South America and the Pacific Islands. While travelers can try to avoid these areas, the citizens of these countries are continually at risk. In 2016, the World Health Organization declared Zika Virus a Public Health Emergency of International Concern. In doing so, it hoped to create a call to action for researchers worldwide to develop vaccines and treatments.5

Every Day Materials:

- Projection device
- Corresponding PowerPoint presentation

Day 1 Materials:

- Infectious Diseases student capture sheet, one per student
- Vials pre-filled partway with distilled water, six per student
  *If this number of vials is not available, you may instead quickly rinse out the vials between each round of the Infectious Disease Simulation.
- Droppers, one per student
- Vials pre-filled with .1 molar NaOH, two per student
- Phenolphthalein indicator
- Mosquito Model readings*, enough of each reading for one-third of the class *The first reading is provided twice: once as an excerpt and once as an edited excerpt. The unedited excerpt is the most difficult text.
- Optional: Copies of Zika Virus Key Facts Sheet

Day 2 Materials:

- Mosquito Tracker Grid student capture sheet, one per student
- Research Notes student capture sheet, one per student
- Devices with internet access, one per two students
- Optional: Copies of mosquito control articles one and two (See Slide 7, Step 4)

Day 3 Materials:

- Copies of the following GMO articles, enough for half the class
- GMO Foods
- Gene Therapy
- Genetically Modified Embryos
- Genetically Modified Animals*
  *This article can be used to differentiate for groups who would benefit from an easier text.
- Debate Prep student capture sheet, one per student

Day 4 Materials:

- Ballots, one per student

OBJECTIVES

Students will be able to:

- Investigate how humans can influence the characteristics of organisms.
- Participate in a simulation that models the spread of infectious disease and apply what they learned to mosquito-borne infections.
- Compare how GIS mapping and computer-based models are an improvement over older mosquito trackin methods.
- Research and analyze the role of biotechnology in the prevention of mosquito-borne diseases.
- Identify the benefits and considerations of mosquito control options in order to construct their own well-informed opinion on the best way to combat disease.

BACKGROUND INFO

The World Health Organization defines GMOs as organisms (i.e. plants, animals or microorganisms) whose DNA has been altered in a way that does not occur naturally. In other words, scientists manipulate the genes of an organism to produce a new organism that has a desired characteristic or trait. This technology is often referred to as biotechnology or genetic engineering.6 As students will explore in this lesson, scientists are studying how biotechnology can be used to alter or stop the transmission of disease. The mosquito is a strong focus of this research, because it is the greatest disease transmitter of all insects and is responsible for several million deaths and hundreds of millions of disease cases every year.7

This guide gives educators a collection of resources designed to help students investigate the concept of genetic modification and its potential link to disease-carrying mosquitos. It provides slide-by-slide instructions to ensure educators are prepared to explain, discuss and facilitate the hands-on content in the presentation. The presentation is designed to cover four class sessions, but it can be flexible depending on the students' needs and the time available. Additional extension ideas are included at the end of the manuscript.

This lesson plan follows an inquiry-driven 5E instructional model: Engage, Explore, Explain, Elaborate and Evaluate. After a brief introduction to GMOs, the lesson begins with a problem scenario that tasks students with investigating solutions to halt the spread of the mosquito-borne Zika Virus in their community. Over the course of four class periods, students will work together to understand the problem, research potential solutions and independently arrive at what they believe is the best way to combat the outbreak.

Students will begin to gain an understanding of the problem through a simulation that models the spread of disease. Next, they will participate in a jigsaw discussion after learning how and why scientists use mosquitos as model organisms to study disease progression and test treatments. They will then play a game to understand how mosquito tracking occurred in the past, and they will look at an example of a Geographic Information Systems (GIS) map used today to see how mosquitos are currently tracked. Once students understand the importance and scope of mosquitos in modern science, they will research various methods that scientists are using to combat the spread of vector-based diseases and they will consider the other ways GMOS are being used in today's society. Students will then reflect on all of the information they have collected as they develop a stance on GMOs and come to their own conclusion on the best way to combat their community's mosquito outbreak. A class debate will ultimately decide how this community will move forward.

Sources:

1. "Areas with Risk of Zika." Center for Disease Control. cdc.gov/zika/geo/index.html.
2. McNeill, John. "How the Lowly Mosquito Helped America Win Independence." Smithsonian Institution. smithsonianmag.com/science-nature/how-lowly-mosquito-helped-america-win-independence-180959411/.
3. McNeil, Donald Jr.; Saint Louis, Catherine; St. Fleur, Nicholas. "Short Answers to Hard Questions about the Zika Virus." The New York Times. nytimes.com/interactive/2016/health/what-is-zika-virus.html
4. "Zika Cases in the United States." Center for Disease Control. cdc.gov/zika/reporting/case-counts.html.
5. "Progress toward discovery of Zika virus vaccines and therapeutics." World Health Organization. who.int/emergencies/diseases/zika/discovery-of-vaccines/en/.
6. World Health Organization. Frequently Asked Questions on Genetically Modified Foods. http://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/.
7. World Health Organization. Executive Summary: Insect-Borne Disease. http://www.who.int/whr/1996/media_ centre/executive_summary1/en/index9.html.

PROCEDURE

DAY 1

ENGAGE (Slides 1-2)
Overview: Students will participate in an engaging activity and watch a corresponding video to identify the benefits and considerations of genetic modification.

Slide 1

1. Begin class by displaying "3 Truths and a Lie," which outlines three genetic modifications that scientists have made and one they have not.
2. Encourage students to think individually about which modification they believe is a lie and then discuss their thoughts with a partner.
3. Take a class poll to see which bullet the class believes is the lie.
   - Note: The lie is #2!
4. Move forward through the slides to discover which are true and which is the lie.

Slide 2

1. Lead students in a broader discussion around the "3 Truths and a Lie". Ask: Considering the three truths, do you agree or disagree with humans influencing the traits of organisms?
2. Tell students to first think about their response and then nonverbally demonstrate their opinion by choosing a position on an agree/disagree continuum. Designate one wall of your classroom for those who agree and the opposite wall for those who disagree. Students should silently demonstrate their position by taking a stance along the continuum. Students who are undecided or conflicted should stand in the middle. Before students return to their seats, encourage them to observe where their classmates stand.\
3. Click the "Watch Video" button to play a video about genetic engineering. Show the video from 0:45 - 3:45 and stop to check for student comprehension at the following points:
   - 1:35 – Ask: What is DNA?
   - 3:10 – Ask: What are some examples of genetic engineering?
4. Click once to display the next question: Considering your original stance and the new information introduced in the video, what are some of the potential benefits and considerations of being able to influence the traits of organisms? Did anything in the video make you change or reconsider your opinion?
5. Instruct students to share their thoughts in pairs or groups of three.

EXPLORE (Slides 3-6)

Overview: Students will be introduced to a Zika problem scenario in which they are tasked with taking a stand on the best way to combat a dangerous mosquito outbreak in their community. In order to better understand the problem, students will first participate in a disease transmission simulation. Once they understand how quickly diseases can spread, they will learn that the study of mosquitos helps scientists not only combat often-deadly mosquito diseases, but a range of other parasite/human infections as well. Students will then play a game to better grasp how the tracking of mosquitos has improved over the years as scientists have begun to study mosquitos with increasing urgency.

Slide 3

1. Introduce students to the problem scenario by explaining that the concept of influencing genetic traits is about to become very relevant to the students' lives.
2. Read the first half of the problem scenario aloud:

- The CDC has just announced a Zika outbreak in your area. In addition, they're reporting that the population of Aedes aegypti mosquitos has reached alarming levels.

3. Click the "WATCH VIDEO" button and view this video, which will give students background on the outbreak.
   - Note: If you believe your students would benefit from additional information about Zika, you may distribute copies of the World Health Organization fact sheet listed in the Materials Section.

4. Click again to project the second half of the problem scenario and read it aloud:
   - Scientists have been using a variety of approaches to modify mosquitos in order to halt its spread. After learnin more about the role mosquitos play in transmitting this extremely dangerous disease and the strategies scientists are trying to prevent it from spreading, you will take a position on one of the strategies and debate with your fellow classmates to arrive at a recommended approach to combat this local health crisis.

5. Distribute the Infectious Diseases student capture sheet to each student and explain that it will be used to taknotes throughout the upcoming activities. Students will need these notes as they decide how to combat the outbreak.

Slide 4

1. Explain that in order to better understand the problem and eventually arrive at a solution, students must first understand how infectious diseases spread. Therefore, before figuring out how to stop the spread of disease, students will examine the role mosquitos play in disease transmission.

2. Lead students through the following simulation:

   - Distribute a dropper and a test tube filled with distilled water to every student except for one. The one remaining student (unbeknownst to him/her) will receive a test tube filled with 0.1 molar NaOH.

   - Tell students that one of the test tubes is infected with an imaginary mosquito-transmitted disease.

   - Instruct students to use droppers (which represent biting mosquitos) to model disease transmission by exchanging some of the contents of their test tubes with one other participant.

   - After one round of exchanges, two different scenarios can occur depending on materials and time available:

   - Option A (slightly more time and resource intensive):

   1. Take on the role of a doctor and call students one at a time to your "doctor's office" – i.e. a space in your classroom that is slightly secluded from the rest of the class.

   2. Put a drop of phenolphthalein in each student's test tube.

   3. Any tube that turns pink is infected. If a tube is infected, quietly make a tally on a separate piece of paper and then exchange the student's test tube for another clear vial of NaOH. If the student's test tube is not infected, instead exchange it for another vial of distilled water. Students should not share their results with their classmates.

   4. Once all students have been tested, at least 3-4 more rounds of the transmission and private testing will occur. Before every round, remind students to find a new partner for each exchange. Keep a separate "infected" tally for each round. You may also reference the table provided below, which outlines the expected outcomes assuming students do find a new partner each round.

   5. The final round of testing can be performed openly.

O Option B (If less time and/or fewer resources are available)

   1. Students will keep their hand around their test tube for the entire exchange so that only they can see the color of their own liquid. In addition, students on the receiving end of the exchange should close their eyes, so they can not see the color inside their peer's dropper.

2. As the teacher, you will still take on the role of "doctor" and test for infection by adding phenopthalein to each test tube. However, this won't be done privately, and students will be responsible for looking into their own test tube to see if its contents have changed color.

3. After each round, instruct all students to close their eyes. Invite students who have been infected to raise their hands. Keep a private tally of infected cases. The table below outlines the expected outcomes as long as students find a new partner each round:

Rounds of Transmission	Newly Infected Individuals	Total Infected Individuals
0	1	1
1	1	2
2	2	4
3	4	8
4	8	16
5	16	32

4. Click again and ask: What do you notice about the transmission process? Lead students to a discussion of the following:

- What letter is the data's curve most like? Why do you think this occurred?
  - Explain to students that an "S-curve" occurs when there is a rapid spread at the beginning which eventually tapers off. This tapering happens when the spread of disease reaches a saturation point, which means that so many people have been infected that the infection cannot continue to grow at the same rate.

5. Before moving on, clarify that Zika is spread through the bites of infected female mosquitos. During the first week of being infected, Zika can also be passed from an infected person to another mosquito, which can then be passed to another person.

6. Remind students to take notes of their key takeaways on their Infectious Diseases student capture sheet before moving to the next slide.

Slide 5

1. To broaden the scope of this issue, explain that an understanding of mosquitos is important for preventing mosquito-borne diseases like Zika.

2. Ask: How are mosquitos used to study (or better understand) parasite and human interactions? In other words: How are scientists using mosquitos to examine diseases and/or their treatments?

3. Provide student pairs with one of the three Mosquito Model readings. Try to split up the three readings equally among the class.
Note: The first reading is provided twice. It is included once as an excerpt and once as an edited excerpt. The unedited excerpt is the most difficult text.

4. Each passage will help lead students toward understanding how scientists are using mosquito models to examine diseases and their treatments.

5. Before students begin reading, click once and instruct the class to read with the goal of finding the passage's main idea as well as two supporting details. Students will find a place to document the main idea and details on their Infectious Diseases student capture sheet.

6. Once students have finished reading and recording their notes, click again and explain that students will now participate in a jigsaw discussion.

- To facilitate this discussion, create discussion groups of approximately three students. Each group should have as many readings represented as possible. (Ideally each of the three students will have read a different text.)

- It will be each student's responsibility to share the main idea and supporting details of their article with their group.
- Groups should then work together to develop an answer to the guiding question and record their answer on their student capture sheet.

7. End the class with a brief full-class discussion around the students' answers.

DAY 2
Slide 6
Note: Before class begins, it would be helpful to download the ArcReader mapping application so it is ready to go.

1. As students enter the classroom, pass out the Mosquito Tracker Grid student capture sheet. Instruct students to read through the slide's instructions and begin to set up their grid.

2. Once students are settled, explain that they will be investigating the following scenario: Since it's increasingly clear that studying mosquitos has large implications for public health, how has the tracking of mosquitos improved over the years?

3. Explain that students will play "Mosquito Tracker" (similar to Battleship), which will give them an idea of what tracking mosquitos used to entail.

4. Click once to review the game's rules:
   - Once you have marked your mosquito locations on your home territory grid, find a partner.
   - With your partner, take turns figuring out where to spray insecticide in their neighborhood by guessing street coordinates. For instance: Should I spray the corner of 5th Street and 3rd Avenue?
   - If your partner has a site at that coordinate, they should explain what is at that location. If there is nothing at that coordinate, they should say "Miss."
   - The guesser should keep track of all hits and misses on their Investigation Grid.
   - Partners should continue taking turns for five minutes, with the goal of accomplishing the most "hits."

5. When students have played for about five minutes, ask students to discuss what it felt like to constantly refer to someone else for information. Explain that this was how mosquito tracking once worked. There was no central source of information, and scientists, citizens and pest control workers constantly had to refer to others for information.

6. Click again and tell students that now a new system called GIS (Geographic Information System) provides a system of real-time maps that show overlays of:
   - Reports of mosquito-related issues
   - Insecticide and larvicide sprayings
   - Field treatments and inspections
   - Locations of no-spray areas
   - Locations and treatments of drain and still water areas

GIS enables all data to be uploaded and tracked through mobile devices and relies on professionals, scientists and the public to input the information.

7. Take a moment to click over to the ArcReader Mapping Application that you downloaded before class to demonstrate how different layers of data can be manipulated and displayed simultaneously.
   - If time allows, encourage students to use their own devices to interact with this application.

8. Ask: What are the positive implications of this new technology compared to what you experienced during the mosquito tracker game?

EXPLAIN (Slides 7-10)

Overview: Students will work in pairs to research current methods that scientists are using to stop mosquitos from spreading diseases. They will continue this research to investigate how genetic modifications extend beyond mosquitos and into other parts of society, and they will use this research to create a class-wide pro/con list about genetically modified organisms. Students will then reconsider their own opinion about GMOs, and they will take another stance on the agree to disagree continuum line.

Slide 7

1. Explain that students will now consider: While GIS mapping is a monumental leap in the ability to track mosquitos, what strategies are scientists using to actually stop mosquitos from spreading disease?

2. Explain that scientists are testing and using a variety of approaches including genetically modifying mosquitos and other biological control techniques to stop the spread of mosquito diseases.
    - O You may wish to extend the learning and review specific steps of genetic engineering techniques.

3. Revisit the problem scenario and remind students that their ultimate goal is to choose a mosquito control method that they believe is best.

4. Divide the class into research pairs, and give each student a Research Notes student capture sheet. Review the instructions and explain that students will have at least 30 minutes to use the internet to research current mosquito control techniques and technologies. Encourage them to use search engines like news.google.com to search for current news articles.
    - O Note: It may be helpful to direct students to a couple articles to use as a starting point. For this purpose, two journalistic articles are hyperlinked in the Materials List.

5. If time allows, form groups of four students and allow pairs to share their results with each other before the endof class.

DAY 3
Slide 8

1. Begin class with a quick "popcorn share" of the research students found the day prior.
    - O To do this, a student will begin by sharing a concise one-sentence explanation of one mosquito control technique. Encourage each student to use the sentence starter on the slide. They will then call on another student (without hands being raised) to similarly share. The goal is to "pop" around to a large number of ideas in a short amount of time. If a student wants to pass because all of his/her ideas have been shared, they may say a pre-decided word and call on the next person.

2. During the share, keep a list on this slide of the different mosquito control methods that are mentioned.

3. After all students have responded, explain that many of the solutions shared had to do with genetically modified mosquitos.

Slide 9

1. Explain that since many of the mosquito disease control solutions involved genetic modification, it's important to understand the broader scope of GMOs.

2. Combine student pairs from the previous activity into research groups of four students and assign each group one of the GMO articles.
    - O Note: Feel free to substitute any of the selections with articles of your choice.

3. Groups should read the article together with the following guiding question in mind: What are the potential pros and cons of genetically modified organisms?

4. Review the instructions:
    - O Read the article with your group and annotate for the guiding question.

O Use your annotations to record the following information on your student capture sheet:
- The main idea of the article
- At least one potential benefit (pro) and one consideration (con)
- Be ready to share your findings!

5. When students are ready to present their findings, click a second time. Add benefits and considerations to the pro/con chart as students share.

Slide 10

1. Revisit the continuum that was originally introduced on Slide 2. Ask again: Do you agree or disagree with humans influencing the traits of organisms?

2. Designate the agree and disagree walls of the classroom and direct students to nonverbally demonstrate where they stand on this continuum by choosing a position along the line.

3. Ask students to share if or why they changed their opinion.

ELABORATE (Slides 11-14)

Overview: Students will use their research and their personal opinion to develop a stance on how they believe their community should deal with the Zika outbreak. The following day, after each student has the chance to share their idea with their research group, the group will work together to determine the best option. Each group will then share their stance in the form of a formal statement, followed by a period of questions and answers. A class-wide vote will narrow the options down to two, and students will have the chance to consider their thoughts about each of the options.

Slide 11

1. Debate Prep Time: Explain that students will now use their research and their personal stance on genetically modified organisms to outline how they believe their community should combat infected mosquitos.

2. Distribute the Debate Prep student capture sheet and review Step 1. Remind the class that they should not continue on to Step 2!

3. Allow about 10 minutes for students to independently complete Step 1.

4. During this time, it may be helpful to flip back to Slide 8 to remind students of the different control methods they discussed.

DAY 4
Slide 12

1. Instruct students to rejoin their research groups from Day 3, and explain that they will now be completing Steps 2-4 on their Debate Prep student capture sheet.

2. Review the instructions included on the handout, and answer questions as needed before allowing student-groups to begin working.

Slide 13

1. It's debate time! Reiterate that the goal of this debate is to ultimately select the best way to combat the transmission of Zika in your community.

2. Explain that each group will be given up to two minutes to present, followed by three minutes of questioning from the class. During the questioning period the class may clarify misunderstandings, ask for more details, etc.

3. Instruct students to take notes on Step 5 of their Debate Prep student capture sheet so they are able to remember each of the presentations once the debate is complete.

4. Use the timer as students present and answer questions to keep the class on track.

Slide 14

1. Explain that you will now hold a class vote to narrow the presentation ideas down to two. To do this, have the class help you create a list on the board of the ideas that each group presented. Then instruct all students to close their eyes as you call out each idea and hold a private vote.

2. Share the two ideas that received the most votes.

3. Instruct students to find a partner and discuss their thoughts on these final options.

4. Then click and give students the chance to further consider their opinion through a "Four Corners" activity, in which:

O One of the remaining mosquito control options is announced, and each corner of the classroom will be designated as one of the following: strongly agree, strongly disagree, agree, disagree.

O Students will pick a corner based on their stance. They will then be prompted to cross the room and pair with someone who selected a different corner so they can discuss their opinion with at least one classmate who holds a different viewpoint.

O After a two-minute discussion, students will be given the option to change their mind, which they will demonstrate by going to another corner.

O The second option will then be shared and the same format will be followed.

EVALUATE (Slide 15)

Overview: After considering the wide range of research and work that the class has completed over the past four days, each student will cast a vote on the best way to combat Zika in their community. On their ballot, students will independently justify their opinion, which the teacher can use to assess the student's overall understanding.

Slide 15

1. Fill in Options 1 and 2 with the two final mosquito control techniques, and explain that it is now time to make a final decision.

2. Pass out a ballot to each student. Review the directions and explain that students will vote for one of the two options and explain their opinion in writing using what they have learned to justify their decision. Encourage students to individually review their student capture sheet and all notes they have completed over the course of this exploration to help them arrive at a final decision.

3. When time is up, collect the ballots and quickly count them. Then click once and announce the winning idea. Keep the ballots so you can review the students' writing at a later time to assess their understanding.

EXTENSION (Slide 16)

8. If you have additional time and/or would like to further challenge your students, consider the following extension options:

O Students can become Disease Detectives! In this activity, they will rack up points as they try to solve an outbreak presented on the Centers for Disease Control and Prevention (CDC) website. After mastering the level 1 model outbreaks, they can progress onto the more challenging level 2 outbreaks.

O Students can conduct a Virtual Lab on Bacterial Transformation. Laboratory investigations are also available through science supply companies.

NEXT GENERATION SCIENCE STANDARDS (NGSS):

Science and Engineering Practice

Asking Questions and Defining Problems

Ask questions that arise from examining models or a theory to clarify relationships.

Disciplinary Core Idea

Structure and Function

LS1.A: All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

Inheritance and Variation of Traits

LS3.A: Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.

Crosscutting Concept

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

NEXT GENERATION SCIENCE STANDARDS (NGSS):

CCSS.ELA-LITERACY.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-LITERACY.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.CCRA.SL.3
Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

CCSS.ELA-LITERACY.CCRA.SL.4
Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

ITEAA STANDARDS FOR TECHNOLOGICAL LITERACY

Technology and Society, Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

J. Ethical considerations are important in the development, selection, and use of technologies.

INFECTIOUS DISEASES STUDENT CAPTURE SHEET

Directions: Reread the problem description below. Then use the space provided to take notes as you investigate this problem more thoroughly.

> **Problem:** The CDC has just announced a Zika outbreak in your area. In addition, they're reporting that the population of Aedes aegypti mosquitos has reached alarming levels. Scientists have been using a variety of approaches to modify mosquitos in order to halt its spread. After learning more about the role mosquitos have in transmitting this extremely dangerous disease and the strategies scientists are trying to prevent it from spreading, you will take a position on one of the strategies and debate with your fellow classmates to arrive at a recommended approach to combat this local health crisis.

How are infectious diseases spread? (You may want to include a sketch of the infection versus transmission graph!)	**How are scientists using mosquitos to examine diseases and/or their treatments?** **Article's Main Idea:** **Supporting Detail #1:** **Supporting Detail #2:** **Answer to the guiding question:**
How was the tracking of mosquitos improved over the years?	**What are the potential pros and cons of genetically modified organisms?** **Article's Main Idea:** **Pros:** **Cons:**
Additional Notes:	

Mosquito Model Reading 1:
Excerpt from Insect Immunology by Nancy E. Beckage

Our knowledge of the mosquito's innate immune system has advanced in the last 10 years, enhanced by the completion of the A. gambiae genome [the DNA sequence of the Anopheles malaria-carrying mosquito] and the subsequent development of techniques to assess gene expression and target specific genes for manipulation. The Anopheles mosquito has become an important model organism for the understanding of how invertebrate immunity functions but, more importantly, its immune system directly interferes with a disease affecting millions of people worldwide [malaria] making it relevant to public health. The intention is to use the molecules, cells and pathways of the immune system as targets for vector-based disease control strategies….Studying natural mosquito and parasite populations, understanding immune reactions resulting from a variety of vector-parasite species combinations and clarifying the inconsistences between different species and strains will allow the determination of how universal any immunity-based intervention could be.

Mosquito Model Reading 1:
Edited excerpt from Insect Immunology by Nancy E. Beckage

Our knowledge of the mosquito's immune system has advanced in the last 10 years. This has been helped by understanding the DNA sequence of the Anopheles gambiae (the malaria-carrying mosquito) as well as developments in genetic modifications. The Anopheles breed of mosquitos has become important as scientists try understand how the immune systems of invertebrates (such as mosquitos) work. This mosquito's immune system is able to interfere with malaria, which is a disease that affects millions of people around the world. This makes it relevant to public health. Scientists plan to use the mosquito's molecules, cells and immune system as they try to come up with ways to control the spread of disease. Studying mosquitos, understanding how immune systems react when exposed to living organisms that transmit infectious diseases and understanding the differences between different strains of diseases and different species may help scientists

Mosquito Model Reading 2:
Excerpts from "Invertebrate Immune Systems Are Anything But Simple" by the European Science Foundation. Science Daily: sciencedaily.com/releases/2007/06/070621102626.htm

A hundred years since Russian microbiologist Elie Metschnikow first discovered the invertebrate immune system, scientists are only just beginning to understand its complexity. Presenting their findings at a recent European Science Foundation (ESF) conference, scientists showed that invertebrates have evolved elaborate ways to fight disease. By studying the immune systems of fruit flies, mosquitos and other invertebrates (including bed bugs, moths, crustaceans, worms, sponges and bees), scientists are finding new molecules involved in defenses against pathogens (microbes that cause disease).

In another exciting area of research, scientists showed the sophisticated ways that invertebrates manage their immune systems. Regulating the immune response… is important because immune systems, if left unchecked, can harm an individual by mistakenly attacking cells in the body. In humans, the failure of the body to recognize itself results in autoimmune diseases. Understanding these autoimmune processes in invertebrates might help us to better engineer drugs to tackle these debilitating diseases in humans.

Schmid-Hempel thinks that the molecular mechanisms found in invertebrate immune systems may rival those seen in the vertebrate world. He says: "Insects use different cells and molecules, but follow very similar principles for detecting pathogens as vertebrates." And scientists are only beginning to understand the elaborate ways that invertebrates respond to pathogens. As they discover new molecules, the invertebrate immune system could turn out to be much more like that of vertebrates — making it an even better model for the study of our own immune system.

Mosquito Model Reading 3:
Excerpts from: "Cool Jobs: Sucking up Science with Mosquitos" by Bethany Brookshire. Science News for Students: sciencenewsforstudents.org/article/cool-jobs-sucking-science-mosquitos

Brian Foy sucks up the mosquitos. He works at Colorado State University in Fort Collins. There, this biologist studies animals that transmit diseases. The dining habits of mosquitos, Foy has shown, mean they don't just spread disease— they can also be used to track some sickness to its source. While studying ways to prevent the spread of malaria, Foy and his team realized that mosquitos might have a use in studying people. The insects could serve as living blood samples.

Mosquitos can't filter the blood they suck up. They take in any bacteria and viruses present in that blood. And Foy realized that those blood meals might tell him about the diseases carried by the mosquitos' victims. To prove that mosquitos could serve as tiny blood samples, Foy traveled to Liberia in western Africa. There, he and his team got up at 3 a.m. to head to homes that the owners had volunteered for his study. The researchers arrived wielding Ghostbusterstyle backpacks.

"They're gentle vacuum cleaners with a big tube and a cage on the end that holds the mosquitos," Foy explains. "We run around and suck them off the walls."

Foy was able to show that a blood-filled mosquito indeed could be used to track disease. Blood from a home's mosquitos could be as useful in detecting some illnesses as a finger-prick blood test of the home's inhabitants.

Learning more about the basic biology of these aerial vampires could have big implications for human health. It might seem easier to get a blood sample from someone directly, but Foy argues that in parts of the world where doctors are scarce, mosquitos can be the easier catch.

MOSQUITO TRACKER GRID STUDENT CAPTURE SHEETS

Home Territory: Before you begin playing, mark the following on the grid below:
3 mosquito sightings (1 square each), 2 areas of standing water (1 square each), 1 storm drain (1 square) and 2 areas where insecticide cannot be sprayed (3 squares each).

15th St.														
14th St.														
13th St.														
12th St.														
11th St.														
10th St.														
9th St.														
8th St.														
7th St.														
6th St.														
5th St.														
4h St.														
3rd St.														
2nd St.														
1st St.														
	1st Ave.	2nd Ave.	3rd Ave.	4th Ave.	5th Ave.	6th Ave.	7th Ave.	8th Ave.	9th Ave.	10th Ave.	11th Ave.	12th Ave.	13th Ave.	14th Ave.	15th Ave.

Investigation Grid: Use the grid below to document what you learn about the mosquito situation in your partner's neighborhood.

15th St.															
14th St.															
13th St.															
12th St.															
11th St.															
10th St.															
9th St.															
8th St.															
7th St.															
6th St.															
5th St.															
4h St.															
3rd St.															
2nd St.															
1st St.															
	1st Ave.	2nd Ave.	3rd Ave.	4th Ave.	5th Ave.	6th Ave.	7th Ave.	8th Ave.	9th Ave.	10th Ave.	11th Ave.	12th Ave.	13th Ave.	14th Ave.	15th Ave.

RESEARCH NOTES STUDENT CAPTURE SHEET

Directions: Use the space below to record your notes from your internet research. As you perform your research, do your best to find reputable news sources, and focus on quality over quantity! Your notes do not have to be in complete sentences.

1. Website URL 2. Source name	1. Name of mosquito control technique 2. How does it work?	What are the benefits of this approach?	What are any negative implications of this approach?

DEBATE PREP STUDENT CAPTURE SHEET

Step 1: Review your Research Notes and Infectious Diseases student capture sheet, and consider your own stance on genetically modified organisms. Taking all these factors into account, how do you believe your community should combat infected mosquitos?

The mosquito strategy that I believe is best is: _____

I believe this for the following reasons:

Reason #1: _____

Reason #2: _____

Reason #3: _____

Step 2: Rejoin your group and share your personal stances from Step 1. As ideas are shared, ask each other questions in order to better understand each person's viewpoint. Questions could include: Can you elaborate on __? What research or data supports reason #__? Have you ever considered __? Then work together to select the one strategy that your group believes is best and record it below.

Our group believes the best mosquito control strategy is: _____

Be sure to share your idea with your teacher before moving on to the next step.

Step 3: On a separate piece of paper, work with your group to prepare a one to two minute argument that presents your mosquito strategy and explains why it is the best choice for your community. Be sure to include:

1. An opening statement that captures the class' attention.
2. An overview of your mosquito strategy: What is it called? How does it work?
3. A compelling argument about why this strategy is best for your community. Include specific details!
4. A counter-argument that acknowledges at least one of the other mosquito methods and explains why your method is better.
5. A closing statement that restates your idea and ends in a strong manner.

Step 4: Decide who will be presenting your argument. You may split it up into sections or designate one speaker for your group. If time allows, run through your argument a couple times so the presenter can practice speaking loudly and clearly. Remember that your entire argument should be no more than two minutes!

Step 5: Use the reverse side of this handout to take notes on your classmates' presentations. You will eventually need to decide which technique makes the most sense, and you will use these notes to justify your decision!

BALLOT HANDOUT

FINAL VOTE: COMMUNITY MOSQUITO CONTROL

I, _____ , believe that the best mosquito control method for our community is

_____

Vote Justification:

In the space below, justify your vote! Explain what led you to make your decision and support your opinion with evidence. You may use your notes and include any information that you collected over the past four class periods to explain your position.