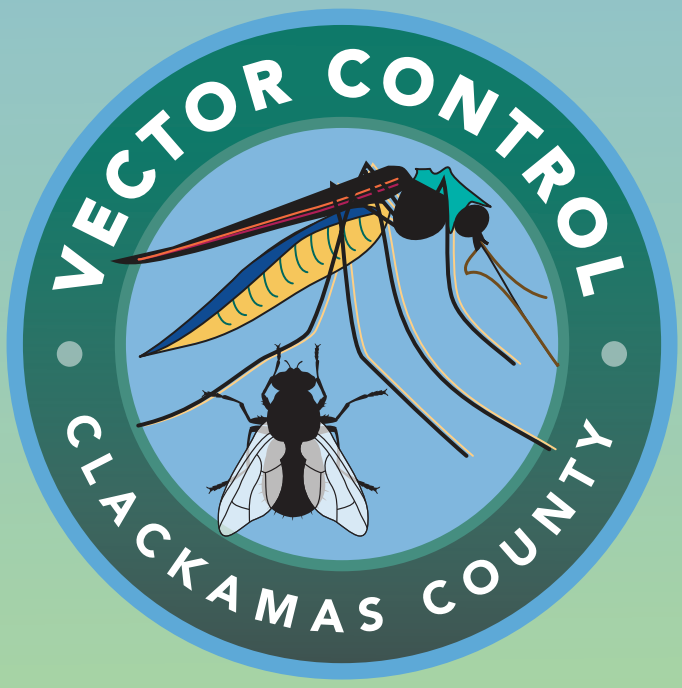
FIGHT THE BITES! Investigating Mosquitoes + Other Disease Vectors

Engaging Hands-On Science Lessons with Free Supporting Resources Adaptable for Grades K-12



Teacher's Guide

Appreciation + Thanks

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Written, designed, and produced by
Rick Reynolds, M.Ed.
Founder, Engaging Every Student
engagingeverystudent.com

In Collaboration with
Clackamas County Vector Control District
1102 Abernethy Rd., Oregon City, OR 97045
Phone: 503.655.8394
fightthebites.com

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Introduction

Fight the Bites! Investigating Mosquitoes + Other Disease Vectors is designed to engage students in enjoyable hands-on science inquiry about disease vectors and how to stay safe from them. Each lesson in the curriculum is aligned to the Next Generation Science Standards (NGSS) and Common Core State Standards, and care was taken to integrate art and other content areas, as well, in a wholistic approach. They can be adapted to meet the needs of learners in grades K–12 through the support of hands-on Life Cycle Kits including live mosquito larvae available free from Clackamas County Vector Control District (CCVCD). Numerous adaptations/ extensions are also included in each lesson which can help you tailor the lessons for your students.

Clackamas County Vector Control District's Education Program

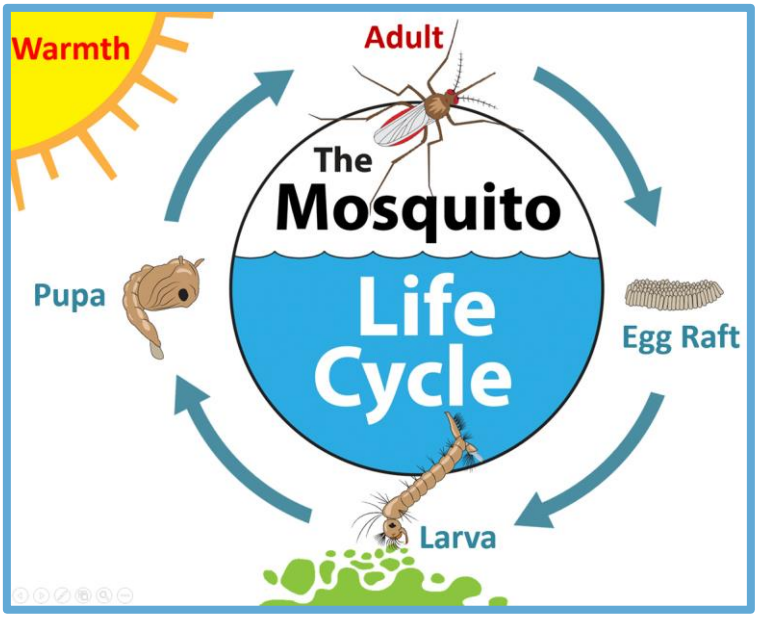
CCVCD supports a comprehensive vector education program for grades K-12. It is a collaborative effort between District staff, outside professionals, state and local agencies, and school educators. Serious vector-borne diseases such as West Nile virus have been spreading into Oregon, and our students and families need to understand why this is happening and how to protect themselves.

Education is an integral part of the Integrated Vector Management Program utilized by CCVCD. We believe that local mosquito control starts with the citizens of Clackamas County in their yards and neighborhoods. Armed with knowledge of mosquito and other vector biology, informed citizens know what actions they can take to suppress the populations of disease vectors.

Free Classroom Resources

CCVCD staff are pleased to be able to support educators and students with hands-on resources including mosquito larvae in safe emergence cages, macro lens magnifiers, pipettes, and more, as well as visits by biologists and other experts. Interactive multimedia presentations can be shared with students, in addition to the activities, or educators can download the presentations and other resources from our website at fightthebites.com/education. We seek to inspire students to think critically about mosquitoes and other potential disease vectors, including their fascinating life cycles and adaptations, and we appreciate you joining us in this important collaborative effort!

Each class keeps a Life Cycle Kit for about two weeks. It contains learning tools that allow students to actively study the biology, ecology, and control of mosquitoes. Students are able to safely observe the metamorphosis of mosquito larvae into pupae and then flying adults. Mosquito fish *(Gambusia affins)* may also be included so students can study the effects of a biological control.



Educators are provided with supplemental resources, including this teacher's guide with suggested lesson procedures, experiments, simulations, and other guided activities that reinforce key concepts. Students are also provided with information to take home, including CCVCD contact information and our services that are provided free of charge.

Objectives of CCVCD's Education Program include:

- Students demonstrate understanding of the mosquito life cycles and that mosquitoes require water to develop.
- Students can explain that some mosquitoes can transmit certain diseases to people and other animals.
- Students can explain verbally and in writing how they can help in the fight against mosquitoes by dumping standing water and educating others about mosquitoes.
- Students demonstrate skills such as careful observation, scientific illustration, data recording, data analysis, graphing, and written/oral expression.

Our education program also aims to increase student STEM and language skills, including:

- Making and recording observations
- Classifying information
- Measuring and counting
- Stating and testing hypotheses
- Describing observations
- Explaining reasoning verbally and in writing
- Identifying and expressing responses to science-related questions
- Using technology as a productivity tool and to enhance learning
- Working in teams to solve problems and
- Critical listening and reading.

Students are encouraged to ask questions, brainstorm solutions, gather information, analyze and interpret data, and communicate their discoveries. They often work in pairs or small groups. These are learning styles that enhance understanding, cognitive skills, and social skills (Moreno 1999).

Developing these skills in our students is essential for an adult citizenry literate in science and for attracting students to professional work in the sciences.

Lesson Plan Format

Each lesson has the following sections:

- Overview
- Lesson Goals
- Objectives
- Alignment to Standards
- Materials + Preparation
- Suggested Procedure
- Adaptations / Extensions
- More Resources / References

The lessons also include a text box that lists subjects covered, the suggested grades to which the lessons can be adapted, the average duration of the lesson, and vocabulary words which are explained in the lesson and in the glossary at the end of the guide.

Materials meant for teachers all begin with bold-face headers in **white**. Handouts and other materials meant for students all begin with a large, bold-face header in **blue text**. An exception is the glossary, which is a resource for both teachers and students.

Subjects: Science, Math, Reading, Writing, Speaking & Listening, Art, Health, Social Studies

Grades: Adaptable for K–12

Duration: 30–50 minutes

Vocabulary

- Hypothesis
- Larva / larvae
- Life cycle
- Metamorphosis
- Pupa / pupae
- Scientific method
- Vectors
- Vector-borne disease

Alignment to Standards

Fight the Bites! need not compete with core curriculum for classroom time. Instead, it can help teachers cover core concepts and improve student skills by using hands-on materials and field study in local areas. To help teachers identify the ways in which the lessons can be used to meet their curriculum requirements, each lesson is correlated to standards. A chart like the one below is included in each lesson plan which lists the standards met.

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Structure and Function • Stability and Change
	Science & Engineering Practices	Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms
Common Core State Standards	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10
	Math Geometry (Grade 5)	1, 2

Please Note:

- Numbers and letters listed for the standards correspond to those in the respective sections of the standards. Links to the standards are provided in the References section at the end of this introduction.
- Lessons are designed to meet multiple standards, but due to space considerations, those listed may not be completely comprehensive. Educators are encouraged to reinterpret standards and lessons and adapt lessons to meet their educational objectives and particular standards.

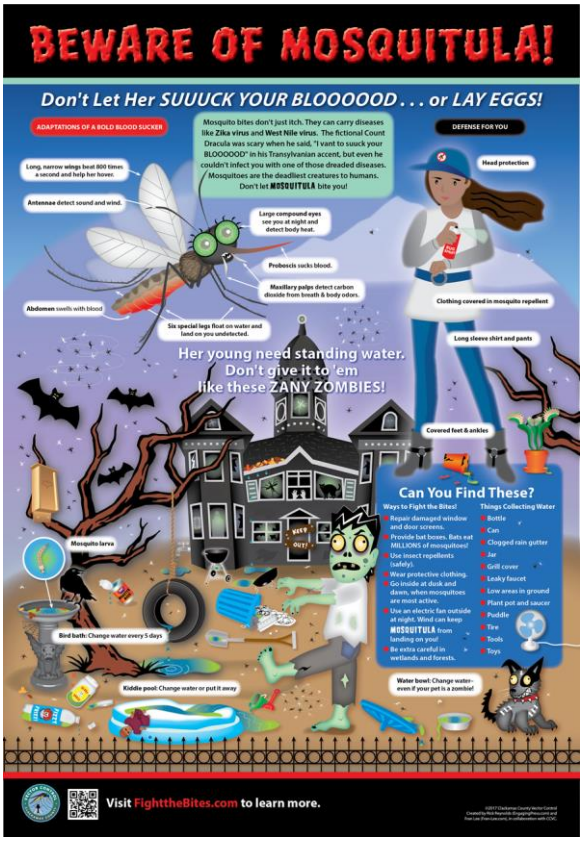
Free Posters, Training, and More!

The "Beware of Mosquitula!" poster describes fascinating mosquito adaptations and how to stay safe from the real-life blood suckers. Contact CCVCD if you would like one or more copies of the poster.

Please also let us know if you would like details about free hands-on and/or online training opportunities or if there is anything else we can do to support you.

You can contact us at 503.655.8394 or via the contact form at fightthebites.com/contact-us.

Thank you for partnering with us to help keep our students and communities safe while we enhance science literacy and other important skills for life.



References

Moreno, N. P. 1999. K-12 science education reform—a primer for scientists. BioScience. 49(7): 569-576.

National Council for the Social Studies (NCSS). 2013. College, career and civic life for social studies state standards: the college, career, and civic life (C3) framework for social studies state standards: Guidance for enhancing the rigor of K-12 civics, economics, geography, and history. Silver Spring, MD. http://www.socialstudies.org/system/files/c3/C3-Framework-for-Social-Studies.pdf

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). Common core state standards for English language arts and literacy in history/social studies, science, and technical subjects. Common Core State Standards Initiative. http://www.corestandards.org

NGSS Lead States. 2013. Next generation science standards: For states, by states. Washington, DC: The National Academies Press. http://www.nextgenscience.org

Lesson 1: Investigating the Mosquito Life Cycle

Overview

Students investigate the mosquito life cycle and learn that mosquitoes require water to develop. Larvae are observed under magnification and a simple interactive multimedia presentation helps provide an overview of the important concepts and terms. Free Life Cycle Kits from Clackamas County Vector Control enable students to safely observe the mosquito metamorphosis over the course of 2 weeks, including the four stages in the life cycle: egg, larva, pupa, and adult. Changes can be documented and analyzed with the support of a handout at the end of the lesson. Numerous adaptations / extensions are listed at the end of the lesson to help meet the needs of all learners.

Subjects: Science, Math, Reading, Writing, Speaking & Listening, Art, Health, Social Studies

Grades: Adaptable for K–12

Duration: 40–60 minutes for main lesson; observing, graphing and analyzing mosquito metamorphosis over 2 weeks

Vocabulary

- Hypothesis
- Larva / larvae
- Life cycle
- Metamorphosis
- Pupa / pupae
- Scientific method
- Vectors
- Vector-borne disease

Lesson Goals

- Increase students' understanding of what mosquitoes need to reproduce and how their adaptations help them to survive and transform
- Provide students with experience in scientific observation, illustration, experimentation, data analysis, and graphing

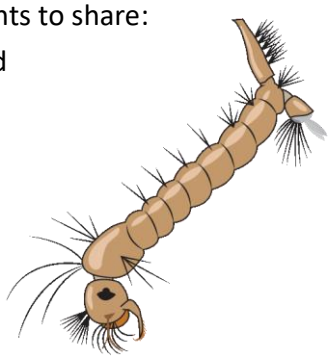
Objectives

- Students will observe and illustrate mosquitoes at all four stages of their life cycle.
- Students will conduct an experiment using live specimens, record data, and graph changes over time.
- Students will reflect on the results of their experiment in writing and in class discussion.

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Structure and Function • Stability and Change
	Science & Engineering Practices	Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms
Common Core State Standards	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10
	Math Geometry (Grade 5)	1, 2

Materials + Preparation

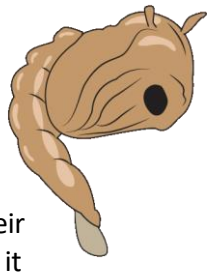
- Prepare to show the *Mosquito Life Cycle* PowerPoint presentation available at fightthebites.com/education. Two versions of the presentation—with and without a game—are explained below, so decide if you will play the game with the class before starting the other activities. You could also do the game with the class after completing the class experiment as a review and/or a quiz.
- Be ready to explain the terms/concepts in the presentation and the rest of the lesson, including:
    - **hypothesis**: a guess made based on what is known
    - **larva**: young wingless form of an insect (such as a mosquito)
    - **larvae**: more than one larva
    - **life cycle**: stages in the life of an organism (egg, larva, pupa, and adult for many insects, such as mosquitoes)
    - **metamorphosis**: a major change some animals make between life stages to become adults
    - **pupa**: the stage of an insect's life when it is changing from a larva into an adult
    - **pupae**: plural of pupa; pupae do not eat or move while they are transforming
    - **vectors**: animals which can spread disease, such as mosquitoes, flies, and ticks
    - **vector-borne disease**: sickness spread by a vector, such as West Nile virus and Zika virus
    - **Clackamas County Vector Control District**: government agency that controls vectors in our county and educates the public about how to stay safe from them
- Copies of "Life Cycle of a Mosquito" handout for each student (at end of lesson)
- These resources available in free Life Cycle Kits from Clackamas County Vector Control (503.655.8394 or fightthebites.com/contact-us) for groups of about 4 students to share:
    - Live mosquito larvae in safe emergence cages; powdered larvae food
    - Dried mosquito specimens and enlarged photographs of mosquitoes at all 4 life stages
    - Rulers for students to share when making line graphs
    - Magnifying device(s): Be ready to magnify live mosquito larvae and/or larvae of another insect.
        - Hand lenses (ideally for each student)
        - The most cost-effective, high-quality alternative to a microscope we have found is a macro lens attachment for a tablet or smart phone with 20x or better magnification. One great option is the AMIR Phone Camera Lens: amazon.com/AMIR-Upgraded-Compatible-Attached-Smartphone/dp/B06XWZJ56Z
    - Mosquito anatomy chart
    - Pipettes (ideally with wider openings to remove larvae from emergence cages without hurting them)
    - Petri dishes



- Colored pencils and/or markers for students to share
- *Optional:* Document camera for students to more easily present illustrations and graphs to the rest of the class

Suggested Procedure

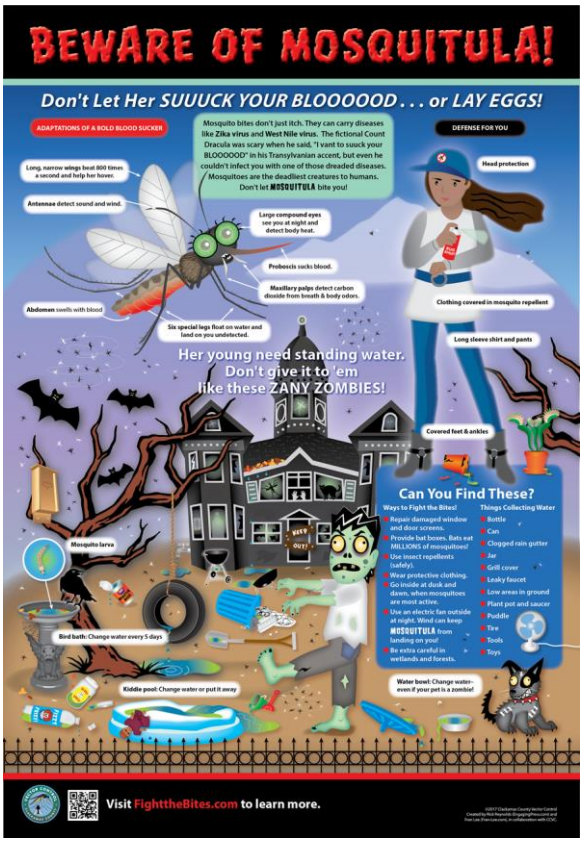
1. Use a magnifying device connected to a computer and/or data projector to show the class live mosquito larvae in water. (Another type of larvae, such as *daphnia magna*, can be used if mosquito larvae are not available: carolina.com/daphnia/daphnia-magna-living).
2. Ask students to turn to a neighbor and brainstorm ideas about what they are looking at and how they might have gotten in the water. After about a minute, ask the groups to share their ideas with the class. If necessary, clarify that the students are looking at young mosquitoes (or another organism) that started out as tiny eggs.
3. Show students the brief "Mosquito Life Cycle" PowerPoint presentation to help explain the life cycle to students and how mosquitoes get what they need to develop. Both versions of the presentation can be used with any class, grade 1 and up, but we suggest using Version 1 (which includes the game explained below), in grades 3 and up, and Version 2 (without the game), for most younger groups. The game is a fun way to reinforce the important concepts and terms, but it may make the introductory mini lesson longer than necessary for some classes.



4. In the course of the presentation, explain that if the mosquitoes meet their needs of water, food, and warmth, there will be a **metamorphosis** as they transform from **larvae** into **pupae** and pupae into adults.
5. *Optional:* For the Scrabble game section in Version 1, ask students to work with a partner to decide on answers to the questions before you reveal them. Pairs can raise their hands when they agree on the answer, and when the majority of students seem to know it you can call on a student to say the answer—or ask all of the groups to say it all together!

6. At the "Your Classroom Experiment" slide, explain that students will be doing an experiment to count how many larvae, pupae, and adults are in the tank each day. They will take care of the mosquitoes so their habitat will help them grow and develop. But they will NOT have to let the adult females suck their blood!
7. Advance to the "Mosquito Growth Graph" slide and explain that students will record the data for how many larvae, pupae, and adults there are in the container each day. They will create line graphs with the data to show how the numbers changed over time.
8. Pass out copies of the 3-page "Life Cycle of a Mosquito" handout (found at the end of the lesson) and explain that students will carefully observe and illustrate mosquitoes at all four stages of their life cycle throughout the experiment. Point out the spaces on the handout where they will add their illustrations, and that they can observe the live larva again using a microscope and/or hand lens, as well as dried specimens and/or enlarged photographs when making their observations/illustrations.
9. Direct students to turn to the second page of their handout and explain what a hypothesis is, if necessary. Point out the table in which they can record the data which will test their hypothesis, and finally direct their attention to the last page of the handout where they will graph the data using 3 different colored pencils or markers. Give students the option of using a spreadsheet such as Microsoft Excel or Google Sheets to record and graph the data.
10. Students will conduct the experiment over the course of about 2 weeks. Explain that they will be responsible for completing the illustrations, questions, and graphs in the handout over that time, and they can ask questions as they arise.
11. At the end of the experiment, discuss the results and student ideas. A document camera (if available) can be use to more easily share student illustrations and graphs.

- Were their hypotheses correct?
- How can they describe the data changes over time?
- Was there anything surprising about the mosquito metamorphosis, such as how quickly it occurred?
- What can they do around their own home and school to reduce the number of mosquitoes that develop into dangerous, blood-sucking adults?



12. *Optional:* Share the "Beware of Mosquitula!" poster with students—and the important concepts presented. Free posters are available from the Clackamas County Vector Control District and online at fightthebites.com/education. Leave the poster up in the classroom and/or elsewhere in the school as a daily reminder of how students can help keep themselves and their community safe from vector-borne illness.
13. Collect the handouts for assessment. Clackamas County Vector Control can pick up the adult mosquitoes to return them to the colony used for education, or you can put the container in the freezer overnight to kill them humanely. The mosquitoes are native to Oregon, but they will bite and are therefore not to be released into the environment. Dead mosquitoes can be disposed of in the trash or compost.

Adaptations / Extensions

- **Start the experiment in lesson 2, "Staying OUT of Mosquito Food Webs," on the next class day.** It is a parallel experiment in a different tank with mosquito larvae and mosquito fish *(Gambusia affinis)* available free from Clackamas County Vector Control. Students can compare the data on the numbers of mosquito larvae, pupae, and adults in the two tanks over time.
- **At the start of the lesson, ask students to think about what they think is the most dangerous animal in the world to humans and why.** After a moment they can turn to a neighbor and brainstorm all of the possibilities, recording their ideas on paper in words and pictures. It might be surprising to students that tiny mosquitoes are the deadliest animals to humans, so that can provide an excellent springboard for the lesson and unit.
- **Discuss the scientific method** with your students before doing the experiment. It is the way scientists—like them—can better understand the world. It uses these steps:
    1. Start with a **question** to investigate, such as "How long does it take a mosquito pupa to change into an adult at room temperature?" Questions may arise from an **observation**, such as, "Mosquitoes change throughout their life cycle."

2. Formulate a **hypothesis**—an educated guess—based on the available information.
3. **Test** the hypothesis: Conduct an **experiment** and/or make more observations.
4. Collect **evidence** from the experiment: make **observations** and record **data**.
5. **Evaluate** the hypothesis based on the evidence. Was it correct? Why or why not? Conduct the experiment again to verify the data and/or refine the hypothesis and experiment based on the evidence from the first experiment. Repeat the process until the results of the experiment can be reliably predicted.

- **Students can engineer insect enclosures** to gain engineering/design experience and help them better study an insect. For example, small habitats can be created using plastic bottles, but be very careful if you decide to try this with dangerous insects, such as mosquitoes: wevideo.com/view/464164823.

- **Show and discuss PBS' short video "Deep Look: How Mosquitoes Use Six Needles to Suck Your Blood"**: pbs.org/video/deep-look-mosquitoes. It is a fascinating examination of the complex structures that mosquitoes use to bite—and why that is such a serious threat to human health

- **Lead a student service-learning project** to identify possible sources of mosquito breeding on school grounds and/or in neighborhoods. Students can work to limit areas of standing water and educate their neighborhood and fellow students about staying safe from mosquitoes by reducing standing water, sharing ways to avoid being bitten, etc.

- **Ask students to compare the life cycle of a mosquito with that of another organism.** For example, a Venn diagram could be used to compare its life cycle with that of another potential disease vector, such as a fly, tick, or flea. A general comparison could also be made between a mosquito and another organism, such as a mosquito fish or a human.

- **Play the "Mosquito Memory" game** at fightthebites.com/education as an enjoyable way to review concepts. It works like the old memory card game, but with a mosquito life cycle theme. One way to play is to divide the class into two teams and award points when each group gets a match. A group can keep guessing as long they get matches. Good opportunities to review concepts are provided as the various pictures are flipped over.

- **Introduce the use of juvenile hormones as one method of insect (and mosquito) control.** Teachers can add a small pellet of Altosid (trade name for a juvenile hormone product used by Clackamas County Vector Control) to a second larval container and students can follow and compare the two treatments (no Altosid vs Altosid). They should observe that no adults emerge from the pupal stage (the product stops the metamorphosis from completing). The same concept could be introduced for the bacterial products used by Clackamas County Vector Control: the teacher can introduce a few grains of bacterial product into a third larval habitat. Students should observe larval death within 24 hours.

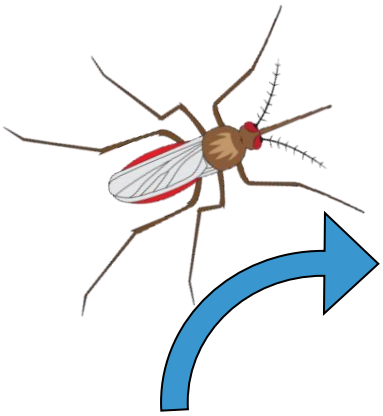
More Resources / References

- Visit Clackamas County Vector Control District's website for more resources and background about our education program: fightthebites.com/education
- "Hypothesis Lesson for Kids: Definition & Examples" with video. Study.com: study.com/academy/lesson/hypothesis-lesson-for-kids-definition-examples.html
- "Mosquito Biology." Maryland Dept. of Agriculture: mda.maryland.gov/plants-pests/Pages/mosquito_biology.aspx
- "The Scientific Method." Explained by Khan Academy with visuals: khanacademy.org/science/biology/intro-to-biology/science-of-biology/a/the-science-of-biology
- The PowerPoint presentation was adapted with permission from Eric Engh, Education Program / Insect Identification Specialist with Marin/Sonoma Mosquito & Vector Control District. More resources are available from their Mosquito School website: msmosquito.com/mosquito%20school
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned: nextgenscience.org/framework-k%E2%80%9312-science-education
- More information about the Common Core State Standards and links to the complete documents: corestandards.org

Name: _____ Period: _____ Date: _____

Life Cycle of a Mosquito

Draw one or more mosquitoes at each life stage.
Observe them carefully to create scientific illustrations.



Adult

Egg Raft

Larva

Pupa

Think About It!

1. What is one thing mosquito larvae, pupae, and eggs all need to live? _____
2. What else did you observe about the mosquitoes?

   _____

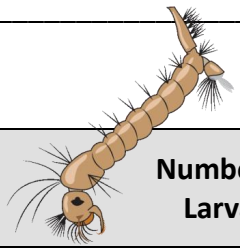
   _____
3. Could mosquito larvae and pupae be living near your home or school? If so, where?

   _____

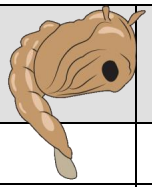
Experiment! Count the number of larvae, pupae, and adults each day. Record the data below.

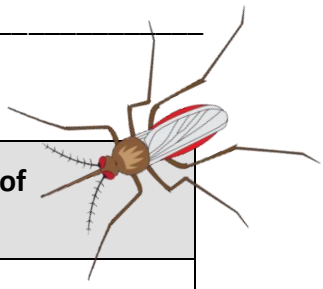
Hypothesis: What changes do you predict? _____

_____



Mosquito Data Table





Day	Number of Larvae	Number of Pupae	Number of Adults
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Graph it!

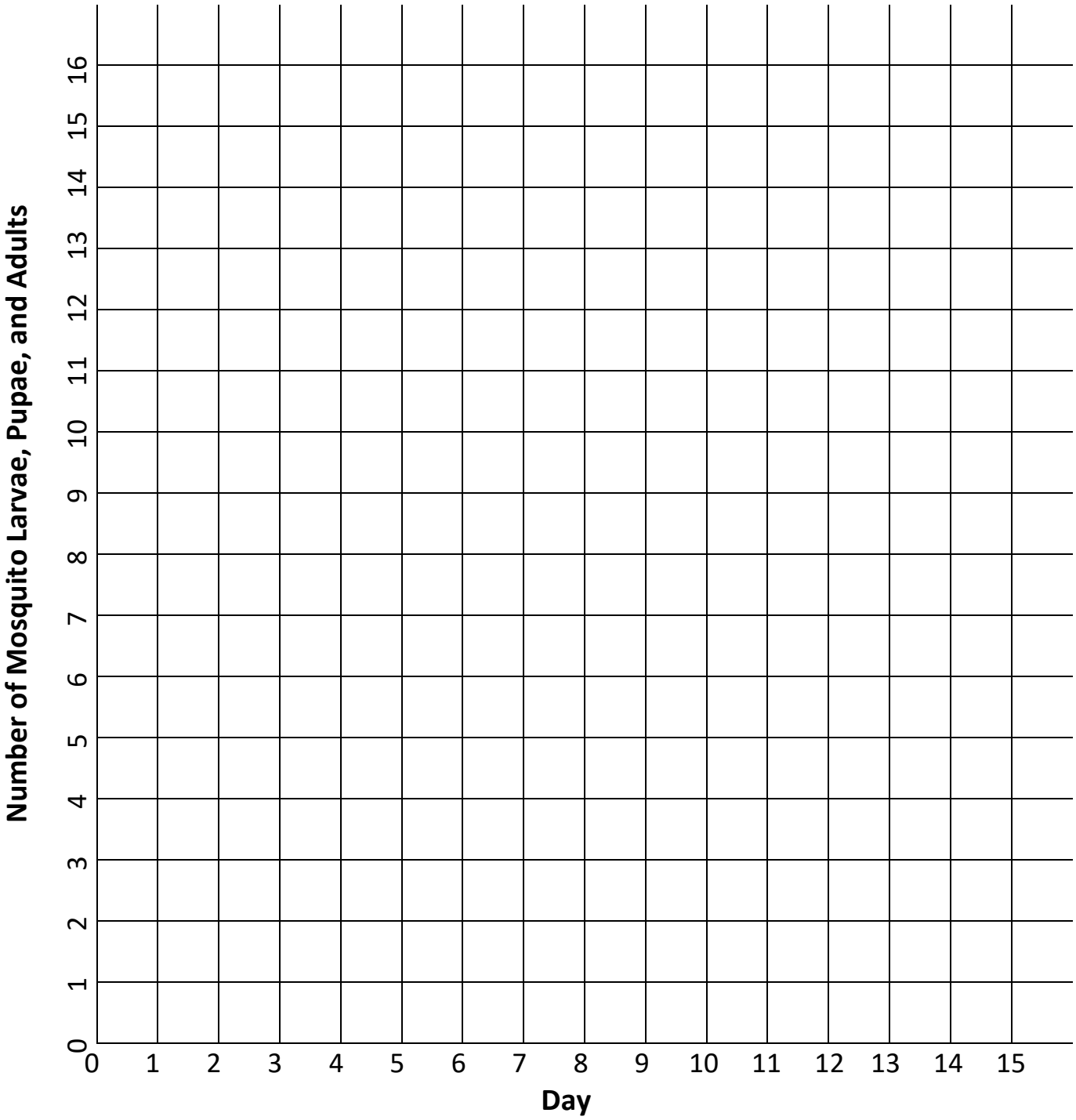
1. Use the data from the table to **create line graphs** on the next page. These will show the number of mosquitoes at each life stage (larvae, pupae, and adults). ***Optional:*** Use a computer and software such as Microsoft Excel to record your data and create line graphs.
2. Compare your line graphs. Was your hypothesis correct? What can you say about how the data changes over time?

_____

_____

Mosquito Growth Graph

1. **Add data points from the table** using 3 different colors.
2. **Label the colors** in the legend.
3. **Connect the points** in the 3 sets of data with straight lines of the same colors. This will create **line graphs** which show the changes over time.



Legend

Color for each life stage: ◯ Larvae ◯ Pupae ◯ Adults

Lesson 2: Staying OUT of Mosquito Food Webs

Overview

Students investigate mosquito food webs, learning about what mosquitoes eat—and what organisms control their population by eating them. Wetland and backyard ecosystems are discussed (with visual aids and/or acting out a food chain), as well as how mosquitoes spread disease. Free Life Cycle Kits from Clackamas County Vector Control help students observe the effect of predators (mosquito fish) on larvae over several days; they record and graph the observed data, comparing it to the data they observed in the mosquito experiment without predators from the previous lesson. Adaptations / extensions are listed at the end of the lesson, including additional projects and games, to help engage all students.

Subjects: Science, Math, Reading, Writing, Speaking & Listening, Health, Art, Social Studies

Grades: Adaptable for K–12

Duration: 40–60 minutes for main lesson; observing, graphing and analyzing mosquito larvae and mosquito fish for 3 days

Vocabulary

- Biodiversity
- Ecosystem
- Food chain / food web
- Habitat
- Host
- Larva / larvae
- Organism
- Pathogens
- Predator
- Prey
- Pupa / pupae
- Stagnant
- Vector
- Wetlands

Lesson Goals

- Increase students' understanding of mosquitoes' role in food webs, as well as in spreading disease
- Provide students with experience in scientific observation, illustration, experimentation, data analysis, and graphing

Objectives

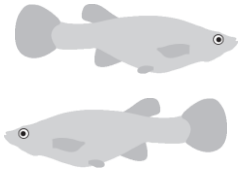
- Students will observe and illustrate mosquitoes and mosquito fish.
- Students will conduct an experiment using live specimens, record data, and graph changes over time.
- Students will reflect on the results of their experiment in writing and in class discussion.

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Systems and system models • Energy and matter • Stability and Change
	Science & Engineering Practices	Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	LS1.A: Structure and Function LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience
Common Core ELA	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

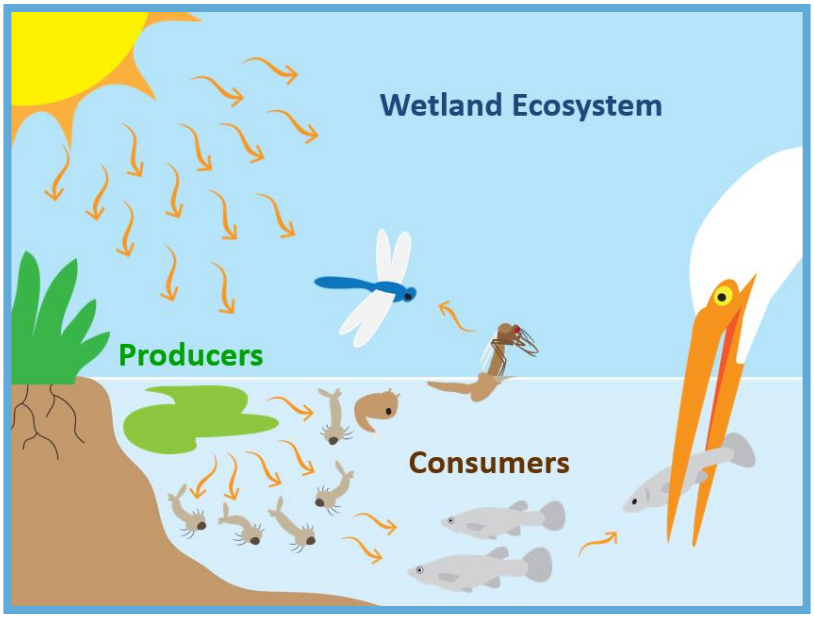
Materials & Preparation

1. Prepare to show the *Staying OUT of Mosquito Food Webs* PowerPoint presentation available at fightthebites.com/education
2. About 15 live mosquito larvae in tank and supporting resources in the free Life Cycle Kit from Clackamas County Vector Control: 503.655.8394 or fightthebites.com/contact-us
3. Two or more mosquito fish *(Gambusia affinis)* from the Life Cycle Kit in separate container
4. Copies of "Staying OUT of Mosquito Food Webs" handout for each student (at end of lesson)
5. Colored pencils and/or markers for students to share
6. Rulers for students to share when making line graphs
7. *Optional:* Magnification device(s) to magnify larvae, such as "Mpow 3-in-1 Clip-On Lens Kits: xmpow.com/selfie-stick-lens/mpow-fisheye-lens-mfe4.html
8. *Optional:* Document camera for students to more easily present illustrations and graphs to the rest of the class

Suggested Procedure



1. Show students the mosquito fish *(Gambusia affinis)* and ask them how the fish might be able to help stop the spread of disease. Discuss how they can help control mosquito populations and explain that the students will get to do an exciting experient with the fish and mosquito larvae later in the class.
2. Engage students with an interative discussion about moquito food webs using the brief "Staying OUT of Mosquito Food Webs" PowerPoint presentation as a visual aide.
    a. **Mosquito Life Cycle** (slide 2): Review the mosquito life cycle discussed in the previous lesson by asking students about each stage in a mosquito's life—egg, larva, pupa, and adult—before you reveal the stages on screen. Ask students questions to get them thinking, such as, "How does a mosquito begin it's life?" and "What does a mosquito larva need to live?"
    b. **Wetland Ecosystem** (slide 3): Ask the class why the Sun is so important for life on Earth. Discuss how it provides the energy which plants (**producers**) use to make food, and that the plants then become food for animals (**consumers**) like mosquito larvae. Explain that mosquito fish are **predators** which can eat the larvae, and birds like egrets can eat the fish, continuing the **food chain**. Dragonflies are one animal which can eat adult mosquitoes. Discuss how all the living and nonliving things (such as sunlight, water, and air) are interconnected in an **ecosystem**—in this case a wetland ecosystem which is known for having a high

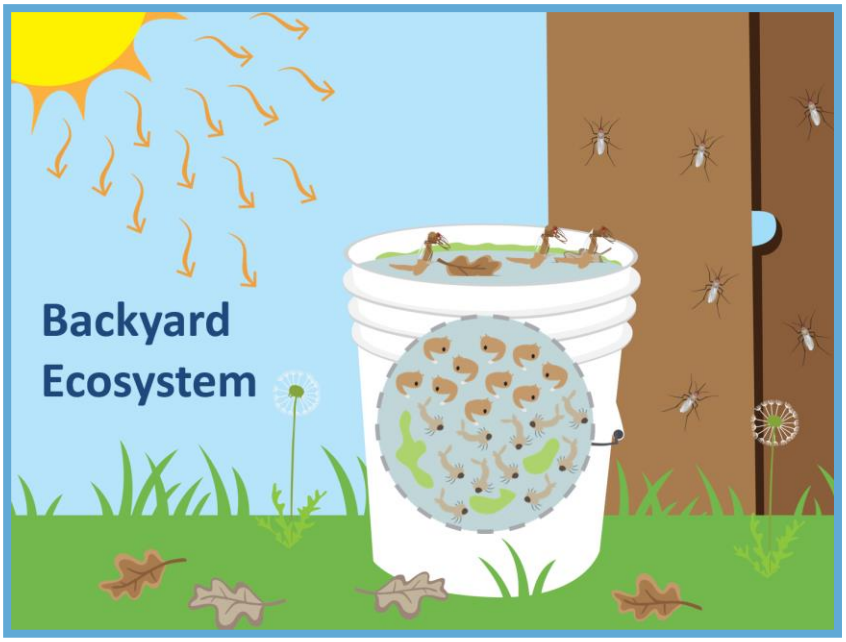


degree of **biodiversity** (different types of living things). Explain that **organisms** (living things) in an ecosystem actually interact in a **food web** (more than just a food chain), because they both eat and are eaten by many other organisms.

Optional: Call on volunteers to act out a food chain for the rest of the class. Start with a volunteer to play the Sun, holding up their arms in a big circle above their head. Then ask for a volunteer to play an organism which can make food from the Sun, followed by mosquito larvae which can eat the producers, fish that can eat the larvae, etc. Ask the students to try to make themselves look and/or act like the organisms they are playing.

c. **Wetland Ecosystem at Night** (slide 4): Discuss how mosquitoes can be most active at dusk, with female mosquitoes who have mated sucking the blood of other animals, such as birds and humans, to get protein to lay eggs. Fortunately, predators such as bats are active at night, too, and they eat tons of insects like mosquitoes!

d. **Backyard Ecosystem** (slide 4): Discuss how backyard ecosystems can be different, including how standing water sources usually don't contain predators like fish to control insect populations. Many adult mosquitoes can be produced in less than a week after eggs are laid, especially in the warmer months, which is why it is so important to dump standing water. Water features like ponds should not have **stagnant** (standing) water, which mosquitoes need to develop. Fortunately, other predators like swallows can eat adult mosquitoes, too, and Clackamas County Vector Control can provide mosquito fish for human-made backyard water features.



e. **Blood-feeding** (slide 5): Explain how mosquitoes can transmit diseases when feeding on blood. Saliva from the mosquito goes into the **host** (the organism being fed on), carrying the **pathogens** which can make people and other organisms sick.

f. **West Nile Virus, etc.** (slide 6): West Nile virus is one pathogen which can make people very sick. A mosquito with the virus can infect a host such as a bird, then another mosquito can transmit the virus from the bird to a human. Mosquitoes

are considered disease **vectors** because they can easily spread diseases from one host to another. Many humans and other animals have died because a mosquito infected them with West Nile virus, malaria, Zika virus, or another disease. Mosquitoes are the deadliest animal in the world to humans.

g. **Staying Safe from Mosquitula!** (slide 7): Discuss the strategies to stay safe listed on the screen and other student ideas, such as:

- ✓ Dumping standing water
- ✓ Being especially careful at dusk and dawn
- ✓ Using an electric fan if sitting outside in the evening
- ✓ Providing bat boxes and bird boxes to help mosquito predators find shelter and reproduce

3. Explain that students will have the opportunity to do an experiment to investigate the role of a predator on mosquito populations. Show them the tank with larvae and explain that, like the first tank in the previous lesson, they will count how many larvae, pupae, and adults are in the tank each day. The difference is that after they do a count on the first day, they will add the mosquito fish to test the role of the predators in determining how many mosquitoes can grow and develop.
4. Pass out copies of the "Staying OUT of Mosquito Food Webs" handout (found at the end of the lesson) and explain to students that they will work with a partner to complete the activities in any order they prefer, taking turns with the other groups to observe the tank. Tell students that they will carefully observe the mosquitoes and fish and record their observations on the handout. They can observe the live larva using a magnification device (if available) when making their observations/illustrations. At the end of the experiment they will graph their data to show how the numbers of mosquitoes changed over time and compare it to the graph from the first experiment which they started in the previous lesson.
5. Students will conduct the experiment over the next several days. Explain that they will be responsible for completing the illustrations, questions, and graphs on the handout over that time, and that they can ask questions as they arise.
6. At the end of the experiment, have groups present their ideas from the questions on the handout, including their illustrations, using a document camera (if available).
7. Results and graphs from the experiment can also be presented and discussed, then you can collect the handouts for assessment.

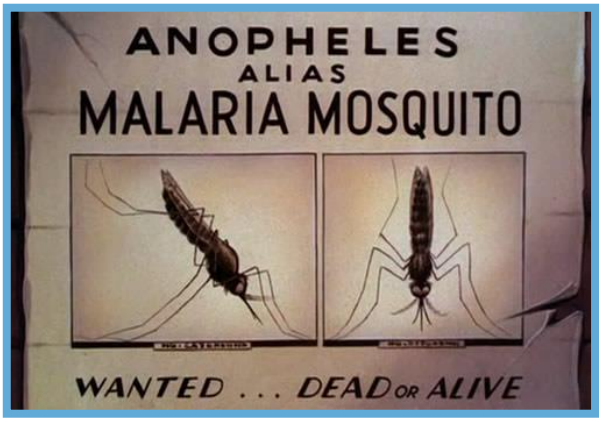
Adaptations / Extensions

- **Take students outside and have them explore a local ecosystem**, such as a wetland or your school grounds. The organisms they discover can be recorded in student-created field guides or journals and observed to determine how they interact with other organisms in a food web. Back at school, research can be conducted to develop a deeper understanding of the organisms and how they interact in the ecosystem. Research findings could be shared with the rest of the class through oral presentations, student-created videos, etc.
- **Play "Bats & Skeeters,"** a new game inspired by the "Beneficial Insects Game" created by Bob Carlson, former director of the Center for Research in Environmental Sciences and Technology (CREST) in Wilsonville, OR: wlwv.k12.or.us/Domain/12.

    - Choose 2 students to be bats and 6-8 students to play skeeters (mosquitoes) for a group of about 25 students. If possible, use different-colored bandanas (tied to wrists to avoid the chance of spreading lice) to distinguish the bats (red, brown, or black bandanas) from the mosquitoes (any other bright color) from the remaining students, who all play humans.
    - Humans are given a head start to get away from the mosquitoes.
    - Second to be released are the mosquitoes who try to tag the humans (to represent sucking their blood and giving them dangerous pathogens).
    - Once a human is tagged, they must freeze until they are rescued (tagged) by a bat, who are the last 2 students added to the game. The bats have 2 responsibilities:
        1. To unfreeze (tag) the humans
        2. To tag (eat) the mosquitoes before they tag more humans
    - When a mosquito is tagged by a bat, they must leave the game (to symbolize that they have been eaten).
    - Humans may be tagged by mosquitoes and rescued by bats twice. The first time they are tagged by a mosquito they must raise one hand to show that they have been bitten. After the second tag, they raise both hands to show they have been bitten twice. On the third tag from a mosquito they have West Nile virus or another serious disease and must leave the game.
    - Debrief after each round, adjust the number of bats and mosquitoes, if necessary, and play a second or third time so all students get to be a tagger at least once. Point out that not all students can be bats.
- **Students can create food web diagrams** of an ecosystem which includes mosquitoes, such as a wetland or backyard. They can create the diagrams on paper using pencils, markers, etc., or using software such as PowerPoint, Inspiration, Kidspiration, Illustrator, or Explain Everything. Show students one or more examples to help them get started and envision more possibilities for how to present the information, such as:

- "Aquatic Food Web" from Univ. of Michigan: www.miseagrant.umich.edu/lessons/files/2013/05/Aquatic-Food-Web-GLEP.jpg
- "Who's Eating Who?": cdas.org.au/sites/all/themes/nexus/images/FoodWeb.png
- "Wetland Food Web": 1.bp.blogspot.com/-XLXufX-ih8c/U6neytFPyYI/AAAAAAAABMs/N5WyGhg0Is0/s1600/wetland+food+web.jpg

- **At the start of the lesson, ask students to turn to a neighbor and brainstorm what they think the most dangerous animal is to humans and why.** After a minute, ask the groups to share their ideas with the class and discuss why mosquitoes are so dangerous to humans and other animals.
- **Students can work in pairs or small groups to create short videos** about mosquito food webs and/or public service announcements about how to stay safe from mosquitoes and vector-borne illness.
- **Play the "Mosquito Memory" game** at fightthebites.com/education as an enjoyable way to review concepts. It works like the old memory card game, but with a mosquito life cycle theme. One way to play is to divide the class into two teams and award points when each group gets a match. A group can keep guessing as long they get matches. Good opportunities to review concepts are provided as the various pictures are flipped over.
- **Ask students to compare a mosquito and another organism**, such as a mosquito fish or bat, using a Venn diagram or another method.
- **Show and discuss one or more short videos**, such as:
  - Disney's classic "The Winged Scourge," which was created during World War II to help fight the spread of malaria: youtu.be/y68F8YwLWdg?t=18s
  - PBS' fascinating "Deep Look: How Mosquitoes Use Six Needles to Suck Your Blood": www.pbs.org/video/deep-look-mosquitoes
- **Lead a student service-learning project** to identify possible sources of mosquito breeding on school grounds and/or in neighborhoods. Students can work to limit areas of standing water and educate their neighborhood and fellow students about staying safe from mosquitoes by reducing standing water, sharing ways to avoid being bitten, etc.



More Resources / References

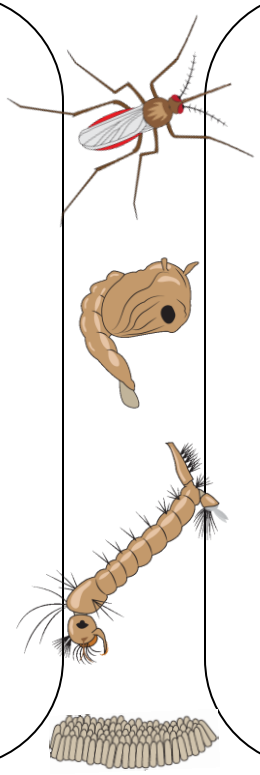
- More free resources are available on Clackamas County Vector Control District's website: fightthebites.com/education.
- Learn more about West Nile Virus and its transmission from the Mayo Clinic: mayoclinic.org/diseases-conditions/west-nile-virus/symptoms-causes/syc-20350320
- Mosquito Habitat Mapper. GLOBE Observer app discussed fully in Lesson 6 of this curriculum, "Mapping Mosquito Habitats": observer.globe.gov/about/get-the-app
- Pittawalla, Iqbal. How Mosquitoes Are Drawn to Human Skin and Breath: ucrtoday.ucr.edu/19377
- PowerPoint presentation used in the lesson adapted with permission from Eric Engh, Education Program / Insect Identification Specialist with Marin/Sonoma Mosquito & Vector Control District; more resources available from their Mosquito School website: msmosquito.com/mosquito%20school
- See the videos referenced above for more background information. The website "Mosquito Magnet" also has an excellent explanation with images of how mosquitoes bite: mosquitomagnet.com/articles/how-mosquitoes-bite
- "Food Webs" lesson plan. CPALMS, Florida State University: www.cpalms.org/Public/PreviewResourceLesson/Preview/75952
- "The freshwater biome." UC Berkeley: www.ucmp.berkeley.edu/exhibits/biomes/freshwater.php
- More information about the Next Generation Science Standards: nextgenscience.org
- More information about the Common Core State Standards: corestandards.org

Name:_____ Period: _____ Date: _____

Staying OUT of Mosquito Food Webs

Draw and label mosquito food sources below . . . and organisms that eat mosquitoes at different life stages.

Mosquito Food Sources



Mosquito Predators

Think About It!

1. List places with **stagnant** (still) water where mosquitoes can grow:

   _____

   _____

   _____

2. What are ways to keep mosquitoes from growing in those places?

   _____

   _____

   _____

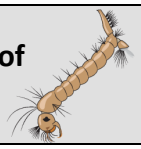
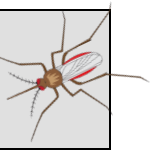
Predator Experiment! Record the number of larvae, pupae, and adults each day.

Hypothesis: What changes do you predict in the habitat with fish compared to one without them?

_____

_____

Mosquito Data – Habitat with Mosquito Fish

Day	Number of Larvae 	Number of Pupae	Number of Adults 
1 BEFORE Mosquito Fish Added			
1 AFTER Mosquito Fish Added			
2			
3			
4			
5			
6			

Graph it!

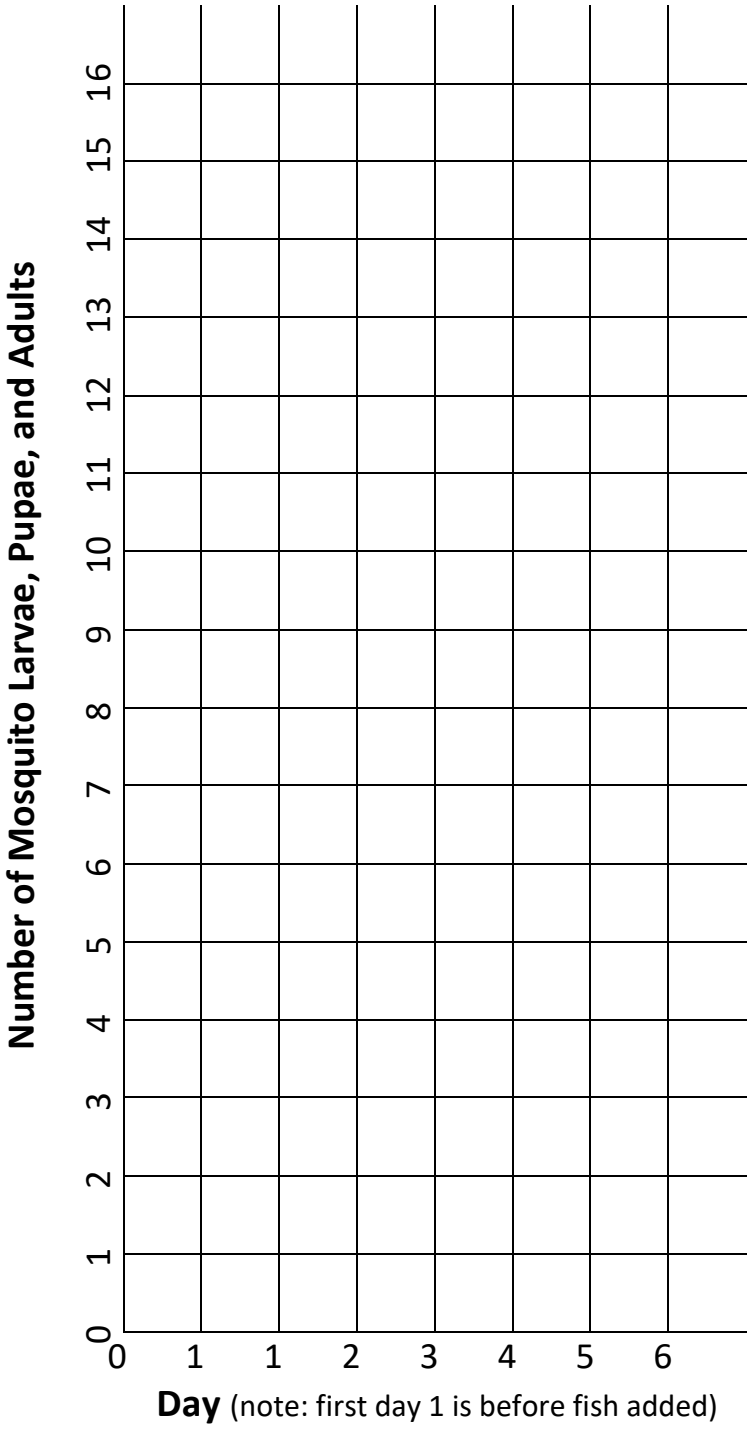
1. Use the data from the table to **create line graphs** on the next page. These will show the number of mosquitoes at each life stage (larvae, pupae, and adults).
   Optional: Use a computer and graphing software to record your data and create line graphs.
2. Compare your line graphs. Was your hypothesis correct? What can you say about how the data changes over time compared to the habitat without predators?

   _____

   _____

Mosquito Growth Graph—with Fish

1. **Add data points from the table** using 3 different colors.
2. **Label the colors** in the legend.
3. **Connect the points** with straight lines of the same colors.



Legend

Choose a color for each data type.

◯ Larvae ◯ Pupae ◯ Adults

Illustrate & Label the Habitat with Fish

Illustrate & Label the Habitat without Fish

Lesson 3: Adaptations of a Bold Blood Sucker

Overview

Students investigate mosquito adaptations at different stages of their life cycle, reinforcing how mosquitoes require water to develop and how to stay safe from them. A short interactive multimedia presentation provides an overview of the important concepts and terms, then students create models of a new type of blood-sucking organism using natural or human-made materials. Adaptations / extensions are listed at the end of the lesson, including ways to include a variety of classroom centers to help meet the needs of all learners.

Subjects: Science, Writing, Speaking & Listening, Reading, and Art

Grades: Adaptable for K–12

Duration: 40–75 minutes

Vocabulary

- Adaptations
- Behavioral adaptations
- Engineering design
- Larva / larvae
- Metamorphosis
- Model
- Proboscis
- Pupa / pupae
- Structural adaptations

Lesson Goals

- Increase students' understanding of mosquito adaptations that help them to survive and reproduce, as well as how to stay safe from them
- Provide students with the opportunity to apply the concept of adaptations to the process of engineering design

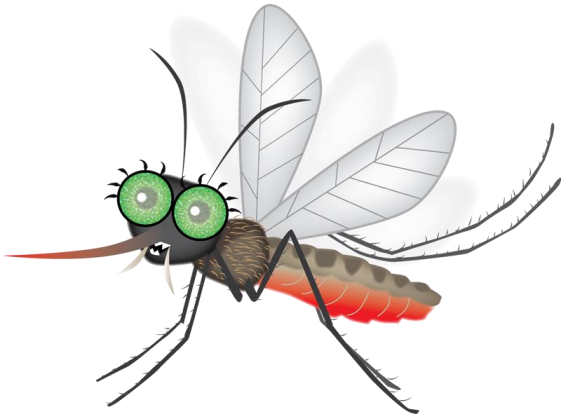
Objectives

- Students will demonstrate understanding of mosquito adaptations at all four stages of their life cycle, including ways they are able to suck blood, reproduce, and survive as larvae, and transform through the process of metamorphosis.
- Students will create models of a new blood-sucking organism and share it with their peers, gaining feedback which could be incorporated into a new iteration of the design.
- Students will write about how their organisms are adapted to survive and share their ideas and models in class presentations and/or discussion.
- Students will verbalize the importance of water in the mosquito life cycle and how they are adapted to best utilize it.

A student explains the adaptations of his new organism.
Image courtesy Lucinda Watson, River Grove Elementary School, Lake Oswego, OR

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Structure and Function • Stability and Change
	Science & Engineering Practices	• Asking Questions and Defining Problems • Constructing Explanations and Designing Solutions • Developing and Using Models • Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS4.C: Adaptation
Common Core State Standards	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials & Preparation



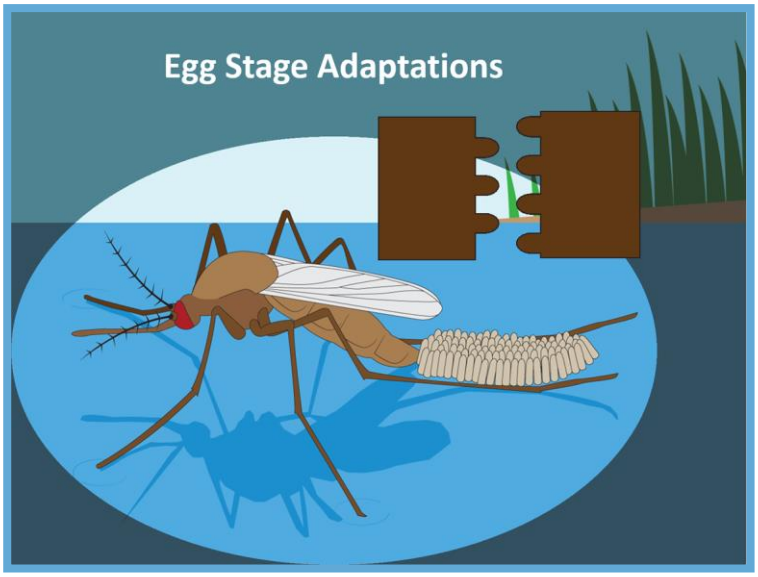
- Prepare to show the *Adaptations of a Bold Blood Sucker* PowerPoint presentation available at fightthebites.com/education. Review the slide notes on the bottom of the slides.
- Write the word "Adaptations" on the board to refer to during the lesson.
- Copies of the "Beware of Mosquitula!" handout for each student (at end of lesson)
- *Optional:* Modeling clay or Play-Doh and natural materials like dried vegetation, twigs, pine needles, and pine cones for students to share
- *Optional:* Human-made materials for students to share, such as used paper towel tubes and/or toilet paper tubes, popsicle sticks, elastic bands, paper, cardboard, tape, and non-toxic glue
- *Optional:* Paper plates on which to construct creatures
- *Optional:* Colored pencils, markers and/or crayons for students to share
- *Optional:* Be ready to magnify dry mosquitoes and/or live mosquito larvae
- *Optional:* Microscope(s) and/or hand lens(es)
- *Optional:* Enlarged photographs of mosquitoes at all 4 life stages

Suggested Procedure

1. Ask students to turn to a neighbor and quickly brainstorm everything they know about how mosquitoes survive and why they can be dangerous. They should jot down their ideas on a piece of paper in words and pictures. Circulate through the room, answering any questions. After about a minute, tell students they have another 30 seconds to brainstorm and that they should be prepared to share one or more of their ideas with the class.
2. Ask the pairs to share their ideas with the class, and explain that the traits which help an organism (living thing) survive in their environment are called **adaptations**, pointing out the word on the board.

3. Share the *Adaptations of a Bold Blood Sucker* PowerPoint presentation with the class, including the brief video clips. Quickly present the visuals and information in the slide notes with the class in an interactive way.

4. When you get to the last slide of the presentation, ask students if they can remember the mosquito adaptations that were discussed for each stage. Discuss the difference between **structural adaptations** (physical structures of an organism which help it to survive) and **behavioral adaptations** (what an organism does which helps it survive). Ask students to spend a minute talking to a neighbor about mosquito adaptations and which they think are the most interesting. *Optional:* Ask students to draw and label and/or act out the adaptations they remember.



An animated slide from the *Adaptations of a Bold Blood Sucker* PowerPoint presentation.
Graphic courtesy Eric Engh, Marin/Sonoma Mosquito & Vector Control District

5. Next, tell students that they will have the opportunity to create a NEW organism which is either adapted to suck blood from other organisms OR has effective defenses against such blood-sucking organisms. Explain that they will be able to use a variety of materials, their creativity, and what they have learned about adaptations to help with their **engineering designs**. Show them the available materials, such as clay, natural vegetation, and/or human-made materials such as toilet paper tubes, used paper, and popsicle sticks with which they can work.

Students begin modeling new organisms with clay, inspired by magnified specimens and images of mosquitoes at different life stages.
Image courtesy Rick Reynolds

6. Ask students to choose a partner and collect materials with which to work. Rotate though the groups of students, answering questions and helping students get started, if necessary. Tell students that they should be prepared to present their work to the class, and that if they have time, they can create another life stage for their organism (such as a mosquito's larval stage).

7. After about 15 minutes, or whenever groups start to complete their designs, tell them that they have 5 minutes left to work. Explain that you will be looking for volunteers to make a brief presentation to the class about their organisms, and ask them to start cleaning up when they are finished. When 5 minutes have passed, ask the remaining students to help clean up.
8. Ask students to explain their organisms' adaptations in writing using one of the following methods or another way which they devise:
    - Labels can be created with small pieces of card stock and attached to their organisms with toothpicks and tape or another method.
    - They can illustrate their engineering designs on paper, labeling the adaptations which help them to survive. Color can be added with pencils, markers, or crayons.

A student proudly presents her new organism.
Image courtesy Lucinda Watson, River Grove Elementary School, Lake Oswego, OR

9. Ask students to raise their hands if they would like to share their organism with the class. Call on a few groups, one at a time, to stand up and share their work, giving other class members a chance to ask questions about the organisms' adaptations at the end of each short presentation.
10. Tell students that they will be able to finish their projects for homework or in class the next day (if necessary and as you deem appropriate). Collect the finished projects to review more carefully and display around the classroom and/or the school. You could also ask students to refine their creations based on constructive feedback you and/or the rest of the class has provided before the creations are displayed publicly.
11. Close with a quick review of concepts learned during the lesson and ways students can help in the fight against mosquitoes (dumping standing water, staying safe from bites, educating others, etc.). Pass out the "Beware of Mosquitula!" handout for students to share with their families.

Adaptations / Extensions

- **Ask students to first plan their organisms** on paper before they start engineering them with physical materials, labeling the adaptations which will help the organisms to survive.
- **Classroom centers can be setup** with other activities related to adaptations, the new organisms, and/or mosquitoes, such as those listed below. This would provide more opportunity for student choice and differentiated learning experiences.

- **Students can create fictional stories** featuring their organisms.
- **Ask students to compare mosquitoes with their new organisms.** For example, a Venn diagram could be used. Details about the organisms' life cycles could also be included.
- **Students can write poems** about their new organisms and/or mosquitoes which include details about how they survive and/or how to stay safe from them. Completed poems can be shared with the class and/or displayed on classroom walls or hallway bulletin boards.

  "Mosquito" by J. Patrick Lewis is a wonderful poem you can to share with your students for inspiration. You can read it aloud or share a video of the former U.S. Young People's Poet Laureate reading it here: nowaterriver.com/poetry-month-2012-childrens-poet-laureate-j-patrick-lewis. Scroll down the page a bit for the video and complete text of the poem. Before or after you share it, ask students to try to identify a detail which could not have been scientifically accurate. (Answer: The mosquito in the poem is called a "he," but only female mosquitoes bite.)

- **Students can create public service announcements** about staying safe from their organisms and/or mosquitoes; video can be used and/or other communication methods, such as live acting.
- **Students can observe mosquito larvae and/or dried adults under magnification** using a macro lens or microscope to better see their unique adaptations. You can also connect it to a computer and/or data projector to show them to the whole class. Students can create detailed scientific illustrations of the organisms, then label and annotate the illustrations. Contact Clackamas County Vector Control District if you need specimens, macro lenses, and/or other hands-on resources.

More Resources / References

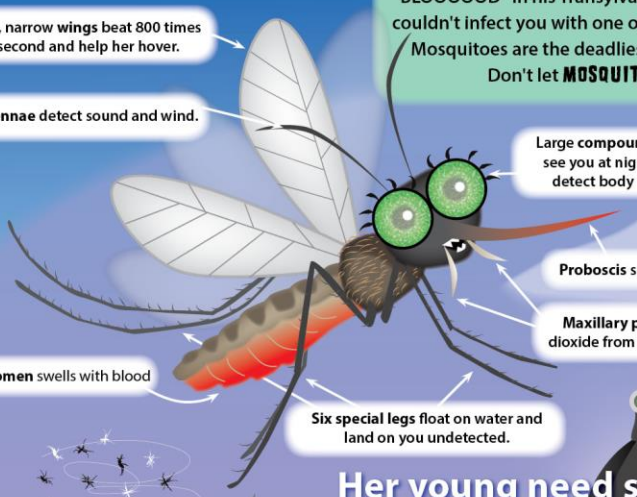
- More free resources are available on Clackamas County Vector Control District's website: fightthebites.com/education. For example, a large printed version of the "Beware of Mosquitula!" poster shown on the next page is available, as well as additional lessons and several short videos about mosquito safety.
- "Animal Adaptations" lesson plan from the Museum of Natural and Cultural History – Univ. of Oregon: natural-history.uoregon.edu/sites/default/files/mnch/Animal%20Adaptations%20Lesson%20Plan.pdf
- PBS' short video "Deep Look: How Mosquitoes Use Six Needles to Suck Your Blood" can be a great springboard for a discussion about adaptations: pbs.org/video/deep-look-mosquitoes
- PowerPoint presentation adapted with permission from Eric Engh, Education Program / Insect Identification Specialist with Marin/Sonoma Mosquito & Vector Control District; more resources available from their Mosquito School website: msmosquito.com/mosquito%20school
- Pittawalla, Iqbal. How Mosquitoes Are Drawn to Human Skin and Breath: ucrtoday.ucr.edu/19377
- More information about the Next Generation Science Standards: nextgenscience.org

BEWARE OF MOSQUITULA!

Don't Let Her SUUUCK YOUR BLOOOOOD . . . or LAY EGGS!

ADAPTATIONS OF A BOLD BLOOD SUCKER

Mosquito bites don't just itch. They can carry diseases like **Zika virus** and **West Nile virus**. The fictional Count Dracula was scary when he said, "I vant to suuck your BLOOOOOD" in his Transylvanian accent, but even he couldn't infect you with one of those dreaded diseases. Mosquitoes are the deadliest creatures to humans. Don't let **MOSQUITULA** bite you!



Long, narrow wings beat 800 times a second and help her hover.

Antennae detect sound and wind.

Large **compound eyes** see you at night and detect body heat.

Proboscis sucks blood.

Maxillary palps detect carbon dioxide from breath & body odors.

Abdomen swells with blood

Six special legs float on water and land on you undetected.

DEFENSE FOR YOU

Head protection

Clothing covered in mosquito repellent

Long sleeve shirt and pants

Covered feet & ankles

Her young need standing water. Don't give it to 'em like these ZANY ZOMBIES!

Mosquito larva

Bird bath: Change water every 5 days

Kiddie pool: Change water or put it away

Water bowl: Change water–even if your pet is a zombie!

Can You Find These?

Ways to Fight the Bites!

- Repair damaged window and door screens.
- Provide bat boxes. Bats eat MILLIONS of mosquitoes!
- Use insect repellents (safely).
- Wear protective clothing.
- Go inside at dusk and dawn, when mosquitoes are most active.
- Use an electric fan outside at night. Wind can keep **MOSQUITULA** from landing on you!
- Be extra careful in wetlands and forests.

Things Collecting Water

- Bottle
- Can
- Clogged rain gutter
- Jar
- Grill cover
- Leaky faucet
- Low areas in ground
- Plant pot and saucer
- Puddle
- Tire
- Tools
- Toys

Visit FighttheBites.com to learn more.

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Created by Rick Reynolds (EngagingPress.com) and Fran Lee (Fran-Lee.com), in collaboration with CCVC.

Lesson 4: Various Vectors: Ticks, Fleas, and More—Oh My!

Overview

Students compare the life cycles and adaptations of disease vectors such as fleas, ticks, and flies, learning about what they need to develop and how to stay safe from them. They can use a graphic organizer to help with the analysis, then create arguments from evidence about why the organisms' traits are the result of their environment and which is the more dangerous organism to humans and why. A short interactive multimedia presentation helps provide an overview of the important concepts and terms. Adaptations / extensions are listed at the end of the lesson, including a simpler activity for younger students.

Subjects: Science, Health, Art, Writing, Speaking & Listening,

Grades: Adaptable for K–12

Duration: 35–75 minutes

Vocabulary

- Flea
- Larva / larvae
- Life cycle
- Metamorphosis
- Nymph
- Tick
- Vector
- Vector-borne disease

Lesson Goals

- Increase students' understanding of disease vectors and how to stay safe from them.
- Provide students with experience researching, writing, and/or presenting about a relevant scientific topic
- Provide students with experience thinking critically through the process of comparing disease vectors with the support of a graphic organizer.

Objectives

- Students will research and compare two disease vectors with the support of a graphic organizer.
- Students will write about and/or present about their research and create an argument from evidence about which is the more dangerous organism to humans and why.

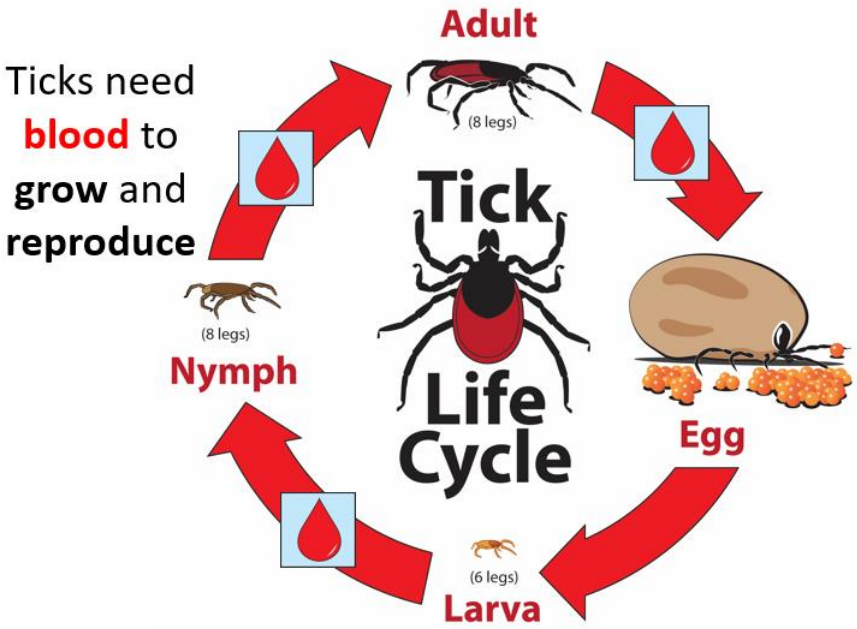
Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Structure and Function • Stability and Change
	Science & Engineering Practices	• Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence
	Disciplinary Core Ideas	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS5.C: Adaptation
Common Core State Standards ELA	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials + Preparation

- Prepare to show the "Various Vectors: Ticks, Fleas, Flies, and More—Oh My!" PowerPoint presentation available at fightthebites.com/education.
- *Optional:* Copies of a graphic organizer template, such a Venn diagram or Box and T-Chart. Students could also create an organizer themselves on larger paper or in their science notebooks.
- *Optional:* Colored pencils and/or markers for students to share
- *Optional:* Review the additional sources listed in the "Adaptations / Extensions" and "More Resources / References" sections at the end of the lesson to prepare to answer student questions.

Suggested Procedure

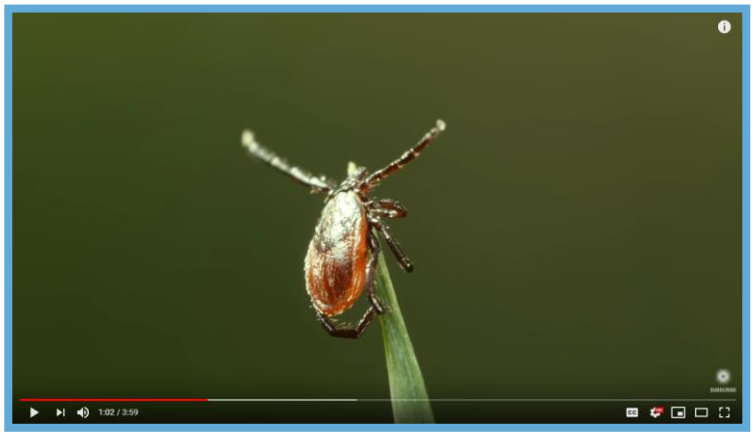
1. Ask students to think about what ticks, fleas, flies, and rats all have in common. After a moment, ask them to turn to a neighbor and quickly brainstorm their ideas. After they've discussed for a minute, ask the pairs to share their ideas. Discuss how all of the organisms are **vectors** which can spread disease, like mosquitoes which they have been learning about.
2. Lead an interactive discussion with students using the brief "Various Vectors" PowerPoint presentation. See the Slide Notes for more information which can be shared with students, depending on their age and how much detail you wish to share. For example, on slide 2 explain that if the ticks meet their needs of water, blood meals, and warmth, there will be a **metamorphosis** as they transform from **larvae** into **nymphs** and nymphs into adults. Additional details can be found on the sources listed at the end of the lesson.



3. Ask students to compare two disease vectors, such as those listed on slide 10. For example, a Venn diagram or Box and T-Chart could be used to compare the similarities and differences of potential disease vectors, such as a ticks, fleas, flies, rodents, and mosquitoes, with words and pictures. You might ask the students to focus on areas such as their life cycles, adaptation, where they are found (both in terms of habitat and geographic distribution), and how they can spread disease. Consider asking them to chose mosquitoes as one of their organisms.
4. After graphic organizers are created, students could explain them in writing, and/or presentations could be prepared and shared with the class. Ask them to discuss how the organisms' traits are the result of their environment and how they are able to survive in it. They can also include an argument from evidence about which is the more dangerous organism to humans and why.

5. Lead an interactive discussion about disease vectors and work with students who researched the particular vectors to answer questions about them, including good ways to stay safe from illnesses which they can spread. For example, they can avoid tick bites when visiting natural areas by wearing light-colored long pants and sleeves, putting repellent on their clothes, and checking for ticks carefully.

Adaptations / Extensions



- **Show and discuss one or more short videos, such as PBS' "Deep Look: How Ticks Dig In With a Mouth Full of Hooks"**: kqed.org/science/1920972/how-ticks-dig-in-with-a-mouth-full-of-hooks.

  The website includes a detailed article which students can read and discuss, as well.

- **For younger students, start with a basic research project about a disease vector**, focused on one or more categories of information, such as its life cycle, adaptations, and how to stay safe from it. Then they can compare it to another disease vector if time allows.
- **Students can compare 3 different vectors** using a Venn diagram with 3 circles. The template can be used or students can create their own on larger paper or using a computer.
- **Students can write personal stories**—either positive or negative—involving a possible vector. Fictional stories or poems can also be created.
- **Students can create detailed, labeled scientific illustrations** of the organisms they research.
- **Have students research individual vector-borne diseases.** The World Health Organization lists the most dangerous ones here: who.int/news-room/fact-sheets/detail/vector-borne-diseases
- **Use one or more of the educational resources from the Global Lyme Alliance** (includes tech-based): globallymealliance.org/education-awareness/curriculum-educational-activities

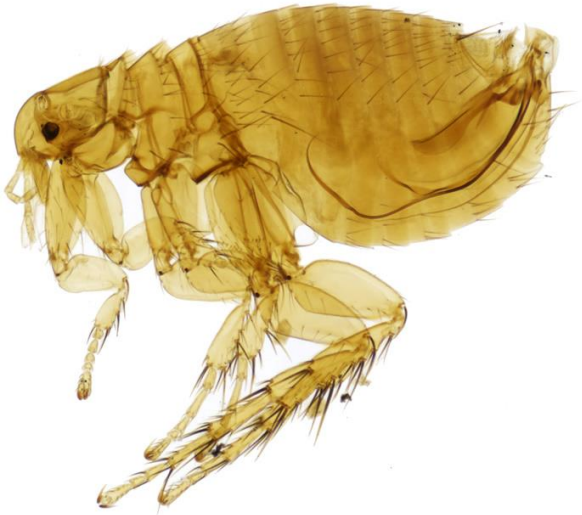
More Resources / References

- "Illnesses on the rise from mosquito, tick, and flea bites." CDC Vital Signs: https://www.cdc.gov/vitalsigns/pdf/vs-0518-vector-borne-H.pdf
- "Diseases spread by ticks, mosquitoes and fleas more than tripled in the U.S. since 2004." *The Washington Post:* washingtonpost.com/news/to-your-health/wp/2018/05/01/diseases-spread-by-ticks-mosquitoes-and-fleas-more-than-tripled-in-the-u-s
- Visit Clackamas County Vector Control District's website for more resources and background about our education program: fightthebites.com/education

Ticks

- "Ticks." Centers for Disease Control and Prevention (CDC): https://www.cdc.gov/ticks/index.html
- "Tick Removal." CDC: https://www.cdc.gov/ticks/removing_a_tick.html
- "Fundamentals of Lyme Disease Prevention." Global Lyme Alliance: globallymealliance.org/education-awareness/fundamentals-lyme-disease-awareness-prevention
- "Fleas and Ticks" Metro: https://www.oregonmetro.gov/tools-living/healthy-home/pest-control/fleas-and-ticks

Fleas



- "Fleas." CDC: https://www.cdc.gov/dpdx/fleas/index.html
- "Fleas." Marin/Sonoma Mosquito & Vector Control District: msmosquito.com/vectors-diseases/vectors/fleas
- Rust, M.K. "Fleas: Integrated Pest Management in and Around the Home." Univ. of California Statewide Integrated Pest Management Program: ipm.ucanr.edu/PDF/PESTNOTES/pnfleas.pdf
- "Flea Facts for Kids." PestWorld for Kids: pestworldforkids.org/pest-guide/fleas
- "How Fleas Work." How Stuff Works: animals.howstuffworks.com/insects/flea1.htm
- Wyrwa, J. "*Pulex irritans:* Human Flea." Animal Diversity Web. Univ. Of Michigan Museum of Zoology: animaldiversity.org/accounts/Pulex_irritans

Flies + Rodents

- "House Flies: *Musca domestica*." Penn State Dept. of Entomology: ento.psu.edu/extension/factsheets/house-flies
- "Diseases from rodents." CDC: cdc.gov/rodents/diseases/index.html

Lesson 5: Outbreak! Vector-Borne Diseases + Epidemics

Overview

Students explore how diseases can spread between humans and/or other organisms, as well as how medical professionals track what diseases may be spreading and try to prevent more people from getting sick. The concept of epidemics is discussed, then students engage in a real-word simulation to determine the cause of an actual disease outbreak and respond to it. Students then reflect on the activity as it relates to the Centers for Disease Control and Prevention (CDC)'s "Steps of an Outbreak Investigation" in discussion and writing.

Adaptations / extensions are listed at the end of the lesson, including research projects, the creation of comparison diagrams, a class game to help teach the concepts of epidemiology, and videos which can be shared with the students—or produced by them.

Subjects: Science, Health, Reading, Writing, Speaking & Listening, Social Studies

Grades: Adaptable for 4–12

Time: 45–60 min. or more

Vocabulary

- Disease
- Epidemic, epidemiology, and epidemiologist
- Host
- Infection
- Investigation
- Outbreak
- Symptom
- Vector
- Transmission

Lesson Goals

- Increase students' understanding of:
  - How diseases can spread, including the role of vectors such as mosquitoes, flies, ticks, and fleas
  - How epidemic investigations are carried out
  - The scientific steps used to answer questions reliably
  - Factors that can influence data quality
- Provide students with the opportunity to play the roles of epidemiologists and community health professionals as they work to solve real-world mysteries involving the outbreak of diseases
- Explore cause and effect through the process of studying disease outbreaks and their impacts on communities

A screenshot of the "Solve the Outbreak" app from the CDC

Objectives

- Students will brainstorm with a partner about ways diseases spread and how medical professionals track what diseases may be spreading and record their ideas in words and pictures.
- Students will play the role of epidemiologists to solve the mysteries of real-word disease outbreaks and plan the best ways to address them.
- Students will reflect on disease outbreak scenario(s) orally and in writing as they relate to the CDC's "Steps of an Outbreak Investigation."

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Patterns • Cause and Effect • Stability and Change
	Science & Engineering Practices	• Planning and Carrying Out Investigations • Asking Questions and Defining Problems • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence
	Disciplinary Core Ideas	LS2: Ecosystems: Interactions, Energy, and Dynamics LS4: Biological Evolution: Unity and Diversity
Common Core State Standards ELA	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials + Preparation

1. Prepare to demonstrate the "Solve the Outbreak" simulation game, either the app available for free download from the CDC at cdc.gov/mobile/applications/sto or the Web-based version at cdc.gov/mobile/applications/sto/web-app.html.
2. Data projector to display the simulation and links for students
3. Review the additional resources listed in the More Resources / References section at the end of the lesson.

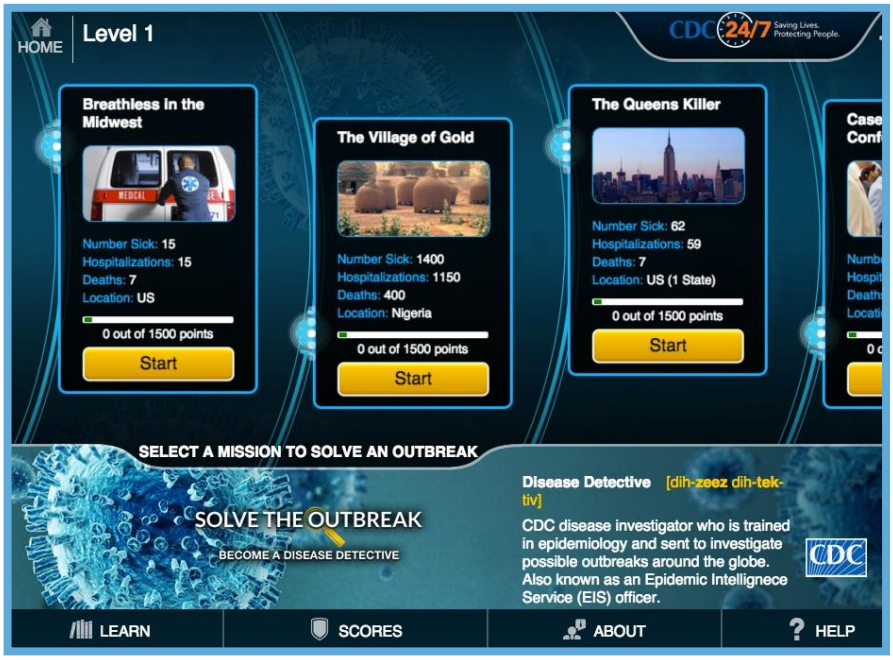
Suggested Procedure

1. Engage students with a quick brainstorming session in pairs about one or more questions designed to activate prior knowledge and prime them for the lesson, such as:
    a. How can diseases spread between humans and/or other organisms?
    b. How do medical professionals track what diseases may be spreading and try to prevent more people from getting sick?

2. Ask students to record their ideas in words and/or pictures on paper or with an electonic device. Circulate through the room, answering any questions. After 1-2 minutes, tell students they have one more minute to brainstorm and that they should be prepared to share one or more of their best ideas with the class.
3. Ask the pairs to share their best ideas and discuss them briefly. Include a review of important vocabulary from earlier lessons in the discussion, such as vector, pathogens, disease, host, and transmission.
4. Write "***EPIDEMIC***"on the board in big, dramatic letters and ask students to raise their hands if they think they know what the word means. After a few moments, call on one of the last students to raise her/his hand and share their ideas. Call on another student or two to share their ideas, as well, and then ask students to think about ways they can try to decode words if they aren't sure what they mean. Someone should suggest looking to see if there is a prefix, suffix, and/or root word they are familiar with and trying to use those as clues to solve the mystery of what the word means. Ask students to each take a moment to break the word down into parts on a piece of paper. Then ask a volunteer to go to the board and break it down there, such as in syllables and/or as "epi-demic."

   Discuss how the word, like many others we use, especially those in science, has its origins in Greek (and Latin that was influenced by Greek). Circle "epi-" and explain that in Greek it meant "upon," "on," "over," "at," or "before." Then circle "-demic" and explain that it comes from the Greek "dēmos" meaning "the people." Discuss how putting the two main parts of the word together to get "upon the people" could help the students know what it means.
   Optional: If the students are engaged and you have time, talk about other words that begin or end in similar ways, such as "epicenter," "epidermis," "epitome," and "epic," as well as "democracy," "demography," "academic," "Democrat," etc.
5. Ask one or more students to look up the definition using respected sources such as the American Heritage Dictionary, available online without distracting ads at ahdictionary.com. Then they can share the authoritative definition(s) with the class, as well.
6. Discuss how one definition of an epidemic is "an outbreak of a contagious disease that spreads rapidly and widely," in the words of the American Heritage Dictionary.
7. Then ask the students if anyone knows what we call a scientist who specializes in the study of epidemics, including the interesting detective work of solving the mysteries about why and how diseases are spreading. Discuss how the suffix "-ologist" is added to make "epidemiologist," the name of the scientist who specializes in the study of epidemics. Ask the students if they know the name of any other professions that end that way, and some should be able to share "biologist," "dermatologist," "entomologist," etc. Then ask students how the suffix changes a little for the name of the field that scientists specialize in; some should share "-ology," like biology or epidemiology, the focus of today's lesson.
8. Tell students they will be playing the role of epidemiologists in simulation games, trying to solve mysteries about how diseases are spreading. They will be using an app on computers or tablets called "Solve the Outbreak," and working with a partner to try to diagnose why sicknesses are spreading and stop them before many more people can get sick.
9. Demonstrate for students how to play the "Solve the Outbreak" simulations via the app available for free download from the Centers for Disease Control (CDC) at cdc.gov/mobile/applications/sto. It can also be played online through any modern web browser at cdc.gov/mobile/applications/sto/web-app.html.

10. We recommend beginning with "Level 1," then choosing "The Queens Killer" simulation; it presents the fascinating true story of how West Nile Virus was first discovered in the United States at the Bronz Zoo and the area surrounding it. There is a text version of the simulation if you'd like to read through the scenario and/or the others in the series before trying the game: cdc.gov/mobile/applications/sto/508STO.html#outbreak9.



A screenshot of the "Solve the Outbreak" app from the CDC

11. Offer suggestions about ways students can get more information and be successful in their new roles as epidemiologists, including exploring the resources in the "Learn" section, accessed by clicking the tab in the lower-left of the game.
12. Tell students that at the end of the exercise they will be reflecting on it in discussion and writing. They should be able to explain how the scenario related to and helped them learn more about the CDC's "Steps of an Outbreak Investigation" explained here: cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html
13. Share the link with students and ask them to take turns reading the steps aloud as a class. Briefly discuss the concepts at each step, which are similar to the steps in any scientific investigation:
    1. Prepare for field work
    2. Establish the existence of an outbreak
    3. Verify the diagnosis
    4. Construct a working case definition
    5. Find cases systematically and record information
    6. Perform descriptive epidemiology
    7. Develop hypotheses
    8. Evaluate hypotheses epidemiologically
    9. As necessary, reconsider, refine, and re-evaluate hypotheses
    10. Compare and reconcile with laboratory and/or environmental studies
    11. Implement control and prevention measures
    12. Initiate or maintain surveillance
    13. Communicate findings
14. When the students complete the exercise, ask them to talk about the scenario with their partner and how it connected with the investigation steps listed above. If there are steps that were not taken in the scenario, ask students what could have been done to help in the investigation,

communicate findings, etc. They can record their ideas for each step in writing, which can be used for evalation.

15. Discuss the activity as a class, asking the pairs of students to share their best ideas about how it helped them to understand each step of an epidemic outbreak investigation. Include a discussion of the ways data was collected and presented in the scenario(s), as well as factors which may have affected the quality of the data. For example, when people are interviewed they do not always remember events clearly, and data collected in a lab may be less accurate due to improper collection techniques, transport, or storage of specimens, so you could ask students how the data quality might have been improved in the scenario(s).

Adaptations / Extensions

- **Students can explore additional mysteries** in "Solve the Outbreak," such as "Sugar Plantation Blues," "Deadlier than War,"and the "Case of the Conference Blues": cdc.gov/mobile/applications/sto/web-app.html
- **Show and discuss one or more short videos about epidemiology and public health**, such as:
    - "John Snow: Pioneer of Epidemiology" from PBS: opb.pbslearningmedia.org/resource/envh10.sci.life.nathis.johnsnow/john-snow-pioneer-of-epidemiology
    - "Mystery Illness in New York City" from PBS: opb.pbslearningmedia.org/asset/midlit11_vid_splwnilea
    - "Mystery Solved! West Nile Virus" from PBS: opb.pbslearningmedia.org/asset/midlit11_vid_splwnileb
    - "Epidemiological Studies - made easy!" youtube.com/watch?v=Jd3gFT0-C4s
    - "What is Epidemiology" (first 53 seconds): https://www.youtube.com/watch?v=mH0Bx92SjE4
    - "What is Public Health??" youtube.com/watch?v=t_eWESXTnic
    - "Global Disease Detectives in Kibera" (5:35): cdc.gov/cdctv/diseaseandconditions/outbreaks/kiberia-disease-detectives.html
- **Read the start of "The Queens Killer" scenario aloud with students.** The text of it and the other scenarios is available here: cdc.gov/mobile/applications/sto/508STO.html#outbreak9.
- **Have students research the history of disease outbreaks** such as malaria, bubonic plague, Lyme disease, cholera, and disentary, and ways the science has been used to control them. Findings could be shared with the rest of the class through oral presentations, research papers, student-created videos, etc.
- **Ask students to compare two vector-borne diseases** and how they are spread using a Venn diagram or another type of diagram. If desired, they can write more detailed explainations of their diagrams in paragraph form. A list of vector-borne diseases with the type of organism that spreads them is available from the World Health Organization: who.int/news-room/fact-sheets/detail/vector-borne-diseases.
- **Students can work in pairs or small groups to create public service announcement videos** about how to stay safe from vector-borne illnesses, such as those they researched.
- **Do a complete simulation in "Solve the Outbreak" as a class** using a data projector to demonstrate the complete process, including how to complete the analysis of the scenario as it

relates to the "Steps of an Outbreak Investigation." Then students can repeat the process using another simulation of their choice on their own.

- **Play the game "What's Lurking in Lunch?"** to teach kids more about epidemiology: askabiologist.asu.edu/whats-lurking-lunch-teachers
- **Student can research careers in public health** and record the required qualifications, daily activities, and organizations that hire individuals in the fields.

More Resources / References

- Centers for Disease Control (CDC) resources:
    - "Solve the Outbreak" lesson plan and supporting resources:
        - Middle grades: cdc.gov/mobile/applications/sto/Lesson_Plan_Middle_School_Level.pdf
        - High school level: cdc.gov/mobile/applications/sto/Lesson_Plan_High_School_Level.pdf
        - Standards alignment for the different scenarios, etc.: docs.google.com/viewer?url=https://www.cdc.gov/mobile/applications/sto/WebVersion_core_curriculum.pdf
        - "Steps of an Outbreak Investigation": cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html
    - Epidemiology in the Classroom: cdc.gov/careerpaths/k12teacherroadmap/classroom/index.html
    - Epidemiology Lesson Plans: cdc.gov/careerpaths/scienceambassador/lesson-plans/epidemiology.html
    - "Teacher Roadmap" website: cdc.gov/careerpaths/k12teacherroadmap/index.html
    - Science Ambassador program: cdc.gov/careerpaths/scienceambassador/lesson-plans/index.html
    - "What is Epidemiology?" definition: cdc.gov/careerpaths/k12teacherroadmap/epidemiology.html
    - "Introduction to Epidemiology." A longer explanation with examples: youtube.com/watch?v=4oaQUAnA6nY
- Lessons from PBS and WGBH:
    - "Epidemiologists: Disease Detectives" opb.pbslearningmedia.org/resource/envh10.health.lp912/epidemiologists-disease-detectives/#.W2wzSMLavgf
    - "Solving a Public Health Problem": opb.pbslearningmedia.org/resource/midlit11.sci.splwnile/solving-a-public-health-problem Student site: lsintspl3.wgbh.org/en-us/lesson/midlit11-sci-splwnile
- More resources from Clackamas County Vector Control District: fightthebites.com/education.
- Learn more about West Nile Virus and its transmission from the Mayo Clinic: mayoclinic.org/diseases-conditions/west-nile-virus/symptoms-causes/syc-20350320

Lesson 6: Fight the Bites! Mapping Mosquito Habitats

Overview

Students participate in a community science project to identify mosquito breeding habitats in their local areas and share the data they collect through the GLOBE Observer program, an international network of youth and professional scientists working together to learn more about our global environment. The data the students collect through the GLOBE Observer app's Mosquito Habitat Mapper will help local scientists with Clackamas County Vector Control District, as well as those across the country and around the world, to identify mosquito habitats and how they might be changing due to factors such as global climate change.

Adaptations / extensions are listed at the end of the lesson, including an introductory video about the project, a reading assignment about a recent study from the Centers for Disease Control and Prevention (CDC) about the dramatic rise in rates of vector-borne illness in recent years, and more ways to share the results of your research.

Subjects: Science, Reading, Writing, Speaking & Listening, Social Studies

Grades: Adaptable for 3–12

Time: 30–40 min. of class time, plus 30 min. or more to conduct the investigation outdoors

Vocabulary

- Collaboration
- Disease
- Infection
- Investigation
- Larvae
- Pathogen
- Pupae
- Research (study) protocol

Lesson Goals

- Increase students' understanding of how mosquitoes breed and ways to control their spread through first-hand research
- Provide students with the opportunity to conduct a scientific investigation in their local community with relevance for helping to reduce the spread of vector-borne illness

Objectives

- Students will brainstorm with a partner about how global climate change may be affecting the spread of vectors such as mosquitoes and the diseases they can transmit, recording their ideas in words and/or pictures.
- Students will work as community-based scientists to gather data about mosquito habitats in their local areas and share it with a global network researchers through the GLOBE Observer app.
- Students will reflect in writing and through class discussion on what worked well with the sampling protocol and technology, and what could be improved to help in the global investigation.

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Patterns • Cause and Effect • Stability and Change
	Science & Engineering Practices	• Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence
	Disciplinary Core Ideas	LS1: From Molecules to Organisms: Structures + Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS4: Biological Evolution: Unity and Diversity
Common Core State Standards ELA	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials + Preparation

1. Prepare to demonstrate the GLOBE Observer app*:* observer.globe.gov. It is available for free download at observer.globe.gov/about/get-the-app.
2. Read through the Mosquito Habitat Mapper tutorial and other resources available at observer.globe.gov/training/mosquitoes.
3. Data projector and ability to connect your smart phone or tablet to it so you can demonstrate for students how to use the Mosquito Habitat Mapper in the *Globe Observer* app.
4. Gather materials for GLOBE Kits which student groups can share, and contact Clackamas County Vector Control at (503) 655-8394 or fightthebites.com/contact-us if you would like help obtaining them; contents listed at globe.gov/web/globe-mosquito-project/overview/globe-kits:
    - Magnifying macro lens that attaches to a mobile device (smart phone or tablet compatible with the GLOBE Observer App)
    - Latex gloves and goggles (to safely collect the water sample)
    - Water bottle, ketchup bottle, turkey baster, or bucket (to collect larvae sample)

- Plastic bag (to transport larvae sample)
- Permanent marker (to write date and location of where sample was taken on the collection bag)
- Ethanol OR hand sanitizer (optional, to euthanize larvae)
- Pipette (to transfer sample from sampling container to plate)
- White plastic plate (to view and count the larvae in your sample)
- Paper towels (to keep the observation area clean and dry)
- Probe (bamboo skewers or toothpicks to help with larvae identification)
- Vial (to store larvae samples - for individuals conducting training workshops)

5. Prepare to take you class outside to do field work, including getting signed permission forms and arranging transportation, if necessary.
6. Review the additional resources listed at globe.gov/web/globe-mosquito-project/overview/for-teachers and those in the More Resources / References section at the end of the lesson.

Suggested Procedure

1. Engage students with a quick brainstorming session in pairs about how global climate change may be affecting the spread of vectors such as mosquitoes and the diseases they can transmit. Ask students to record their ideas in words and/or pictures on paper or with an electonic device.
2. Circulate through the room, answering any questions. After 1-2 minutes, tell students they have one more minute to brainstorm and that they should be prepared to share one or more of their best ideas with the class.
3. After another minute of observing the conversations and answering questions, ask the pairs to share their best ideas and discuss them briefly. Include a review of how mosquitoes breed and relevant vocabulary from earlier lessons in the discussion, such as vector, larve, pupae, pathogens, disease, host, and transmission.
4. Tell students they will be investigating nearby areas to see where mosquitoes might be breeding and collect reliable data. They will be sharing it with Clackamas County Vector Control District scientists, as well as others across the country and around the world, to help identify mosquito habitats, how they might be changing due to factors such as global climate change, and take action to stop their spread.
5. Demonstrate for students how to use the GLOBE Observer app and its Mosquito Habitat Mapper available for free download from observer.globe.gov/about/get-the-app. Explain that they will be using it as part of a global collaboration with other community-based scientists and professional scientists.

6. As explained in the Mosquito Habitat Mapper Tutorial PowerPoint available at observer.globe.gov/training/mosquitoes, show students how they can record reliable data and reduce the threat of mosquitoes through 4 steps:
    - Record time and location
    - Observe and count
    - Identify: Photograph the larvae with a macro lens
    - Eliminate breeding grounds
7. Show students the equipment they will need for habitat mapping, sampling, and identification, listed above in the Materials / Preparation section.
8. Talk about how GLOBE recommends sampling each water source 5 times. Because larvae are not evenly distributed on the surface, they may need several dips to obtain a sample with larvae in it. Then tell students to wait a couple minutes between each dip and ask them why they think that is recommended. Discuss how when the surface of the water is disturbed, the larvae will swim below for safety. However, they will soon return to the surface because they have to breathe.
9. Review ways to stay safe from mosquito bites, such as:
    - Wear long sleeves, pants, socks, shoes, and hats
    - Use insect repellent
10. Talk about how gloves and/or goggles should be used when collecting data if the water where samples are being taken could be polluted.
11. Demonstrate the exact protocol students will be using to collect data. Different sampling methods are shown in the Mosquito Habitat Mapper Tutorial starting on slide 16.
12. Talk about best practices for handling samples:
    - It may be easiest to identify specimens inside
    - Leave air in bags (ask students why)—so that they can breathe
    - Do not keep bags in direct sunlight for too long (overheating will kill larvae)
    - Identify the larvae soon after collection. If left overnight, any pupae in the sample may become adult flying mosquitoes.
    - If you find adult mosquitoes in your sample bag, shake the bag to drown the adult mosquitoes and dispose of the sample by pouring all contents on the ground.
13. Tell students that they should avoid sampling on private property. Samples should be taken in public areas such as school grounds, parks, or their own yards. They should not take samples on private property unless they have gotten permission to do so.

14. If the apps have not already been installed on student electronic devices, share the link with students where they can download them: observer.globe.gov/about/get-the-app.

15. When students return to the classroom, they can finish identifying the larvae they collected and then submitting the data through the app. Discuss the subtle differences that evolved in different mosquito species, and how they can be used to identify the species and the potential diseases that can be spread by them. Useful identification tools they can use for reference include the Mosquito Larvae Identification Chart listed on the GLOBE program's training page: globe.gov/documents/11865/0dcf909a-b4b3-4793-969a-5f88c48fbf26.
    By submitting images of their specimens taken with a macro lens through the GLOBE Observer app, students can also receive help with identificatin through the global netword of experts. Biologists from Clackamas County Vector Control are also available to answer questions:

16. Ask students to reflect on the project in writing. What worked well with the sampling protocol and technology, and what could be improved to help in the global investigation? What was interesting about the project, and how could the student work be helpful for Clackamas County scientists and communities, as well as those around the world? Be sure to tell students that the research is valuable, even if they did not find any mosquito larvae.

17. Discuss the activity as a class to give students the opportunity to share their ideas and reflect as a class about the science and meaningfulness of the project. Include an analysis of how their work could be increasingly important as the threat of vector-borne illnesses increases due to climate change. And discuss why the research is valuable even if no mosquito larve were found.

Adaptations / Extensions

- **Show and discuss the video on the "Crowd & the Cloud" website about a school using the GLOBE Observer**: Mosquito Habitat Mapper program: crowdandcloud.org/globe-observer-mosquito-habitat-mapper
- **Have students review the results of this study by the Centers for Disease Control (CDC)** that found the rate of vector-borne disease increased 300% in recent years: "Illnesses on the rise from mosquito, tick, and flea bites": cdc.gov/vitalsigns/vector-borne/index.html. Discuss the likely causes of the increases and predict what might happen in the future, based on how we respond to the dangers of disease vectors and global climate change.

- **Students can design different experiments to learn more about vectors in your area**, such as one with dry ice and a smart phone's microphone, designed with this fascinating research from Iqbal Pittawalla in mind: How Mosquitoes Are Drawn to Human Skin and Breath: ucrtoday.ucr.edu/19377
- **Students can work in pairs or small groups to create short videos** about their project to share with the rest of the school and/or the wider community.
- **Make presentations to your community about the project(s)** and send invitations to local newspapers and other media outlets. See the next lesson about community presentations for strategies about effective ways to host community events and a rubric to help students prepare effective presentations.

More Resources / References

- Detailed training information about GLOBE Observer's Mosquito Habitat Mapper: globe.gov/get-trained/protocol-etraining/etraining-modules/16867649/12273
- Another excellent training is available at astc.org/wp-content/uploads/2017/05/GlobalExperiment-UsingTheMosquitoHabitatMapperApp.pdf
- More resources from Clackamas County Vector Control District: fightthebites.com/education.
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned: nextgenscience.org/framework-k%E2%80%9312-science-education
- More information about the Common Core State Standards and links to the complete documents: corestandards.org

Lesson 7: Community Presentations + Engagement

Overview

Students create multimedia presentation(s) about vectors such as mosquitoes and/or their mosquito habitat research—or another vector-related project—and it's importance for reducing the threat of disease. In this way, students strengthen their understanding and skills, and magnify their positive impact on the community. This can be both in terms of increased awareness of their scientific investigation, as well as enhanced education of the public about how to reduce the spread of vectors-borne illness. There is also the opportunity to help the community gain better understanding of some of the local impacts of global climate change at this critical moment in history. Creating videos and/or poster presentations are additional options.

Subjects: Speaking & Listening, Science, Reading, Writing, and Art

Grades: Adaptable for 2–12

Time: Will vary

Vocabulary

- Rubric (if you have not used one with the students yet this year)

Lesson Goals

- Allow students the opportunity to share the results of their research and gain experience writing, presenting, and listening to their peers
- Increase public understanding of how mosquitoes breed, ways to control their spread, and how to stay safe from them

Objectives

- Students will create effective multimedia presentations which educate the community about vectors, vector-borne disease, and/or the results of their research.
- Students will present their work to peers and the broader community with the assistance of a rubric to help them enhance their skills and exceed standards.

A student presents about her research project.
Image courtesy U.S. Dept. of Agriculture

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	**Crosscutting Concepts**	• Cause and Effect • Stability and Change
	Science & Engineering Practices	• Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence
	Disciplinary Core Ideas	LS2: Ecosystems: Interactions, Energy, and Dynamics LS4: Biological Evolution: Unity and Diversity
Common Core State Standards ELA	**Speaking & Listening**	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials + Preparation

- Computer access and software such as PowerPoint, Prezi, and/or iMovie to create multimedia presentations and/or videos
- Display screen
- Schedule an event well in advance and, if desired, work with partners to invite community members such as parents, administrators, and other members of the school and broader community, including elected officials.
- Encourage students to dress appropriately when it is time to present to the public.
- Encourage students to incorporate props and/or different types of visuals into their presentations, if possible, such as research tools and/or live magnified mosquito larvae which which can help engage the audience and help convey their points.
- Send invitations to local newspapers and other media outlets.
- *Optional:* Tables for students or partner organizations such as Clackamas County Vector Control or health officials to display information

Suggested Procedure

1. Talk to students about ideas for the format of the community presentations. This will give them the opportunity to incorporate their ideas for the event(s) and have more "buy-in" and enthusiasm for them. For example, what groups do they think should be invited? When should the event be held?
2. Explain to students how they will be working. For example, if you would like them to present with their small groups from their research project, creating a 5-10 minute oral presentation or video about their project (if applicable), etc.. Tell them if engaging multimedia content should be incorporated using software such as PowerPoint, Keynote, or Prezi, and/or if videos can be created using software such as iMovie. Encourage students to conduct additional research to enhance their presentations/videos and bolster their arguments.
3. Pass out copies of the Presentation Rubric found at the end of the lesson to guide student learning and let them know how they will be assessed. Tell students that they will complete the "Self-Score" portion of the rubric and turn it in to you before they present.
4. Discuss what content you would like students to include and/or provide them with a sample outline they can use to help them structure their presentations. For example, instruct students to include details such as:
    - All the elements of their mosquito habitat investigations (if applicable), including visuals,
    - What they learned about mosquitoes and other vectors during the unit, and/or
    - How their field work enhanced what they learned in the classroom.
5. Discussing best practices for multimedia presentations with students while showing them a good example, such as those listed on the Clackamas County Vector Control District's education page: fightthebites.com/education. For example, they should not include too many words on slides, font sizes need to be large enough to be read from the back of a large room, there should be enough contrast between colors, even for those in the audience who may be color blind, etc.
6. If desired, work with partner organizations such as Clackamas County Vector Control or county/state health officials to develop an agenda for the community presentations. Other organizations can also be invited to attend who can staff tables and provide information before the presentations begin and after they are complete.
7. On the day of the event, sit back and watch the students shine!

A student points out an element of his service project.
Image courtesy SOLVE

Adaptations / Extensions

- **Identify students who have photography and/or filming experience** and ask them to use a camera(s) and/or video camera(s) to document the community presentations. Students can then share their presentations with Clackamas County Vector Control, via YouTube, the school website, social media, etc., as allowed by school and district policy.
- **Collaborate with grade level English/Language Arts teachers** to support standards that have been taught in the students' LA classes. Students could do a joint project in which they work on science and literacy together in both their LA and science classes.
- **Students can present to younger students** to teach them about their work.
- **Students can work in pairs or small groups to create short videos or poster presentations** as an alternative to, or in addition to, oral presentations.
- **One or more awards could be presented to outstanding class members**, either individuals or groups. Awards could be for exceptional additional volunteer efforts to reduce mosquito breeding areas, leadership in the field and/or classroom, exceptional education of the public, etc.

More Resources / References

- Professionals can be invited to serve as keynote speakers for community presentation events from organizations such as those listed above.
- More resources from Clackamas County Vector Control District: fightthebites.com/education.
- More information about the Next Generation Science Standards: nextgenscience.org
- More information about the Common Core State Standards: corestandards.org

Name(s): _____ Date: _____

Presentation Rubric

Title: _____

Presentation Component	Maximum Points Possible	Self-Score (fill out before presentation)	Teacher Score
Part 1: Content			
Subject and purpose of presentation clearly introduced	10		
Key concepts identified and clearly explained in well-organized way	10		
Ideas supported by examples, data, graphs, etc.; All information accurate and from reliable sources	10		
Conclusion summarizes key points in persuasive way; Questions answered thoroughly and accurately	10		
Part 2: Delivery / Audience Engagement			
Speech delivered clearly at appropriate volume and speed (not too fast, slow, loud, or soft)	10		
Speed, volume, and voice inflection are varied to engage audience and emphasize key points	10		
Speaker connects with audience through eye contact and does not spend too much time looking at notes or screen	10		
Speaker demonstrates enthusiasm for topic throughout presentation; audience is persuaded by speaker	10		
Part 3: Visuals			
Visuals help to clearly explain concepts	10		
Part 4: Writing Conventions			
Grammatical and spelling conventions followed	10		
TOTALS:	**100**		

Comments:

Glossary

adaptation	a trait of an organism that helps it survive and reproduce; an aspect of its form, function, or behavior that changes over many generations which helps it out-compete other organisms. *Example:* If plants have deep roots, they are more likely to survive and reproduce during dry years. In this way, future generations are more likely to have the adaptation of deep roots, as well.
animal	organism that eats or absorbs nutrients from other organisms, which typically has specialized sense organs and can quickly respond to stimuli
behavioral adaptation	what an organism does which helps it to survive
biodiversity	the variety of life in a community, habitat, or ecosystem
biology	the study of living things
CDC	Centers for Disease Control and Prevention; U.S. agency which seeks to protect the public from health threats, including vector-borne illnesses
climate	the average weather conditions of a place, such as temperature and rainfall levels, over a long period of time
climate change	the change in Earth's global climate or in regional climates over time, particularly the average warming of global temperatures in recent decades and related climate disruptions which scientists attribute to the burning of fossil fuels and other human activities *Rates of vector-borne illnesses have more than tripled in the U.S. recently according to the CDC, and climate change has been cited as a leading factor, because warmer, wetter conditions make it easier for vectors such as mosquitoes and ticks to survive, reproduce, and spread.*
collaboration	working with one or more other people to produce something (verb: collaborate)
common name	a name by which a species is known, rather than its scientific name; can vary by region or country, unlike scientific names
ecological community	(or simply a community): all the organisms in a habitat, which interact in a complex food web; a community is also a group of people who interact
controlled experiment	a scientific test (an experiment) in which only one variable at a time is changed and others are held constant so they will not affect the experiment's outcome; this lets researchers isolate the results
disease	an abnormal health condition of an organism caused by factors such as infection, genetic defect, environmental factors, or a vector such as mosquitoes and ticks; characterized by identifiable symptoms, signs, or both

diversity	a variety of different things; the number of different species, communities, or habitats; can also apply to human communities
ecosystem	a community of organisms (living things such as animals, plants and fung) and nonliving things (such as soil, water, air, sunlight), which interact with one another through a flow of energy and cycling of materials in the environment
epidemic	*noun:* an outbreak of a disease which spreads rapidly and extensively *adjective:* spreading quickly and widely by infection, affecting many individuals in a population
epidemiology	the study of the causes, spread, distribution, and control of diseases
epidemiologist	a scientist which specializes in the study of how diseases spread
engineering design	method used by engineers to identify and solve problems; involves learning about the problem and possible solutions at every stage of the process with a specific goal in mind, planning and designing solutions under constraints, modeling, testing, and improving designs
flea	any of various species of tiny, wingless, bloodsucking insects of the order Siphonaptera that are parasitic on mammals and birds and can jump very long distances relative to their size
flower	the reproductive part of some plants; mosquitoes use nectar from flowers and fruits for energy
food chain	a succession of organisms in an ecological community linked to one another by the transfer of energy and nutrients; most often begins with plants and other organisms which create food from sunlight through the process of photosynthesis
food web	the system of interdependent food chains in an ecosystem
habitat	the place or type of site where an organism lives
host	*meaning used in the curriculum:* an organism on which or in which another organism lives, such as a mammal or bird from which a mosquito sucks blood
hypothesis	a prediction of what might happen in a scientific experiment
infection	the invasion of bodily tissue by microscopic pathogens which proliferate, resulting in tissue injury that can progress to disease
investigation	careful examination or search in order to discover facts or learn new information; inquiry
larva	immature, wingless form of many insects, such as mosquitoes and flies, after they hatch from an egg; the six-legged immature form of a tick or mite after it hatches from an egg

larvae	plural of larva
life cycle	the progression through a series of different stages in an organism's development, from its inception through reproduction
metamorphosis	change in the form and often habits of an animal during normal development of an organism; includes the transformation from larva to pupa to adult in many insects, such as butterflies and mosquitoes
microscopic	so small as to be invisible without a microscope
model	*meaning used in the curriculum:* a representation of something, such as a system or phenomenon, that accounts for its properties and is used to study its characteristics
mosquito	any of numerous species of thin, two-winged insects in the family Culicidae having aquatic larvae; adult females have a long proboscis used by most species for sucking blood
nymph	*meaning used in the curriculum:* the eight-legged immature form of certain arachnids, such as ticks and mites; also describes the immature form of an insect that does not pass through a pupal stage during metamorphosis, such as a grasshopper
organism	individual living thing that can react to stimuli, reproduce, and grow
outbreak	a sudden and dramatic increase in something, such as a disease
pathogen	an agent that causes disease, especially a virus, bacterium, or fungus
photosynthesis	the process in which plants and other organisms produce carbohydrates from carbon dioxide and water, with light as a source of energy
predator	an organism that lives by preying on other organisms
prey	an animal hunted or caught by another for food
proboscis	a thin, tube-like organ in the head region of organisms such as mosquitoes; usually used for sucking and/or piercing
pupa	an insect in the nonfeeding stage between the larva and adult, when it typically undergoes complete transformation within a protective cocoon or hardened case; only insects such as mosquitoes that undergo complete metamorphosis have pupal stages
pupae	plural of pupa
scientific method	the process of systematically testing an idea through these steps: observation of a phenomena, formulation of a hypothesis about it, experimentation to test the

	hypothesis, and development of a conclusion based on evidience which confirms, rejects, or modifies the hypothesis
scientific control	group in an experiment that is not changed so it can be compared with a similar group that is changed
scientific name	the two-part Latin name assigned to a species
species	a particular kind of living thing; the populations of organisms whose members interbreed under natural conditions and produce fertile offspring
stagnant	still; not moving
structural adaptation	physical structure of an organism which helps it to survive
symptom	something that incidates the possibility of a disease
tick	an arachnid which bites warm-blooded vertebrate animals to suck their blood; a dangerous vector on disease to these organisms, including humans
variable	the part of an experiment that changes during the investigation
vector	an organism, such as a mosquito or tick, that carries disease-causing pathogens from one host to another
vector-borne disease	disease spread by a vector
transmission	*meaning used in the curriculum:* the passage of something, such as a disease or a radio signal, between two places
wetlands	areas that are covered with shallow water or have soil saturated with moisture

Youth Permission and Waiver Form

Field Study/Site Location: ____ Date: ____________________

ALL PARTICIPANTS UNDER THE AGE OF 18 WHO ARE UNESCORTED BY AN ADULT MUST HAVE A PARENT OR GUARDIAN SIGN THIS PERMISSION AND WAIVER FORM. Escorted youth may be included by their parent, guardian or authorized adult on the adult registration and waiver form.

This is a waiver and release. Please read it carefully before signing. I am the parent or legal guardian of Participant named below and I, the undersigned, enter this Release and Waiver of liability and Assumption of Risk Agreement ("Agreement") on behalf of myself, the Participant, my personal representatives, next of kin, heirs, successors, and assigns and anyone else who may make any claim for or on behalf of the Participant.

- I will **cause the Participant to agree and comply** with the terms of the Agreement and not to take any actions that would assist or cause the Participant to invalidate, renounce, negate, revoke, or disclaim any part of the Agreement.
- I make this Agreement for the benefit of partner organizations, other individual volunteers, project coordinators, sponsors, suppliers, supporters, and all private and public land owners on whose property the project described above may be located (collectively the "Released Parties), including, without limitation, the Released Parties' employees, agents, personal representatives, next of kin, heirs, successors and assigns.
- I make this Agreement in consideration of the Released Parties providing Participant with the opportunity to **participate as a volunteer** in this project.
- I understand that the Project may include **dangerous or hazardous** activities and that the Project may take place on a location or under conditions that may be dangerous to Participant.
- Participant and I **accept full personal responsibility** for all risks arising from or relating to this Project.
- Participant's involvement in this Project is **completely voluntary** and neither participant nor I have received nor expect to receive any compensation for participation in it.
- Participant will read, listen to and follow all **safety instructions and procedures** presented in conjunction with this Project and **use best judgment** based upon physical and mental abilities at all times, and to immediately terminate participation in this Project if activities become too strenuous, difficult or hazardous.
- I agree to **waive all liability** of the Released Parties, **discharge them, and covenant not to sue them** for any liability, claims, sums, costs, or other expenses on my account that may be caused in whole or in part by Participant's involvement in the Project.
- I agree that this Agreement shall act as a **complete bar against all actions or claims** that I might otherwise bring against the Released Parties, including negligence claims, arising from or related to this project.
- I have read this Agreement, fully understand its terms, understand that I have **given up substantial rights** by signing it, and have **signed it freely** and without any inducement or assurance of any nature. I intend this Agreement to be a **complete and unconditional release of all liability** to the greatest extent allowed by law, and I further agree that if any portion of this Agreement is held invalid, then the balance of the Agreement shall continue in full force and effect.
- I understand that a photographer may be present to photograph the activities at the Project and that Participant may be photographed while participating in the Project. I agree that Participant will contact the photographer if he or she does not wish to be photographed.
- I hereby grant the irrevocable and unrestricted right to **use and publish photographs of Participant**, or in which Participant may be included. I hereby release Photographer and his/her legal representatives and assigns and partner organizations from all claims and liability relating to any such photographs.

Thank you for filling out the form below and signing to give permission for your student to participate in field work. Please print clearly. We would never sell or trade your information.

Name of Participant							
Name of Parent/Guardian							
Relationship to Participant		**Phone**	-	-		☐ **Home** ☐ **Business**	
Address							
City			**State**		**Zip**		
Age of Participant							
Signature of Parent or Guardian: ______________________________	**Date:** __________________						

Are you able to chaperone? ☐ YES ☐ No ☐ Maybe

If so, please indicate your preferred method(s) of contact.

☐ **Email, using address below** (please write your email address in the boxes below)	☐ **Mail, using address above**	☐ **Phone:**
		☐ **Home** ☐ **Business**

Student Feedback

Fight the Bites! Education Program

We want to hear about your experience! Please help us find out what was good and bad about the program. You do not need to put your name on the paper and there are no right or wrong answers.

Please read each statement below and decide if you agree or disagree with the statement.
Put an X in one box in each row.

Statement	Strongly YES	Sort of YES	I'm Not Sure	Sort of NO	Strongly NO
What I did in this program was interesting.					
I think I will remember the things I learned about mosquitoes and other disease vectors.					
I care more about staying safe from disease vectors after participating in this project.					
I can see the connection between this program and the other things I am learning in school.					
I might help dump out standing water and take other steps to reduce the threat of vector-borne disease.					
I might like to enter a career dealing with science because of this program.					

Comments and/or suggestions about the program:

THANK YOU SO MUCH! Your input helps a lot.

Meet the Next Generation Science Standards and Common Core State Standards.

Keep Your Community Safe from Vector-Borne Diseases!

VECTOR CONTROL CLACKAMAS COUNTY

Learn more at

FightTheBites.com/education