



Deadly Messengers



No one likes getting bitten by mosquitoes. But few people in the United States realize that the mosquito is the most dangerous spreader of disease on Earth. From malaria to yellow fever to West Nile virus, mosquito-borne diseases strike millions of people around the world. Malaria alone is estimated to kill one million children under the age of five each year. Yet, mosquito control is possible, and public health workers are working hard to get the upper hand in the battle against mosquitoes and the diseases they carry.

ACTIVITY AT A GLANCE

PURPOSE: To examine mosquitoes as a vector of disease and examine methods for preventing the spread of mosquito-borne diseases

OVERVIEW: Students conduct a role-play to examine how a vector transmits a disease. Next, teams of students research West Nile virus and six mosquito-control techniques. They find at least two arguments in favor of and against each technique and use them to debate the pros and cons of spraying insecticide to control mosquitoes. The class then discusses which combination of techniques might work best to reduce the number of malaria-related deaths around the world.

LEVEL: Grades 7–12

TIME: 2–3 classes

CORE CONCEPTS

- Vectors transmit disease by carrying disease-causing microbes from an infected host to an uninfected one.
- There are many vectors of disease, such as mosquitoes, fleas, and ticks.
- There is disagreement over the best way to eliminate vector-borne diseases.

MATERIALS

- Student sheet for each student
- Bowl of popped popcorn and, for each student, a small paper cup or paper towel
- Access to print and Web resources on West Nile virus and mosquito-prevention programs

STANDARDS CONNECTION

Geography

- Standard 12: Understand the processes and patterns of human settlement.
- Standard 16: Examine the meaning, use, distribution, and importance of resources.
- Standard 18: Apply geography to interpret the present and plan for the future.

Social Studies

- Standard VIII c: Analyze how technology and science influence the attitudes of society.
- Standard VIII d: Evaluate policies that have been proposed as ways of dealing with social issues resulting from new technologies.
- Standard VIII e: Recognize and interpret varied perspectives about human societies.
- Standard IX d: Analyze the causes, consequences, and possible solutions to persistent global issues such as health.

Health

- Standard 1: Comprehend concepts related to health promotion and disease prevention.
- Standard 2: Access valid health information and health-promoting products and services.
- Standard 3: Practice health-enhancing behaviors and reduce health risks.
- Standard 4: Analyze the influence of culture, media, technology, and other factors on health.
- Standard 5: Use interpersonal communication skills to enhance health.
- Standard 7: Advocate for personal, family, and community health.

PROGRAM CONNECTION

Vector-borne diseases—those that rely on insects and animals to spread infectious agents—have long posed a serious threat to public health. For example, the Bubonic Plague killed millions of Europeans in the Middle Ages. The virus was carried by rats and transmitted to people by the fleas living on the rats. Today, the most dangerous vector on Earth is the mosquito. From malaria to yellow fever to West Nile virus, mosquito-borne diseases compromise the health of millions of people around the world. In fact, mosquitoes transmit the majority of new diseases that have surfaced in the past 25 years. The program, “Deadly Messengers,” recounts the stories of the heroic scientists and health workers who battled against the mosquito.

This activity examines current efforts to control mosquitoes and the range of views concerning these control measures.

BEFORE WATCHING

- Review the following terms:
organism: an individual life-form, such as a plant, animal, fungus, or protozoa
host: an organism on or in which another organism lives
vector: an organism, such as a mosquito or tick, that does not cause disease itself but which spreads infection by carrying disease-causing microbes, such as viruses, bacteria, and plasmodia, from one host to another. Vector is the Latin word for a “bearer.”
- Ask if anyone has gotten sick due to an insect bite. Insect-borne diseases include Lyme disease, West Nile virus, Rocky Mountain spotted fever, encephalitis, and malaria. Explain that for these diseases, the disease-carrying insects are the vectors for the disease-causing microbes. Ask if students can guess what organism is the most dangerous vector on Earth.
The mosquito is the most dangerous vector on Earth.
- Review how and why mosquitoes bite people.
Female mosquitoes use blood to help their eggs develop. They insert a sharp proboscis into the skin and inject an anticoagulant to help the blood flow easily. This exchange of fluids is how disease-causing microbes enter a host.



FOR MORE INFORMATION

[pbs.org/rxforsurvival](https://www.pbs.org/rxforsurvival)

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AFTER WATCHING

- Have students brainstorm steps they can take to avoid being bitten by mosquitoes, including:
 - Wear long-sleeved clothing and long trousers and apply a repellent containing DEET on exposed skin and thin clothing.
 - If sleeping outdoors, use a mosquito net (preferably treated with insecticide).
 - Discourage mosquitoes from entering an area by using window screens, spraying insecticides, or burning insecticide-impregnated tablets and coils.
 - Eliminate standing water anywhere around your property, such as in birdbaths and gutters.
- Ask why diseases that are transmitted from human to human are not considered vector-borne.
Some diseases are transmitted directly from one person to another without requiring a vector as an intermediary. Thus, while the common cold, flu, and measles are infectious diseases, they are not considered vector-borne diseases because they can be transmitted directly from person to person.
- Have students act out how the diseases they identify are transmitted from host to host.
Vector-borne diseases have three components: a disease-causing microbe, a host in which the microbe lives (e.g., deer, humans, rodents), and an organism that transmits the microbe to a new host. For a vector-borne disease to spread, a vector must carry the disease-causing microbes from one host to another.

continued

AFTER WATCHING (continued)

- Ask students to identify vector-borne diseases found in their community (e.g., Lyme disease, Rocky Mountain spotted fever, West Nile virus, Eastern equine encephalitis, and plague). Ask students to list ideas for reducing the risks of getting insect-borne diseases.

Answers might include: Applying pesticides to kill insects; reducing the number of vectors through integrated pest management; eliminating breeding areas; and protecting people with repellent, netting, and appropriate clothing.

- Have students draw a flow chart or make a poster about the ecology of mosquitoes. Where do they breed? (*In standing water*) What animals eat mosquitoes? (*Birds, bats, insects, frogs*) In what parts of the day do mosquitoes prefer to come out? (*Dawn and dusk*)
- Many experts believe that controlling malaria will require the involvement of entire communities. Discuss what this means.

Controlling vectors is a large-scale, widespread effort that works best when everyone does his or her part, such as eliminating mosquito-breeding areas and avoiding mosquito-infested areas.

PROCEDURE

1. Use the following role-play to explore how a vector transmits disease-causing microbes and to brainstorm ways to halt the spread of vector-borne disease.
 - Distribute a small paper cup or paper towel to each student.
 - Designate one student as the vector and give him or her a bowl of popped popcorn, which represents a disease-causing microbe.
 - Give the vector 30 seconds to put popcorn into as many empty cups or paper towels as possible. Infecting a student requires at least five kernels because not every mosquito carries disease-causing microbes and increased exposure increases the risk of getting sick. After the vector has finished the round, count how many students became infected.
 - Identify the components of the disease cycle. *The popcorn is the disease-causing microbe. The person carrying the popcorn is the vector. The new host is a student with at least five pieces of popcorn.*
 - Brainstorm ways to prevent popcorn from getting into the individual cups. *Answers may include: covering the empty cups, which represents using insect repellent or nets to prevent being bitten by an infected insect; preventing the vector from delivering the popcorn, which represents applying an insecticide or eliminating breeding areas; and emptying the small cups of popcorn, which represents curing an ill person.*
2. To help students understand that eradicating mosquitoes can raise sensitive issues, have them research West Nile virus and the issue of mosquito control. Student teams should fill out the table on the student sheet with at least two arguments for and against each of the six techniques listed in the first column. They can find discussions of the pros and cons by visiting the suggested Web sites, contacting state extension, health, or fish and wildlife agents, or reading articles published in periodicals.
3. While still working as a team, have each student complete questions 2–6 on the student sheet.
4. Conduct a discussion after the class completes questions 2–6. Designate one wall or area of the classroom as “Pro-Spraying” and another wall or area as “Opposed to Spraying.” Students then “vote with their feet” by standing in one of the areas. Standing in the middle and saying “I see both sides” is not permitted. Once students have voted, call on an individual to explain the reasoning behind his or her choice. Other students can ask clarifying questions. Next, call on a student with an opposing view. Continue the discussion, letting students on each side alternatively express their views. Once all views have been shared, ask whether the discussion changed anyone’s thinking and if anyone wants to change his or her vote. See the Assessment section for answers to the questions and for key discussion points.
5. Have students write a paragraph stating how they voted and why. Have them support their reasoning based on the team research and class discussion.
6. Discuss student answers to questions 5 and 6 on the student sheet.

GOING FURTHER

- Controlling mosquito breeding often involves a discussion of water quality issues. Wetlands, ponds, and rivers are often sources of drinking water. They are also the breeding grounds for mosquitoes. Have students map the route that water takes from where it falls as rain to the water tap at school. How does it get to your school? How might regional spraying programs impact the quality of your drinking water? Every community has a department assigned to oversee water purity and distribution. Have a student or two call this department for maps and other water-related information.
- Have students research one of the insect-borne diseases below.

DISEASE	VECTOR
Chagas Disease	Assassin Bugs
Dengue Fever	Mosquitoes
Filariasis (elephantiasis)	Mosquitoes, Blackflies
Leishmaniasis	Sandflies
Lyme Disease	Ticks
Malaria	Mosquitoes
Onchocerciasis (River Blindness)	Black Flies
Plague	Rodent fleas
Rabies	Mammals
Relapsing Fever	Ticks and Lice
Rift Valley Fever	Mosquitoes
Sleeping Sickness	Tsetse Flies
Typhoid Fever	Ticks and Lice
Viral Encephalitis	Mosquitoes, Ticks
Yellow Fever	Mosquitoes

- Have a student call the local public health agency to ask what the local disease vectors are and what is being done to control them. Also, find out its recommendations for eliminating mosquito-breeding sites around the home.
- Have students research the story of how malaria was eradicated from the United States after the Second World War. This information is available online, in books about health, public health, and malaria, which can be found at the library.
- Play the following classroom games to explore the health conditions around the world and some of the issues related to delivering health care. Download these free games at pbs.org/wgbh/rxforsurvival/campaign/givetime/index.html.
 - *Investing Your Money Wisely*: If you were advising a government on how to spend its limited healthcare budget, how would you keep the largest possible number of people healthy? In this game, you decide which public health measures should be put in place first. (Activity type: Debate. Duration: 30 minutes. Requires a table. Preparation time: 15 minutes.)
 - *Growing Up Healthy*: How easy is it for a child to grow up healthy without an adequate public health care system? Find out how challenging it can be! (Activity type: Board game. Duration: 10 minutes. Requires tabletop. Preparation time: 15 minutes.)
 - *Unfair Race*: How much of an impact does where you live have on your health? Players assume the roles of different countries and examine the extent to which one's country can help or hinder one's health. (Activity type: Group experience. Duration: 15 minutes. Requires a large room or outdoor space. Preparation time: 20 minutes.)

ASSESSMENT

Students' responses to the questions on the student sheet should incorporate the points discussed in the answers (included in this section). In addition, consider the following when assessing student work:

- Participated in the role-play in a cooperative manner.
- Supported the team by contributing to the discussion, listening to others' ideas, discussing a variety of views, and helping the team develop a consensus.
- Used an adequate number of appropriate sources when researching mosquito-control techniques.
- Understood different points of view about controlling mosquitoes and can discuss the pros and cons of each position.
- Wrote thoughtful responses to student sheet questions and based conclusions on a variety of information.
- Offered thoughtful recommendations for controlling mosquitoes and reducing the number of malaria-related deaths of children under the age of five.
- Demonstrated an understanding of mosquitoes as a vector of disease and how controlling them and preventing the spread of mosquito-borne diseases is a crucial global health issue.

1.

METHOD FOR INSECT CONTROL	HOW METHOD WORKS	ARGUMENTS FOR	ARGUMENTS AGAINST
Spray pesticides	Uses chemicals to kill mosquitoes (larvae and adults)	<ul style="list-style-type: none"> • <i>Lethal and effective</i> • <i>Easy to apply</i> • <i>Covers large area</i> 	<ul style="list-style-type: none"> • <i>Kills all insects and some small animals indiscriminately</i> • <i>Poison can get into food chain</i> • <i>Expensive</i> • <i>Spray can drift into untargeted areas</i>
Conduct surveillance	Tracks population and uses pesticides once numbers reach a certain level	<ul style="list-style-type: none"> • <i>Monitors actual situation</i> • <i>Identifies appropriate time to take action</i> • <i>Inexpensive</i> 	<ul style="list-style-type: none"> • <i>Permits a certain background level of mosquitoes</i> • <i>May delay action until too late</i>
Disrupt ability to breed	Eliminates ideal breeding conditions, such as eliminating standing water and draining wetlands	<ul style="list-style-type: none"> • <i>Many pools of standing water easily eliminated</i> • <i>Eliminates breeding site for many mosquitoes</i> • <i>Non-toxic</i> • <i>Effective</i> 	<ul style="list-style-type: none"> • <i>Depends on quality of public participation</i> • <i>Cannot drain all breeding areas</i> • <i>Draining wetlands alters these ecologically important areas</i>
Use biological controls	Increases numbers of predators that eat mosquitoes (larvae and adults)	<ul style="list-style-type: none"> • <i>Non-toxic</i> • <i>Effective</i> 	<ul style="list-style-type: none"> • <i>Cannot stock all breeding areas</i> • <i>Predators will only eat a certain proportion of the mosquitoes</i> • <i>Can introduce non-native species into ecosystem</i>
Trap mosquitoes	Lures mosquitoes to a place where they can be captured	<ul style="list-style-type: none"> • <i>Designs that work well becoming more available</i> 	<ul style="list-style-type: none"> • <i>Cannot trap all mosquitoes</i> • <i>Requires lots of traps</i> • <i>Labor intensive</i>
Use repellent, window screens, and insecticide-treated netting	Keeps mosquitoes off an individual	<ul style="list-style-type: none"> • <i>Prevents people from being bitten</i> • <i>No public monies spent</i> 	<ul style="list-style-type: none"> • <i>Not a control method</i> • <i>Unreliable</i>

2. Describe why West Nile virus is a problem.

About one in 150 people infected with West Nile virus develops severe illness. Symptoms can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness, and paralysis. Symptoms may last several weeks, and neurological effects may be permanent.

3. Why can spraying to control mosquitoes be a controversial issue?

While spraying is an easy way to treat a large area and is an effective way to kill mosquitoes, pesticides are toxic and can get into the food chain. Spray can kill insects and animals other than mosquitoes and can drift into untargeted areas, posing a potential risk to people and pets that are sensitive to insecticides.

RESOURCES

RELATED *RX FOR SURVIVAL* WEB SITE FEATURES (see pbs.org/rxforsurvival)

Why Global Health Matters: Learn why we should all be involved in global health initiatives.

Global Health Atlas: Access health profiles of nations and the incidence of vector-spread disease.

Deadly Diseases: Learn about some of most feared vector-borne diseases.

Global Health Champions: Learn about men and women who have profoundly changed global health outcomes and saved lives in many parts of the world.

Get Involved: Find meaningful ways to take action.

Dispatches from the Field: Hear first-person accounts from people on the frontlines of health care.

LINKS

American Mosquito Control Association
mosquito.org

Find the answer to almost any question on mosquitoes as a threat to public health.

Beyond Pesticides
beyondpesticides.org

Weigh the benefits of mosquito control against the potential harm of pesticides, and learn what alternatives to spraying are currently available.

The Centers for Disease Control
cdc.gov/ncidod/dvbid/westnile

Collect background information on outbreaks, surveillance, and control of the West Nile Virus.

City of Fort Worth
fortworthgov.org/health/HP/Mosquito_Spray2002.asp

See why the city of Fort Worth has not sprayed for mosquitoes since 1991.

Illinois Department of Public Health
idph.state.il.us/envhealth/factsheets/psreduction.htm

Find out what you can do to prevent insect-borne disease in and around your home.

National Biological Information Infrastructure
westnilevirus.nbi.gov

Provides data, information, and maps related to outbreaks of the West Nile virus.

New Jersey Mosquito Biology and Control
rci.rutgers.edu/~insects/ipm.htm

Uncover the many different methods of environmentally conscious mosquito control.

U.S. Environmental Protection Agency
epa.gov/pesticides

Learn about pesticide policy and where to get more information about spraying in your area.

BOOKS

Bitten: True Medical Stories of Bites and Stings

Pamela Nagami. New York: St. Martin's Press, 2004.

Hear true stories of people and animals bitten by a wide variety of creatures—from rats to fleas to komodo dragons!

The Black Death Thomas Streissguth. San Diego: Greenhaven Press, 2004.

Delve into vivid primary-source accounts of one of the most terrifying pandemics in human history.

Malaria Mick Isle. New York: Rosen, 2001.

Relive the history of this crippling disease and see the present-day havoc it still wreaks in the developing world.

Silent Spring Rachel Carson. Cambridge, MA: Riverside Press, 1962.

Read the impassioned call for environmental awareness that sparked an entire movement.

West Nile Virus Phillip Margulies. New York: Rosen, 2004.

Take a detailed look at the surveillance, symptoms, and prevention of this ever-growing threat.



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Deadly Messengers

1. Your team will research the issues related to controlling mosquitoes to stop the spread of West Nile virus. West Nile is a potentially deadly disease. Pesticides are toxic. Is it worth the risks associated with spraying pesticides in order to eliminate mosquitos, which may carry the West Nile virus?

DID YOU KNOW?

Usually, a virus only adapts itself to a few types of mosquito. The West Nile Virus, however, can adapt itself to over 30 different mosquito species.

METHOD FOR INSECT CONTROL	HOW METHOD WORKS	ARGUMENTS FOR	ARGUMENTS AGAINST
Spray pesticides	Uses chemicals to kill mosquitoes (larvae and adults)		
Conduct surveillance	Tracks population and uses pesticides once numbers reach a certain level		
Disrupt ability to breed	Eliminates ideal breeding conditions, such as eliminating standing water and draining wetlands		
Use biological controls	Increases numbers of predators that eat mosquitoes (larvae and adults)		
Trap mosquitoes	Lures mosquitoes to a place where they can be captured		
Use repellent, window screens, and insecticide-treated netting	Keeps mosquitoes off an individual		

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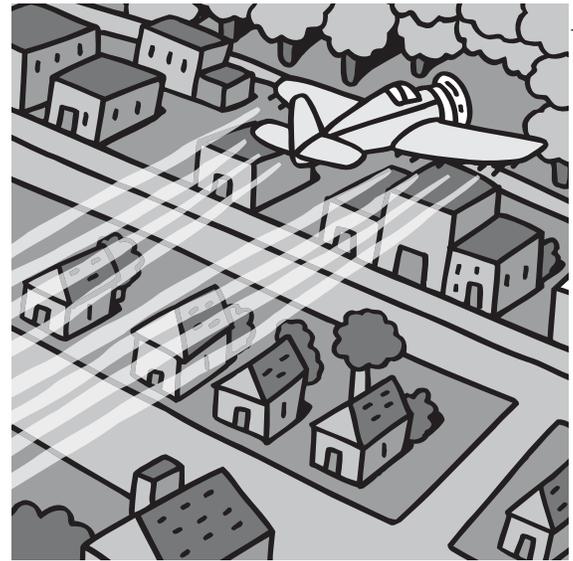
DID YOU KNOW?

The legend of the werewolf may have come from the strange behavior of people in the Middle Ages who were bitten by rabies-carrying wolves.

2. Describe why West Nile virus is a problem.

3. Why can spraying to control mosquitoes be a controversial issue?

4. Based on your team's work, what is your recommendation for controlling mosquitoes?



DID YOU KNOW?

Every 30 seconds, a child dies from mosquito-borne malaria.

5. Malaria is transmitted by mosquitoes and each year kills over one million children under the age of five, primarily in the tropics. Describe which technique or combination of techniques might work best to reduce this number. In your approach, what is the balance between eliminating mosquitoes and taking individual action to avoid getting bitten?

6. Explain whether the technique you described in question 5 could be implemented on a large scale in the tropics where malaria-carrying mosquitoes are widespread.

DID YOU KNOW?

The first known plague epidemic began in Egypt in 542 AD.



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