

# *Teaching Materials on Infectious Diseases*

## *MEDICAL MYSTERIES*



### *Mission 4: Malady at Mabufo*

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**MEDMYST** is a product of the Center for Technology in Teaching and Learning, Rice University and is supported by funds from the National Center for Research Resources, National Institutes of Health, Science Education Partnership Award (R25 RR15295) and funds from the National Institute of Allergy and Infectious Disease (R25 AI062762).

# ***MISSION BRIEFING: Contents***

## ***OVERVIEW***

We hope that you and your students extend the ***MEDMYST*** adventures with the activities designed to cover related learning objectives. The activities described are intended for use both **before** and **after** students have “played” missions of ***MEDMYST***. The files may be printed for classroom use **ONLY**. They consist of mini-labs that can be done with relatively little equipment or expense.

Feel free to adapt these activities to your own classroom needs. Another resource that we suggest is the National Institutes of Health (NIH) web site at <http://www.nih.gov/>. It contains some excellent resources and teaching materials.

If you have specific questions, please contact us.

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## ***MISSION BRIEFING***

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## ***MISSION DEBRIEFINGS***

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## ***MISSION BRIEFING:* Mission Synopsis**

**This synopsis is provided as an overview for TEACHERS. We advise teachers NOT to hand this out to the students prior to playing the adventure since much of the suspense will be eliminated.**

The mission begins with Beta, Delta, Eureka, and the player on their last day of vacation at *Roboland*, an amusement park. The player has a chance to try out his/her piloting skills against Beta in the game, *Mars Lander*. After this game, the team proceeds to the *Vectorama* arcade, a game designed to introduce the player to vectors (organisms, usually insects that transmit diseases to humans).

After completing the *Vectorama* game, the team ends their vacation and returns to work at the Center for Disease Control and Prevention in Neuropolis. The team's leader, Alpha, shares an incoming message from Sirius, a public health officer stationed in Africa. There is an outbreak of malaria in the region of Mabufo. The team is needed immediately to help with treatment and prevention efforts. The player gets an overview of the worldwide impact of malaria, through a short quiz. Prior to leaving Neuropolis, Beta calls in to report that her daughter is ill and she cannot go to Mabufo.

On the flight to Africa, Eureka shows the player a short segment about investigations in the 1800s to discover the cause and transmission of malaria. Included is a re-enactment of one of the experiments linking mosquitoes to malaria. Two of the three scientists that are introduced won a Nobel Prize for their work. Dr. Alphonse Laveran discovered that malaria is caused by a protozoan parasite. Dr. Ronald Ross and Dr. Patrick Manson worked out the transmission between humans and mosquitoes. At the conclusion of the interactive, there is a quiz to summarize the contributions of the three scientists.

Upon arriving at Mabufo, the player is introduced to Kamili (local doctor) and Sirius (public health officer). Both Kamili and Sirius need help. If the player selects Sirius, he/she receives training in mosquito control. The training includes a short video about the stages in the life cycle of the mosquito. The video is followed by a training game called *Mosquito Massacre*. The objective of the game is to kill the stage of mosquito with the appropriate weapon -- a water pump for draining breeding sites of eggs, larvae, and pupae; a larvacide for killing larvae; and insecticide for killing adult mosquitoes.

If the player selects Kamili, he/she goes to the clinic and is introduced to the symptoms and treatment of malaria. The *Plasmodia Invaders* segment teaches the player that malaria plasmodia invade red blood cells and cause a toxin to be released which results in a cyclic high body temperature. In *Immune System*, the player sees the body's reaction to the invasion with responses from B-cells, antibodies, and phagocytes. The player shows what he/she has learned by answering training review questions. The next game, *Plasmodia Invasion*, shows the body being invaded while the player tries to fight off the plasmodia. Following that game, *Plasmodia Invasion 2* shows how much easier it is to battle the invaders when anti-malarial drugs are present.

## ***MISSION BRIEFING:* Mission Synopsis**

After reviewing the player's knowledge of malaria symptoms, Kamili asks for help identifying patients with the illness. A phone call interrupts and the caller reports that Eureka never arrived with the supplies. It appears that Eureka is being held ransom in exchange for diesel fuel the rebels need, but fortunately, the robot escapes and reports the mission of delivering supplies was completed. The work of spraying and delivering bed nets continues and the scene flashes forward two months. The Reconstructors are going home after a successful mission. Delta hopes next time no one is kidnapped in the process!

# ***MISSION BRIEFING:* Correlation with Standards**

## **National Science Education Content Standard Correlation Grades 5-8**

<b>Instructional Objectives “Malady at Mabufo”</b>	<b>Science Content Standard</b>
<ul style="list-style-type: none"> <li>Conduct a virtual experiment to explain how the malaria parasite is transmitted through mosquitoes to humans.</li> </ul>	<p><b><u>Science as Inquiry</u></b></p> <p><b>Content Standard A: All students should:</b></p> <ol style="list-style-type: none"> <li>Develop abilities necessary to do scientific inquiry</li> <li>Understand about scientific inquiry</li> </ol>
<ul style="list-style-type: none"> <li>Relate how the protozoan <i>Plasmodium</i> interacts with the human body and the <i>Anopheles</i> mosquito to cause malaria.</li> </ul>	<p><b><u>Life Science</u></b></p> <p><b>Content Standard C: All students should develop an understanding of:</b></p> <ol style="list-style-type: none"> <li>Structure and function in living systems</li> <li>Reproduction and heredity</li> <li>Regulation and behavior</li> <li>Population and ecosystems</li> <li>Diversity and adaptations of organisms</li> </ol>
<ul style="list-style-type: none"> <li>Describe the symptoms and treatment for malaria.</li> <li>Describe ways to prevent the spread of malaria (mosquito control and anti-malarial drugs).</li> <li>Comprehend the prevalence and worldwide problem of controlling malaria.</li> </ul>	<p><b><u>Science in Personal and Social Perspectives</u></b></p> <p><b>Content Standard F: All students should develop understandings of:</b></p> <ol style="list-style-type: none"> <li>Personal health</li> <li>Populations, resources, and environment</li> <li>Natural hazards</li> <li>Risks and benefits</li> <li>Science and technology in society</li> </ol>
<ul style="list-style-type: none"> <li>Associate specific scientists—Laveran, Ross, and Manson— with the early investigations into the cause and transmission of malaria.</li> </ul>	<p><b><u>History and Nature of Science</u></b></p> <p><b>Content Standard G: All students should develop understandings of:</b></p> <ol style="list-style-type: none"> <li>Science as a human endeavor</li> <li>Nature of science</li> <li>History of science</li> </ol>
<ul style="list-style-type: none"> <li>Summarize the storyline.</li> </ul>	<p>NA</p>

## ***MISSION BRIEFING:* Correlation with Standards**

### National Health Standard Correlation Grades 6-8

Instructional Objectives “Malady at Mabufo”	Health Content Standard
<ul style="list-style-type: none"> <li>Conduct a virtual experiment to explain how the malaria parasite is transmitted from mosquitoes to humans.</li> </ul>	<p><b>Standard 1:</b> Students will comprehend concepts related to health promotion and disease prevention to enhance health.</p>
<ul style="list-style-type: none"> <li>Relate how the protozoan <i>Plasmodium</i> interacts with the human body and the <i>Anopheles</i> mosquito to cause malaria. .</li> </ul>	<p><b>Standard 1:</b> Students will comprehend concepts related to health promotion and disease prevention to enhance health.</p>
<ul style="list-style-type: none"> <li>Describe the symptoms and treatment for malaria.</li> </ul>	<p><b>Standard 1:</b> Students will comprehend concepts related to health promotion and disease prevention to enhance health.</p>
<ul style="list-style-type: none"> <li>Describe ways to prevent the spread of malaria (mosquito control and anti-malarial drugs).</li> </ul>	<p><b>Standard 5:</b> Students will demonstrate the ability to use decision-making skills to enhance health.</p>
<ul style="list-style-type: none"> <li>Comprehend the prevalence and worldwide problem of controlling malaria.</li> </ul>	<p><b>Standard 1:</b> Students will comprehend concepts related to health promotion and disease prevention to enhance health.</p>
<ul style="list-style-type: none"> <li>Associate specific scientists--Laveran, Ross, and Manson-- with the early investigations into the cause and transmission of malaria.</li> </ul>	<p>NA</p>
<ul style="list-style-type: none"> <li>Summarize the storyline.</li> </ul>	<p>NA</p>

## ***MISSION BRIEFING:* Vocabulary Terms**

Vocabulary terms that are fundamental to understanding the concepts included in Mission Four are listed below. Some of the words will be encountered while playing Mission Four. They are hot-linked in the mission so you can click on them and get the definition as you play.

**Anemia** - a condition in which there is a reduction in the number of healthy red blood cells to carry oxygen to the body's tissues. It can result from blood loss, iron deficiency, and from certain infectious and inherited diseases. Some symptoms of anemia are fatigue, pale skin, dizziness, shortness of breath, chest pain, and coldness in the arms and legs.

**Anopheles mosquitoes** - a genus of mosquito that has several hundred species. Only mosquitoes of this species can transmit malaria to humans. Worldwide there are over 370 species of *Anopheles* mosquito, yet fewer than 40 species are responsible for transmitting malaria.

**Antibody** - also known as an immunoglobulin, it is a protein produced in response to a foreign substance or germ.

**Anti-malarial medication** - drugs used to prevent or treat malaria. The right medicine depends on a variety of factors.

**Endemic** - a disease that is constantly present to some degree in a population of a particular location or region. Malaria is endemic currently in parts of Africa, Latin America and Asia and was once endemic in the United States.

**Immune system** - The body's principal defense network. The immune system defends the body in many ways. Some of its defenses are classified as nonspecific because they work against all pathogens. The immune system also has specific defenses that can target a particular germ.

**Infectious disease** - a disease caused by an infectious agent. The currently known types of infectious agents are bacteria, viruses, helminthes, protozoa, fungi, and prions.

**Liver** - the largest organ inside the body, it is about the size of a football in adults and about the size of a grapefruit in children. The liver controls cholesterol, makes bile, processes vitamins, removes toxins from the blood, produces hormones, as well as performs hundreds of other important functions.

## ***MISSION BRIEFING:* Vocabulary Terms**

**Malaria** – a vector-borne disease common in hot, tropical areas. It is caused by a single-celled parasite (plasmodium) carried by the *Anopheles* mosquito. Chills, recurrent high fever, and anemia are some of its symptoms. Malaria was eradicated from the United States in the 1950s, but it remains a major health problem in many developing countries.

**Parasite** - an organism that lives in or on another organism (the host) and causes it harm. Leeches, malaria plasmodia, pinworms, and athlete's foot fungus are examples of this type of organism.

**Phagocyte** - a type of white blood cell that engulfs and digests germs. Examples of phagocytes are monocytes and macrophages. Monocytes circulate in the blood. When they migrate into tissues, these cells turn into macrophages.

**Plasmodia** - one-celled parasites that cause malaria. The singular is plasmodium. There are four types of plasmodia that can infect humans: *Plasmodium ovale*, *P. falciparum*, *P. vivax*, and *P. malariae*. *Plasmodium falciparum* can cause severe complications and even death. Between 700,000 and 2.7 million people a year are killed by this organism. The majority of these deaths occur in young children in Africa.

**Protozoan** - a type of simple single-celled organisms such as the amoeba and paramecium. Some have flagella or cilia and are capable of rapid movement. Protozoans can spread through food, water, or animals.

**Toxin** – any poisonous substance. Malaria parasites make glucose phosphate isomerase (GPI) and other toxic chemicals that act to produce the chills, shaking, and fever characteristic of the disease.

**Vector** - An organism, often an insect or rodent, which carries disease. Some examples are mosquitoes, ticks, flies, fleas, mites, and rats.

**Vector-borne disease** - a disease transmitted to a human by an organism. Examples of vector-borne diseases include malaria, West Nile virus, dengue fever, and Lyme disease.

# *MISSION BRIEFING* Mission Log

## Teacher Version

**Teacher Directions:** Ask students to fill in the clues in the answer column as they proceed through the mission.

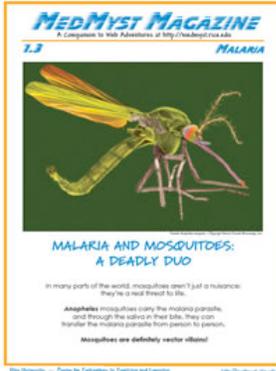
Question	Answer
1. In the game <i>Vectorama</i> , record two of the matches you make and list the disease the vector transmits.	1. deer tick/ lyme disease 2. body louse/typhus (or tsetse fly/sleeping sickness, Anopheles mosquito/malaria, rat flea/plague, Culex mosquito/West Nile virus)
2. How many people die each year from malaria?	over a million
3. Match the achievement to the scientists on the right: a. Discovered that a mosquito carried a parasite that caused disease b. Discovered that red blood cells had a one-celled organism living in them c. His experiments proved that Anopheles mosquitoes can carry the malaria parasite	<u>b.</u> Laveran <u>a.</u> Manson <u>c.</u> Ross
4. What is unique about mosquitoes that bite?	They are adult females only.
5. In <i>Plasmodia Invaders</i> , the malaria parasite invades the liver and then destroys red blood cells. If too many red blood cells are destroyed, the patient can get _____.	anemia
6. In <i>Immune System Defenders</i> , B-cells make special chemicals called _____ that recognize a _____	antibodies specific invader
7. "Phagocyte" means _____	eating cell
8. The immune system causes the body to respond to the flood of toxins released by _____.	increasing its temperature
9. What do anti-malarial drugs do to fight the disease?	They wipe out the plasmodia.
10. How did Eureka escape?	Eureka put the guards to sleep by showing them files of Latin and Greek terms.

## *MISSION BRIEFING* Mission Log

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Directions:** Record your observations by finding the clue that correctly matches each description. Write down the clues as you proceed through the mission.

Question	Answer
1. In the game <i>Vectorama</i> , record two of the matches you make and list the disease the vector transmits.	
2. How many people die each year from malaria?	
3. Match the achievement to the scientists on the right: a. Discovered that a mosquito carried a parasite that caused disease b. Discovered that red blood cells had a one-celled organism living in them c. His experiments proved that Anopheles mosquitoes can carry the malaria parasite	<p>_____ Laveran</p> <p>_____ Manson</p> <p>_____ Ross</p>
4. What is unique about mosquitoes that bite?	
5. In <i>Plasmodia Invaders</i> , the malaria parasite invades the liver and then destroys red blood cells. If too many red blood cells are destroyed, the patient can get _____.	
6. In <i>Immune System Defenders</i> , B-cells make special chemicals called _____ that recognize a _____ _____	
7. "Phagocyte" means _____	
8. The immune system causes the body to respond to the flood of toxins released by _____.	
9. What do anti-malarial drugs do to fight the disease?	
10. How did Eureka escape?	



## Activity 1: Read All About It!

The following activities are intended to accompany *Malaria*, Volume 1.3 of MedMyst Magazine. It is available at <http://medmyst.rice.edu>. Click For Educators, then MedMyst Original, then Mission 4, then Teacher Materials, then MedMyst Magazines. You may download and/or photocopy the number of magazines you need or may order a set from the information given on that page.

### Background

These reading activities are designed to help students understand non-fiction text. They represent a strategy to be used before, during, and after reading the magazine.

### Learning Objectives

The students will:

1. Complete Part 1 of the Anticipation Guide (Activity 1a) before reading the magazine. Part 2 of the Guide will be completed after reading the magazine. Students will compare their ideas before reading to actual facts they learn after reading the text.
2. Be able to illustrate the cycle of malaria transmission from mosquito to human and back to mosquito (Activity 1b).
3. Collect information on malaria from the text and use the information to write a script for a radio broadcast (Activity 1c).

### Materials

#### For Activity 1a

1. *Malaria*, Volume 1.3 of *MedMyst Magazine*: one copy per student
2. *Student Activity Guide 1a*: one copy per student

#### For Activity 1b

1. *Malaria*, Volume 1.3 of *MedMyst Magazine*: one copy per student
2. Markers and white dry erase boards or poster paper for each group of 3-5 students

#### For Activity 1c

1. *Malaria*, Volume 1.3 of *MedMyst Magazine*: one copy per student
2. *Student Activity Guide 1c*: one copy per student
3. Paper and pencil

## Procedure

Before class:

1. Copy *Student Activity Guides 1a* and *1c*, making one copy for each student.
2. Obtain one copy of *Malaria*, Volume 1.3 of MedMyst Magazine, for each student.

During class:

### Activity 1a—Anticipation Guide for *Malaria*

**Part 1:** Pass out copies of Activity 1a to each student. Do NOT allow students to read the magazine yet. In the column labeled “Before Reading: Agree or Disagree,” students should write the word “agree” or “disagree” next to each of the statements. Having the teacher or students read the statements out loud is often a good technique. Responding to these questions before they read helps the students to identify misconceptions they might have regarding malaria.

**Part 2:** After reading the magazine and doing Activities 1b and 1c, students should complete the column labeled “After Reading: Agree or Disagree.” Discuss findings as a class.

### Activity 1b—Picture It!

**Part 1:** Arrange students into groups of 3-5. Random mixing is not important, so grouping them in the desk areas where they usually sit is fine. Have students read page 3 of the magazine out loud in their groups, either by taking turns or by having a volunteer read.

**Part 2:** Give each group a marker and a white dry-erase board or a large piece of paper on which they can create their visual. Write the following task on the board: *Your group will create a visual representation of the steps in malaria transmission. You may use words, arrows, and pictures to show what happens. Begin with an infected mosquito biting an uninfected person. Hint: Check out paragraph one on page 3 under “Here’s how malaria works.”*

As students finish, the teacher can do quick assessment checks to see if each group has shown the following sequence: infected mosquito bites uninfected person → parasite transferred to person → parasite migrates to person’s liver → parasite develops in liver → parasite enters the bloodstream and goes into a red blood cell → another mosquito bites the infected person and picks up the parasite → parasite moves from the mosquito’s stomach to its salivary glands → mosquito bites a person and transfers the infection to them → the cycle begins again!

Groups will finish at different times. As groups finish, they could be assigned the task of brainstorming ways to prevent the cycle from continuing. Most students will not be aware of the actual measures taken to prevent malaria. Some may think to read further in the magazine to find answers, while others may talk over ideas of their own.

When groups have finished, the teacher could allow some or all of the groups to present their visuals.

### **Activity 1c—Spread the News!**

**Part 1:** In this activity, students will read the magazine pages they have not yet covered. They will focus on gathering enough good facts to create a two minute, written radio broadcast. The scenario is that a fictitious radio station has decided to allow a short broadcast to raise awareness of malaria’s causes, symptoms, and treatments. The broadcast may also include the past history of the disease and a cool fact or two that people may not know. Students will need to summarize key facts for each of the categories as they read. A handout for taking notes is provided, but students could also use their own notebook paper with some instruction on setting it up for structured note taking.

**Part 2:** Students will use their notes to create the radio broadcast script. Encourage them to be authentic and creative as they write; they don’t want the listener to “change the station” on them! Model creative starts for them, such as, “This is Mrs. Jones from radio station WBUZ with the buzz on a disease you may think is a thing of the past. That’s right, malaria....., etc.” You can keep the project simple by letting each student write their own broadcast and deliver it to a small group of students, or you can choose some of the better broadcasts for students to read aloud to the class. You could expand the project by actually letting students group together and record their broadcasts. Some schools may have the option of presenting the best broadcast in the morning announcements or as part of a school news segment.

# *MISSION DEBRIEFING*: Teacher Guide

## ( TEACHER VERSION )

### Student Activity Guide: 1a

#### Anticipation Guide for *Malaria*, Volume 1.3 of MedMyst Magazine

Name \_\_\_\_\_

**Directions: Part 1--** In the column labeled “Before Reading: Agree or Disagree,” write the word “agree” OR “disagree” next to each of the statements. **Part 2—**As you read the magazine, you will find answers to the statements in the text. In the column labeled “After Reading: Agree or Disagree,” write the word “agree” OR “disagree” next to each of the statements. You may be surprised by some of the malaria facts!

<i>Before</i> reading: Agree or Disagree	<i>After</i> reading: Agree or Disagree	
		1. Malaria can be spread from person to person. <i>Malaria is not contagious (p. 3).</i>
		2. Malaria affects at least one out of every 10 people in the United States. <i>Malaria is now almost non-existent in the US (p. 3).</i>
		3. Malaria is a problem for 41% of the world’s population. <i>Malaria is still a problem for 41% of the world’s population (p. 3).</i>
		4. Although malaria can make people feel really sick, it is not life-threatening. <i>In many areas, especially those close to the equator, malaria is a life-threatening problem (p. 3).</i>
		5. Once a person gets malaria, there is no treatment that can help. <i>Mild malaria can be treated with oral medications. Severe malaria requires hospitalization (p. 4).</i>
		6. The mosquito lays its eggs in the water. <i>Mosquitoes lay eggs on top of standing water (p. 4).</i>
		7. Fortunately, the U.S. does not have the type of mosquitoes that carry malaria. <i>Some of the mosquito species that are capable of carrying malaria are present in the United States, so there is a constant risk that it could be reintroduced (p. 6).</i>
		8. All people would benefit from getting a malaria vaccination. <i>Vaccine development is progressing very slowly. Some vaccines are now being tested, but further research is needed (p. 8).</i>

**( TEACHER VERSION )**  
**Student Activity Guide: 1c**  
**Spread the News!**

Name \_\_\_\_\_

**Directions:** Your task is to gather information about malaria so you can write a script for a two minute radio broadcast. Our “fictitious” radio station has decided to allow this broadcast as a public service to raise awareness of malaria’s causes, symptoms, and treatments as well as some of the past history of the disease and a cool fact or two that people may not know.

Write “bullets” of information below. Try to put the facts in your own words.

## **Malaria’s Causes**

- **An *Anopheles* mosquito is the vector for the disease.**
- **An infected mosquito passes malaria to a human in its saliva as it bites.**
- **A microscopic parasite called a plasmodium transfers the disease.**

## **Malaria’s Symptoms**

- **Shaking chills, high fever, sweating**
- **Fevers typically rise and fall in a predictable pattern.**
- **Severe malaria symptoms include an inability to eat or drink, diarrhea, convulsions, and confusion.**

## **Malaria's Treatments**

- **Oral medicines can kill the parasite.**
- **In severe cases, anti-malaria medications can be given intravenously in a hospital.**
- **Malaria patients who develop anemia may require blood transfusions.**

## **Malaria's Past History**

- **The French abandoned the building of the Panama Canal after 30,000 workers died from mosquito-borne diseases.**
- **The United States sent Dr. William Gorgas to Panama, where he treated standing water to kill mosquitoes and used screened areas to protect people. He was able to reduce the incidence of malaria.**
- **Malaria was eradicated from the United States in the 1950s, but it still reappears occasionally.**
- **In the past, DDT was used to kill mosquitoes in the US, but it is banned here now because of environmental issues.**

## **Additional Facts about Malaria**

- **Malaria is a higher risk in warm tropical areas, but two of the mosquito species that carry malaria still live in the U.S.**
- **Vaccinations are being developed and tested for malaria prevention.**
- **Simple and cheap things like draining standing water and using bed nets over people sleeping at night can help prevent malaria.**
- **International travelers should take malaria-preventing medicine before leaving home. They should use insect repellent and avoid fruity perfumes.**

## Student Activity Guide: 1a

### Anticipation Guide for *Malaria*, Volume 1.3 of MedMyst Magazine

Name \_\_\_\_\_

**Directions: Part 1--** In the column labeled “Before Reading: Agree or Disagree,” write the word “agree” OR “disagree” next to each of the statements. **Part 2—**As you read the magazine, you will find answers to the statements in the text. In the column labeled “After Reading: Agree or Disagree,” write the word “agree” OR “disagree” next to each of the statements. You may be surprised by some of the malaria facts!

<i>Before</i> reading: Agree or Disagree	<i>After</i> reading: Agree or Disagree	
		1. Malaria can be spread from person to person.
		2. Malaria affects at least one out of every 10 people in the United States.
		3. Malaria is a problem for 41% of the world’s population.
		4. Although malaria can make people feel really sick, it is not life-threatening.
		5. Once a person gets malaria, there is no treatment that can help.
		6. The mosquito lays its eggs in the water.
		7. Fortunately, the U.S. does not have the type of mosquitoes that carry malaria.
		8. All people would benefit from getting a malaria vaccination.

**Student Activity Guide: 1c  
Spread the News!**

**Name** \_\_\_\_\_

**Directions:** Your task is to gather information about malaria so that you can write a script for a two minute radio broadcast. Our “fictitious” radio station has decided to allow this broadcast as a public service to raise awareness of malaria’s causes, symptoms, and treatments as well as some of the past history of the disease and a cool fact or two that people may not know.

Write “bullets” of information below. Try to put the facts in your own words.

**Malaria’s Causes**

- 
- 
- 

**Malaria’s Symptoms**

- 
- 
- 

**Malaria’s Treatments**

- 
- 
-

**Malaria's Past History**

- 
- 
- 

**Additional Facts about Malaria**

- 
-



## Activity 2: It's Raining Again?!

Using real data from one particular location, students will interpret a graph that relates rainfall to the number of cases of malaria.

### Background

The relationship between climate and malaria is complex. Climatic factors such as daily minimum and maximum temperatures, humidity, and rainfall influence both the size of the mosquito population and the maturation of the malaria parasite. This activity focuses on the timing and intensity of the annual rainy season, which is one of the factors affecting malaria in Africa.

Zimbabwe is a landlocked country in southeastern Africa. Its population is approximately 13 million people. In some parts of Zimbabwe, malaria is endemic, so there are always many cases of the disease at any given time. In other parts of Zimbabwe, the number of cases increases and decreases dramatically, depending on the season. The summer rainy season, which lasts from November until April, coincides with a great increase in the number of cases of malaria.

The data for this activity comes from the Hwange area, where malaria is a seasonal problem. Because rainfall and malaria case data are both available, researchers (and students) can make a connection between the two.

*Anopheles* mosquitoes require water in which to breed. Large amounts of rainfall increase the number of breeding sites available to the mosquito, especially if the rain falls in a short period of time so that it's more likely to create large puddles. When rainfall has been heavy, breeding sites are likely to remain long enough for the mosquito to complete the aquatic part of its life cycle. If rainfall is accompanied by warm temperatures, this leads to a lot of additional mosquitoes, and having more mosquitoes means that there are more opportunities for people to be bitten by a mosquito that is carrying the malaria parasite.

### Learning Objectives

The students will:

1. Interpret a graph depicting two variables which change with respect to time.
2. Discuss the relationship between the amount of rainfall and the number of malaria cases.

### Materials

1. Student Activity Guide, one per student
2. **two** markers, **one red** and **one blue**, for each student or group of students
3. map of Africa, optional
4. overhead of completed graph, optional

## MISSION DEBRIEFING: Teacher Guide

### Procedure

Before class:

1. Make one copy of the *Student Activity Guide*, "It's Raining Again?!" for each student and one copy of the graph, "Monthly Malaria Cases and Rainfall in Hwange, Zimbabwe."
2. Obtain a map of Africa. One is available at <http://www.clickandlearn.com/GIFFiles/WhiteAfr.gif>

During class:

1. Briefly introduce malaria and the mosquito life cycle.
2. To help orient students, locate Zimbabwe on the map of Africa.
3. Have students complete the *Student Activity Guide*, "It's Raining Again?!" individually. Next, have them share their answers with a partner. You may need to introduce the concept of a graph with information on the left and right sides if they are not familiar with that style.
4. Discuss the answers to the worksheet as a class.

The actual data graphed on the student graph is listed below for your reference. This data is provided courtesy of Moshe Hoshen at the University of Liverpool.

Month and Year	Monthly Total Rainfall (mm)	# of Malaria Cases
Oct 1995	0.71	2,280
Nov 1995	0.87	3,200
Dec 1995	38.99	2,800
Jan 1996	151.67	3,000
Feb 1996	134.74	9,600
Mar 1996	189.86	19,200
Apr 1996	406.50	39,000
May 1996	7.11	35,000
Jun 1996	8.18	14,000
Jul 1996	15.70	6,400
Aug 1996	0	4,080
Sep 1996	0	5,000
Oct 1996	0	4,480
Nov 1996	0.51	5,520
Dec 1996	17.63	4,400
Jan 1997	124.92	4,160
Feb 1997	55.86	4,880
Mar 1997	241.19	11,520
Apr 1997	162.08	14,840
May 1997	134.19	19,000
Jun 1997	0	10,000
Jul 1997	1.02	8,800
Aug 1997	0	4,800
Sep 1997	0	5,400
Oct 1997	0	5,600
Nov 1997	5.77	5,320
Dec 1997	46.37	5,120

## **Teacher Key: It's Raining Again?!**

The gray circles represent monthly rainfall. With your blue marker, connect the gray circles. On the figure legend, draw a blue line next to the monthly rainfall entry.

The y axis on the left side shows the monthly rainfall in mm. Draw over this y axis in blue.

1. Which month had the highest amount of rainfall?  
**April 1996**
2. During 1996, which months had the lowest recorded rainfall?  
**August, September and October 1996 (some may include November)**
3. About how much rain fell in March 1997?  
**241 mm**
4. Is rainfall consistent from month to month?  
**No, it varies greatly.**

The black triangles represent the number of malaria cases recorded.

With your red marker, connect the black triangles. On the figure legend, draw a red line next to the “number of malaria cases” entry.

The y axis on the right side shows the number of malaria cases. Draw over this y axis in red.

5. During which month were the most malaria cases seen?  
**April 1996**
6. What is the lowest number of malaria cases?  
**About 2,300**
7. How many malaria cases were seen in June 1997?  
**About 10,000**
8. Is the number of malaria cases consistent from month to month? Explain.  
**No, it varies greatly, but it never reaches zero.**
9. The months between December and May are the rainy season. During which rainy season did the largest number of malaria cases occur?  
**1995 -1996**
10. The increase in the number of malaria cases happens a few weeks after the beginning of the rainy season. Why?  
**It takes time for the mosquitoes to grow, for the parasite to be transmitted from mosquito to human, and for the disease to cause symptoms and be diagnosed in the human.**
11. Scientists predict that climate change will lead to changes in the amount and timing of rainfall. This might cause the length of the rainy season to change in parts of the world. What do you think the effect of a shorter rainy season would be on the number of malaria cases?  
**A shorter rainy season would probably mean fewer cases of malaria.**

## **Extension Activities**

*Mathematics* – Calculate the total rainfall (mm) during the first rainy season (Dec-May, '95-'96) and compare it to the total rainfall during the second rainy season (Dec-May, '96-'97). Calculate the average rainfall for 1996 and 1997.

*Science* – Research ways to reduce the number of malaria cases. Recommend solutions depending on the season.

## **Standards**

National Science Education Standards, Grades 5-8

- Science Content Standard A: All students should develop abilities necessary to do science.
- Science Content Standard C: All students should develop understanding of the diversity and adaptations of organisms.
- Science Content Standard F: All students should develop understanding of personal health.
- Science Content Standard F: All students should develop understanding of science and technology in society.

## **Reading Material for Teachers**

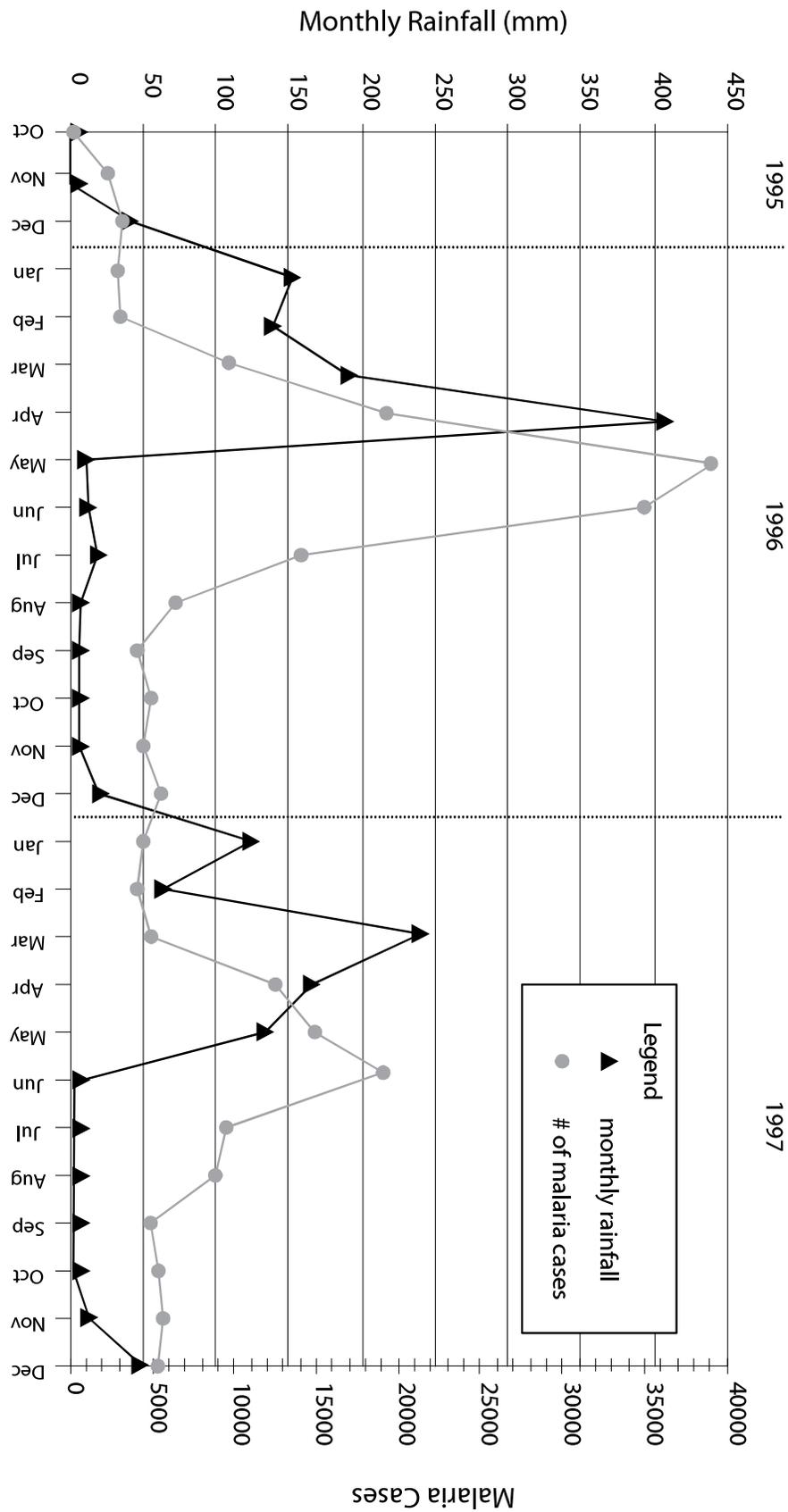
- Spielman, A. and D'Antonio, M. 2001. Mosquito: A Natural History of Our Most Persistent and Deadly Foe. New York: Hyperion. This book provides a good layman's introduction to mankind's interaction with mosquitoes. It includes extensive information on the history and life cycle of malaria.
- Dunavan, CP 2005. "Malaria." *Scientific American*, December 2005, p. 76-83. This article is an excellent overview of current efforts to prevent and treat malaria. It includes a life cycle graphic.

## **Reading Material for Students**

- Dunavan, CP 2005. "Malaria." *Scientific American*, December 2005, p. 76-83. This article is an excellent overview of current efforts to prevent and treat malaria. It includes a life cycle graphic. This article is most appropriate for strong readers.

## **Web sites**

- <http://www.epa.gov/globalwarming/kids/climateweather.html>  
This site by the Environmental Protection Agency gives a basic overview of weather, climate, and how people might be changing the earth's climate. It is geared toward children.
- <http://www.exploratorium.edu/climate/index.html>  
The Exploratorium in San Francisco includes data on and explanations of different aspects of climate and climate change. This site is geared toward adults.





Name \_\_\_\_\_

## Activity 2: It's Raining Again?!

In some parts of the world, the number of malaria cases varies according to the season. You will use data from one area of Africa to determine the relationship between malaria and rainfall.

### Materials

1. one red and one blue marker
2. Copy of the handout *Monthly Malaria Cases and Rainfall in Hwange, Zimbabwe*

### Procedure

Using the graph, complete the steps below and answer questions where indicated. Use complete sentences when the answer is longer than just a single word or number.

The gray circles represent monthly rainfall. With your blue marker, connect the gray circles. On the figure legend, draw a blue line next to the “monthly rainfall” entry.

The y axis on the left side shows the rainfall in millimeters (mm). Draw over this y axis in blue.

1. Which month had the highest amount of rainfall?
2. During 1996, which months had the lowest recorded rainfall?
3. About how much rain fell in March 1997?
4. Is rainfall consistent from month to month?

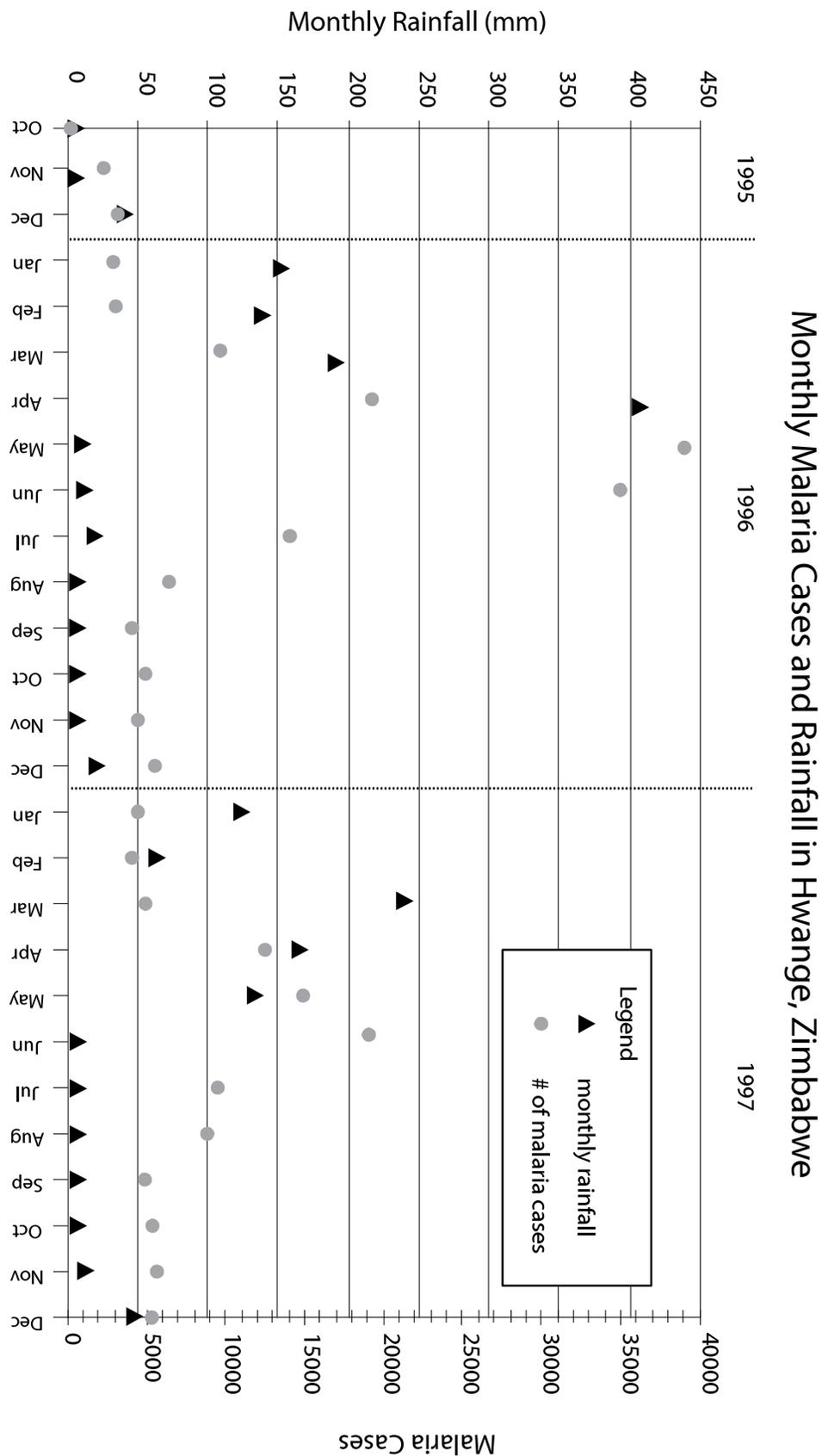
The black triangles represent the number of malaria cases recorded. With your red marker, connect the black triangles. On the figure legend, draw a red line next to the “number of malaria cases” entry.

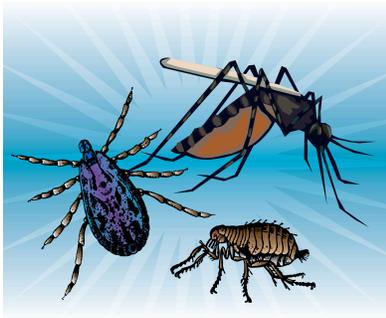
The y axis on the right side shows the number of malaria cases. Draw over this y axis in red.

5. During which month were the most malaria cases seen?

## ***MISSION DEBRIEFING:* Student Activity Guide**

6. What is the lowest number of malaria cases?
  
7. How many malaria cases were seen in June 1997?
  
8. Is the number of malaria cases consistent from month to month? Explain.
  
9. The months between December and May are the rainy season. During which rainy season were the most number of malaria cases recorded?
  
10. The increase in the number of malaria cases happens a few weeks after the beginning of the rainy season. Why?
  
11. Scientists predict that climate change will lead to changes in the amount and timing of rainfall. This might cause the length of the rainy season to change in parts of the world. What do you think the effect of a shorter rainy season would be on the number of malaria cases? Explain your answer.





## Activity 3: Vector Villains

The students will learn how some insects act as vectors that carry a disease. They will then create a "Wanted Poster", complete with a rap sheet of details for their fictitious insect vector. Will it be one of the "baddest" of the bad and make the list of the "Ten Most Wanted?"

### Background

Vectors are organisms that transmit diseases. The vectors are not affected negatively by the disease. Examples of vectors are flies, mites, fleas, ticks, rats, and dogs. The most common vector for disease is the mosquito. Mosquitoes transfer disease through the saliva which comes in contact with people or animals when they are withdrawing blood. Mosquitoes are vectors for infectious disease like malaria, West Nile virus, dengue fever, and yellow fever.

Vectors add an extra dimension to disease transmission. Since vectors are mobile, they increase the transmission range of a disease. Changes in vector behavior will affect the transmission pattern of a disease. It is important to study the behavior of the vector as well as the disease-causing microorganism in order to establish a proper method of disease prevention. In the case of malaria, insecticides are sprayed and breeding grounds for mosquitoes are eliminated in an attempt to control the spread of malaria.

Biting is not the only way vectors can transmit diseases. Diseases may be spread through the feces of a vector. Microorganisms could also be located on the outside surface of a vector (such as a fly) and spread through physical contact with food, a common touch surface, or a susceptible individual (mechanical transmission).

### Learning Objectives

The student will:

1. increase their awareness of insect vectors and the methods these insects use to transmit disease by researching different vector-borne diseases
2. demonstrate his/her understanding of insects as vectors and insect adaptations by creating a fictitious insect with characteristics similar to actual insect vectors.

### Materials

1. Copies of Student Activity Guides: Vector Villains: "The Ten Most Wanted" for each student
2. Colored Pencils or Markers

### Procedure

## ***MISSION DEBRIEFING:*** Teacher Guide

1. **Before class time:** Copy the student guide, Vector Villains: “The Ten Most Wanted” for each student. If the assignment value is NOT 100 points, make sure you fill in your own chosen “point value” in the rubric before making copies. If your copy machine will copy 11 x 17 sized papers, it is very effective to copy the Mug Sheet and Rap Sheet side-by-side on the front of a page, and then copy the Student Activity pages called Vector Villains: “The Ten Most Wanted” side-by-side on the back. The directions and grading rubric are accessible to students and the picture and rap sheet can be hung up and displayed easily.
2. **During class:** Introduce the concept of vector borne diseases and ask each student or a small group of students to select a vector-borne disease to research and report back to the class on key facts about that disease and mode of transmission. The chart below is a good start.

[Note: Many other animals, such as spiders and some mammals, can be vectors for diseases, but the following chart focuses only on insect vectors. You may want to check out insect books from the library or show them pictures from the web (go to Yahoo.com and click on Images, type in the names of the insects listed below and there are images of each available) so students can see some of the many adaptations of insects before they create a composite, fictitious drawing of their own.]

Insect Vector	Disease it transmits	More details
Mosquito ( <i>Anopheles</i> )	Malaria	All human malaria is spread by a female <i>Anopheles</i> mosquito that needs a supply of blood in order to produce and lay eggs. This mosquito becomes infected by taking blood from infected individuals. The malaria parasite reproduces inside the infected mosquito forming a sac with thousands of new malaria parasites. As a mosquito bites, it injects infected saliva into a person who will then develop malaria.
Mosquito ( <i>Aedes</i> )	Dengue ( <b>deng</b> -gey or gee) fever	The mosquito is a carrier of the virus from one person to another. This disease is found in tropical or subtropical areas predominately. There are over 100 million cases each year.
Mosquito ( <i>Aedes</i> )	Heartworm disease	Heartworm is a <a href="#">parasitic roundworm</a> that is spread from <a href="#">host</a> to host through the bites of <a href="#">mosquitoes</a> . The heartworm affects <a href="#">dogs</a> , <a href="#">cats</a> , <a href="#">wolves</a> , <a href="#">coyotes</a> , <a href="#">foxes</a> , and some other animals, such as <a href="#">ferrets</a> , <a href="#">sea lions</a> , and even <a href="#">humans</a> . The parasitic worm is called a "heartworm" because the parasite, in the final reproductive stage of its <a href="#">life cycle</a> , resides in the <a href="#">heart</a> of its host where it can stay for many years and may even kill its host through <a href="#">congestive failure of the heart</a> .
Flea ( <i>Xenopsylla</i> )	Bubonic plague	Plague is an infectious disease that is caused by bacteria. It is carried from animals to humans by a flea that bites an infected animal and then bites a human. Outbreaks of plague occur both in rural areas and in cities worldwide. In the U.S., a few cases occur in rural areas. It can be treated with antibiotics.
Mosquitoes	West Nile Virus	The West Nile virus is transmitted between animal and human hosts via blood-feeding vectors such as ticks and

## ***MISSION DEBRIEFING:*** Teacher Guide

		mosquitoes.
Flies	Cholera	Flies can transmit food-borne diseases such as cholera and typhoid. They breed in organic wastes, refuse, and animal excrement. They carry disease agents from feces to our food. This vector uses mechanical transmission rather than a bite.
Tsetse fly ( <i>Glossin</i> )	Trypanosomiasis (sleeping sickness)	Sleeping sickness is an infectious parasitic disease carried by tsetse flies and characterized by inflammation of the brain and the covering of the brain (meninges).
Triatomine bugs (kissing bugs)	Chagas' disease	Chagas disease is an insect transmitted disease caused by a protozoan parasite. It is spread by reduvid (kissing or triatomine bugs) and is one of the major health problems in South America. Due to immigration, approximately 500,000 people in the United States are believed to be infected.
Mosquitoes	Filariasis	A parasitic worm causes this disease. The female worm lays eggs in the person's bloodstream. A mosquito ingests the larvae when it bites and then passes the parasite to an uninfected person. 120 million people worldwide are affected. The disease causes severe disfigurement (such as elephantiasis) more often than death.

3. Explain to the students that they will be creating a fictitious insect vector with characteristics based on actual insect vectors. Show the model "Rap Sheet" and "Mug Sheet" for a real vector—the mosquito—that is included at the end of the Teacher Guide pages. This model is based on an actual vector so the rap sheet does not model highly creative responses. You may want to have students use their textbook or another source (have them cite their source for a bibliography) for additional information on actual insects and their characteristics so they can base their drawings on composite characteristics of these. See the Book section or the Web Sites listed at the end of the Teacher Guide for additional references.
4. Distribute the Student Activity Sheet called "The Rap." Explain that a Rap Sheet is a list of information about a criminal. They will develop both the "Rap Sheet" information and draw the "Mug Shot" picture of the insect. Creativity is encouraged but they must also meet the criterion that has been listed in the directions on "The Rap" page of the Student Activity Sheet. If you would like for them to use a Latin Etymology (word origin) sheet to create their scientific name, you may print a list of science related word meanings from the following link:  
[http://en.wikipedia.org/wiki/Latin\\_and\\_Greek\\_roots\\_in\\_English](http://en.wikipedia.org/wiki/Latin_and_Greek_roots_in_English)
5. Make sure the students are familiar with the concept of binomial nomenclature (two-word Latin or Greek origin names) in science.

6. Optional: The focus of this activity is for students to learn about insect vectors that carry disease. Many insects are important in positive ways, too. If you would like to emphasize that aspect of insects, you could offer an extension activity where students design nominees for Time Magazine Entomology Issue: “Bug of the Year” award. These could be based on actual insects they research, or you could introduce actual insects and let the students design fictitious “Bug of the Year” entries as modeled in the previously described activity. Benefits of insects are outlined at this web site: <http://www.si.edu/RESOURCE/FAQ/nmnh/buginfo/benefits.htm>

### Extension Activities

- *Science/Art:* Create “Wanted Posters” or “Bug of the Year” posters for actual insects.
- *Health:* Research the effectiveness of prevention measures used to combat the vector borne diseases listed.
- *Social Studies:* Research information about some of the vector borne diseases listed. Create a spreadsheet that shows geographical occurrences, number of cases, mortality rate, and other interesting facts about the diseases.
- *Language Arts:* Using the Latin word meaning list, create a story about a vector borne disease occurrence. Within your story, use “mystery words” you create from a combination of Latin prefixes, root words, and suffixes.

### Standards

National Science Education Standards, Grades 5-8

- Science Content Standard C: All students should develop understanding of structure and function in living systems.
- Science Content Standard C: All students should develop understanding of diversity and adaptation of organisms.
- Science Content Standard F: All students should develop understanding of personal health.

### Books:

Nuridsany, Claude, and Marie Perennon. Microcosmos: the Invisible World of Insects. New York: Stewart, Tabori and Change, 1996.

McGavin, George C. Bugs of the World. New York: Facts on File, 1993.

Wyborny, Sheila. Parasites!--the Malaria Parasite. San Diego: Kidhaven, 2005.

## **Web Sites:**

- Vector-borne diseases

<http://www.cdc.gov/ncidod/dvbid/>

- Diseases caused by insects

<http://www.si.edu/resource/faq/nmnh/buginfo/diseases.htm>

- Facts about insects

<http://content.scholastic.com/browse/article.jsp?id=4628>

- Incredible insects

<http://www.si.edu/RESOURCE/FAQ/nmnh/buginfo/incredbugs.htm>

- Mosquito information

<http://www.mosquito.org/mosquito-information/index.aspx>

- Arthropod borne diseases in the United States

<http://www.kcom.edu/faculty/chamberlain/arthro.htm>

## The Rap Sheet

<b>Common name:</b>	Mosquito
<b>AKA :</b>	“Mo Skeeto”
<b>Scientific name and its meaning:</b>	<u>Anopheles quadrimaculatus</u> which means “hurtful with four dark spots on the wings”
<b>Description:</b>	Mosquitoes are insects belonging to the order Diptera, the True Flies. Like all True Flies, they have two wings, but unlike other flies, mosquito wings have scales. Female mosquitoes' mouthparts form a long piercing-sucking proboscis. Males differ from females by having feathery antennae and mouthparts not suitable for piercing skin.
<b>Diet:</b>	A mosquito's principal food is nectar or a similar sugar source. The female requires a blood meal before laying eggs.
<b>Habitat:</b>	These pesky villains must have water as part of their life cycle habitat but they also live on land as adults. The reason they have various habitats is because mosquitoes go through four separate and distinct stages in their life cycle: Egg, Larva, Pupa, and Adult. Eggs are laid one at a time on the water surface. They hatch to form larva which live and feed in the water and come to the surface for oxygen. The pupa stage is in a water habitat and this is where they develop into an adult which hatches and can live on land.
<b>Wanted for:</b>	Spreading diseases such as malaria that cause the death of one person every 40 seconds worldwide; other species spread dengue, yellow fever, filariasis, and encephalitis diseases such as West Nile Virus.
<b>Usual victim</b>	Mosquitoes prey on humans and animals who might be near mosquito habitat in the evenings
<b>Expected punishment:</b>	The danger of these villains is hopefully being reduced by sentencing them to death by spraying insecticide, treating water habitat areas with larvicide, and reducing their feeding options by using bed nets over sleeping people in the countries at risk.
<b>Reward:</b>	This villain is tricky because it spreads so many diseases worldwide yet it is important as part of the food chain for many species. The reward for learning to control this villain and its spread of disease would be a payoff worth MILLIONS OF DOLLARS and lives saved worldwide each year.

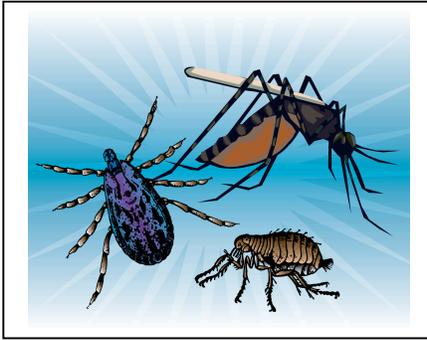
# The Mug Shot of Mo Skeeto

Created by: Student's name

The Mug Shot of Mo Skeeto



Created by: student's name



### Activity 3: Vector Villains

Insects can be heroes or villains. In this activity you will learn about some of the troublemakers who act as vectors and transmit diseases. Then, you will design your entry. Will it be one of the "baddest" of the bad and make the list of the "Ten Most Wanted?"

#### Background Information

What is a vector borne disease? Vectors are animals that are capable of transmitting diseases without the disease affecting them. Examples of vectors are flies, mites, fleas, ticks, rats, and dogs. The most common vector for disease is the mosquito. Mosquitoes transfer disease through the saliva which comes in contact with their hosts when they are withdrawing blood. Mosquitoes are vectors for malaria, [West Nile virus](#), dengue fever, and yellow fever. Because insects fly, they can spread diseases much farther.

Biting is not the only way vectors can transmit diseases. Diseases may be spread through the feces of a vector. Microorganisms could also be located on the outside surface of a vector (such as a fly's feet) and then spread through physical contact with food or a surface that is touched.

#### Materials

- Mug sheet, Rap sheet, colored pencils or markers

#### Procedure

1. You will create a "Rap Sheet" (information about your fictitious insect vector) and draw a "Mug Shot" (picture of your fictitious insect vector).
2. Use the following rubric to make sure you include all of the requirements:

## ***MISSION DEBRIEFING* Student Activity Guide**

### **For the Rap Sheet:**

Requirement	More details	Point Value 50 points	Your score
Common name:	What name do the guys on the street call this villain?	5	
AKA :	This means “also known as” in criminal science circles; it is the alias name.	5	
Scientific name and meaning:	The correct form will include a two-word name created from Latin or Greek root words. The first word of the name is capitalized, the second word is not, and both words are underlined. Explain the meaning of the words you have chosen.	5	
Description:	Use your best language arts skills to describe the appearance of your insect.	5	
Diet:	Consider the mouth parts and other adaptations of your insect when describing its diet.	5	
Habitat:	The hideout...where does your insect live?	5	
Wanted for:	It is wanted for transmitting a disease, of course—it’s a vector. Describe the disease it transmits <u>AND explain how it is passed from one species to another.</u>	5	
Usual victim	The insect vector passes the disease from victim to victim. Who are these victims?	5	
Expected punishment:	Explain how this crime can be stopped. How will you suggest getting this insect vector out of circulation?	5	
Reward:	What do you suggest the reward should be to encourage others to help catch this villain?	5	

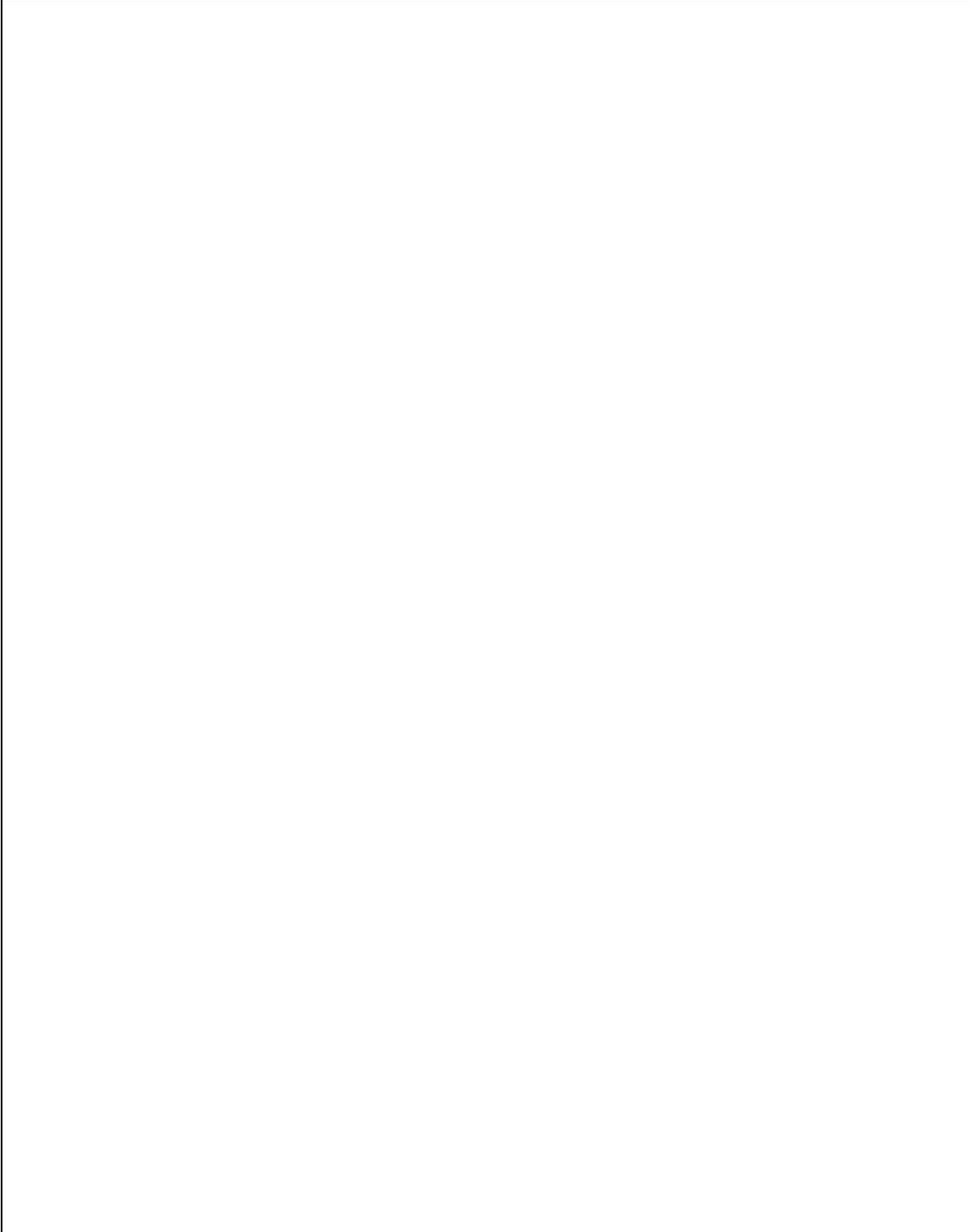
# ***MISSION DEBRIEFING-*** Student Activity Guide

## For the *Mug Shot*:

Requirement	More details	Point Value 50 points	Your score
Mug shot (head) plus body is drawn.	You may draw a side view or front view of your insect but do a full length body drawing.	10	
Correct insect anatomy shown:	Insects have a head, thorax, and abdomen. Your villain is an adult so it will have wings (usually) coming from the thorax segment. Antennae are on the head.	20	
Creativity	Details of actual insect anatomy have been combined in your fictitious insect. You have added adaptations that will help it “commit the crime” as a vector for the disease.	10	
Neatness and color	A quality effort is shown in your drawing. Color is used to improve the appearance. Your villain fills the space allowed for the mug shot drawing.	10	

Requirement	More details	Point value	Your score
Bibliography	Cite your sources correctly. A sample is shown at this link: <i>I am still searching for the link we used at my school. I will let you know it soon.</i>	10	

## The Mug Shot



Created by: \_\_\_\_\_

## The Rap Sheet

<b>Common name:</b>	
<b>AKA :</b>	
<b>Scientific name and its meaning:</b>	
<b>Description:</b>	
<b>Diet:</b>	
<b>Habitat:</b>	
<b>Wanted for:</b>	
<b>Usual victim</b>	
<b>Expected punishment:</b>	
<b>Reward:</b>	