

# *Teaching Materials on Infectious Diseases*

## *MEDICAL MYSTERIES*



### *Mission 2: Peril in Prokaryon*

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# ***MISSION BRIEFING: Contents***

## ***OVERVIEW***

We hope 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.

Rice University and the sponsoring agency cannot be responsible for any accidents or injuries that may result from: 1) the conduct of the activities without proper supervision, 2) the failure to follow the directions provided, or 3) the ignoring of cautions contained in the text.

Feel free to adapt these activities to your own classroom needs. Other resources that we suggest are the National Institutes of Health (NIH) web site at <http://www.nih.gov/> and the Centers for Disease Control web site <http://www.cdc.gov>. They contain excellent resources and teaching materials.

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## ***MISSION BRIEFING***

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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 on the Arora II Spacecraft. An urgent transmission is coming in from Alpha, the Reconstructor Leader. He tells the student that he/she must terminate the repair mission of Eureka, the medical bot, and head to Prokaryon. A recent earthquake in the Eastern province has sent a flood of refugees into Prokaryon and, with them, a number of deaths due to a diarrheal disease. Because of these deaths, the fringe group, the Areloch, have demanded the closing of the refugee camps. The Areloch believe that the refugees are a stress on the local resources and a health hazard. Alpha tells the student to meet Beta, the chief medical officer, and Sirius, the local public health officer in Prokaryon. They need help to stop the mysterious diarrheal disease outbreak and end the conflict between the refugees and the Areloch.

While en route to Prokaryon, Eureka recommends that the student review important material about infectious disease on the spacecraft's computer. First, the student reviews the Germ Theory, with information on Louis Pasteur, Robert Koch, and Joseph Lister. These scientists were instrumental in showing the connection between microbes and infectious disease. Students will have to answer three questions about these scientists at the end of this section. Next, the student reviews the six types of infectious agents: bacteria, viruses, prions, fungi, helminthes, and protozoa. Unfortunately, there is a glitch in the Arora II's computer, so the student can only access detailed information on bacteria, and none of the other agents. The student can explore the structure of a bacterial cell, view an animation on bacterial reproduction, and play a game in which bacteria are classified according to shape.

Once at Prokaryon, Sirius meets the student and reports that tension over the refugee camp is mounting. It appears that the Areloch have been sneaking into the refugee camp to spy. In addition to the Areloch problem, the number of cases of diarrheal disease appears to have reached epidemic proportions. Sirius leads the student to the MedBay field station and shows a graph with the number of diarrhea cases reported in the last few weeks. The student is then asked to pick the date that indicates the start of the epidemic.

Eureka's repair alarm begins to sound, and Sirius asks the student to fix the bot while he goes to find Beta. To make the repair, the student must reconnect Eureka's loose data chips by matching scientific terms to their correct definitions. Once she is fixed, Eureka intercepts a transmission between Areloch members describing their plan to use robotic spiders (robo-spiders) to continue the surveillance of the refugee camp.

As the transmission ends, Beta and Sirius enter MedBay. Beta realizes that the Areloch are a problem, but reassures everyone that they have not stopped her work on the mystery disease. Beta shows the student slides made from samples of several patients' stool that contain *Vibrio cholerae*, the bacteria that cause cholera. The student is directed to view an animation on the mode of transmission, pathology, and treatment of cholera.

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

Now that the cause of the diarrheal disease has been determined to be cholera, the source of the disease must be found. Sirius downloads epidemiological data on five of the patients who have cholera. After reviewing the material, the student should conclude that all five patients ate tomatoes and drank/bathed in the water of a nearby lake. The possibility that water could be the source of the cholera germs reminds Eureka of a classic epidemiological study from history. Eureka shows an animation where Dr. John Snow talks about how he used a case map to identify a water well as the source of a cholera outbreak in the 1800s. Similarly, Sirius has mapped the location of each suspected cholera case in Prokaryon. By examining this map, the student should conclude that most of the cholera cases cluster around the nearby lake.

Finally, a case control study is performed. In this study, the eating, drinking, and bathing habits of 50 refugees who contracted cholera (cases) are compared with 50 refugees who did not get the disease (controls). The only common thread with 96% of patients with cholera is the lake. Eureka chimes in that she observed some refugees using the lake as a bathroom and others using it for drinking and bathing water; therefore, the lake is probably the source of the cholera germs. Now all that needs to be done is put in place measures to prevent the spread of cholera and to convince the Areloch that the disease can be controlled as long as the refugees stop using the contaminated water. They send this information to Alpha and ask him to bring in more water after the lake is blocked. The student is able to play "Refugee Rampage," a game where the student must lay down fences in order to block access to the lake. After the lake is blocked, Beta and Sirius stress the importance of clean water and washing your hands in order to prevent cholera. The mission ends with Alpha presenting a graph that shows how the number of watery diarrhea cases dropped after the access to the lake was blocked. The last image is a robo-spider crawling across the screen.

### Scientist Biographies

**John Snow (1813-1858)** Famous for discovering that a water pump was the source of a cholera outbreak in London in 1854. Closing the pump stopped the outbreak.

**Louis Pasteur (1822 -1895)** Father of Germ Theory. Proved that microorganisms are responsible for fermentation. His series of experiments led to pasteurization - heating to kill microbes in liquids to keep milk and wine from spoiling.

**John Lister (1827-1912)** Applied Pasteur's theory to human health and encouraged surgeons to sterilize their instruments and hands between patients.

Robert Koch is profiled in the teaching materials of Mission one.

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

<b>Instructional Objectives “Perils in Prokaryon”</b>	<b>Science Content Standard</b>
<ul style="list-style-type: none"> <li>• Apply the scientific method to the investigation of a mystery disease.</li> <li>• Analyze and interpret epidemiological data – maps, graphs, and patient profiles – to reach a hypothesis about a disease.</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>1. develop abilities necessary to do scientific inquiry</li> <li>2. understand about scientific inquiry</li> </ol>
<ul style="list-style-type: none"> <li>• Associate the bacterium, <i>Vibrio cholerae</i>, with the disease it causes – cholera.</li> <li>• Classify bacteria into each of three basic shapes: bacilli, spirilla, and cocci.</li> <li>• Relate the importance of Germ Theory to our understanding of present-day diseases.</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>1. structure and function in living systems</li> <li>2. reproduction and heredity</li> <li>3. regulation and behavior</li> <li>4. population and ecosystems</li> <li>5. diversity and adaptations of organisms</li> </ol>
<ul style="list-style-type: none"> <li>• Recognize the interaction between population, resources, and the environment.</li> <li>• Identify the symptoms of cholera.</li> <li>• Determine the treatment for cholera.</li> <li>• Describe the best ways to prevent the spread of cholera (sanitation and hygiene).</li> <li>• Recognize the health risks associated with a collapse of infrastructure caused by natural hazards such as earthquakes or floods.</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>1. personal health</li> <li>2. populations, resources, and environment</li> <li>3. natural hazards</li> <li>4. risks and benefits</li> <li>5. science and technology in society</li> </ol>

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

<b>Instructional Objectives “Perils in Prokaryon” (con’t.)</b>	<b>Science Content Standard (con’t.)</b>
<ul style="list-style-type: none"><li>• Describe what epidemiologists do.</li><li>• Recognize the name John Snow and associate his contributions to the early field of epidemiology.</li><li>• Associate Robert Koch, Louis Pasteur, and Joseph Lister with their contributions to Germ Theory.</li><li>• Observe the cooperation required by various individuals, with different areas of expertise in scientific investigation.</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>1. science as a human endeavor</li><li>2. nature of science</li><li>3. history of science</li></ol>
<ul style="list-style-type: none"><li>• Summarize the storyline.</li></ul>	

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

Vocabulary terms that are fundamental in understanding the concepts included in Mission Two are listed below. Some of the words will be encountered while playing Mission Two. Teachers should alert the students to the ability to click on the *hot-linked* words in the game.

**bacilli** - rod-shaped bacteria.

**bacteria** - one-celled microscopic organisms that multiply by cell division or binary fission. Cell is typically contained within a cell wall. Found as spherical, rod, and spiral shapes. Bacteria can spread through direct contact, indirect contact, food, water, air and animals.

**case-control study** - an epidemiological study that compares people with the disease (cholera) to those without the disease, cases versus controls. This can determine how the disease is being contracted. For example, cholera is an infectious disease that can be spread in food or water contaminated with the bacterium *Vibrio cholerae*. By knowing which food and water sick people consumed compared with those who did not get the disease, epidemiologists can identify the source of the contamination.

**cocci** - sphere-shaped bacteria.

**contaminate** - to make unclean, usually from contact with an impure source.

**diarrhea** - frequent, watery bowel movements.

**epidemic** - Increasing numbers of disease cases in a given area. The word comes from the Greek word *epi* meaning “upon” and the *demos* meaning “the people.” Thus, an epidemic is a disease on or among the people.

**epidemiology** - a branch of medicine that studies how and why diseases spread.

**Germ Theory** - proposed by Louis Pasteur, the Germ Theory states that germs cause infectious diseases.

**Koch's Postulates** - a set of rules to test whether a specific germ causes a particular infectious disease.

1. The pathogen must be present in every case of the disease.
2. The pathogen must be isolated from the host and grown in pure culture.
3. The disease must be reproduced when a pure culture of the pathogen is inoculated into a healthy, susceptible host.
4. The same pathogen must be recovered from the newly infected host.

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

**microorganism** - A very small organism. Examples include bacteria, fungi, some parasites, and viruses.

**oral rehydration solution (ORS)** - a simple treatment for cholera and other diarrheal diseases consisting of a solution of salts, sugar, and water.

**pathogen** - an organism that can cause an infection or disease.

**spirilla** - spiral-shaped bacteria.

**rice-water stool** - the classic symptom of cholera; watery diarrhea containing electrolytes and bits of tissue that look like rice.

**stool** - excrement; waste eliminated from the body through the anus. "Feces" or "poop" are other words for stool.

# *MISSION BRIEFING: Mission Log*

## TEACHER VERSION

**TEACHER DIRECTIONS:** Ask the students to fill in the **CLUE** column as they proceed through the mission.

Question	Answer
In the Arora II spacecraft, you learn of an outbreak of disease in Prokaryon. What type of disease is it?	diarrheal
In the CyNN news article, a news crawler appears at the bottom of the story. It tells of a fringe group who are demanding the closure of the refugee camp. What is the name of this fringe group?	Areloch
Before arriving in Prokaryon, Eureka helps you review the Germ Theory first proposed by Louis Pasteur. What is this theory?	germs (microorganisms) cause infectious diseases
Eureka also shows you information on Joseph Lister, a surgeon who believed in the Germ Theory and therefore insisted that doctors do what?	wash their hands and sterilize their instruments
In reviewing the infectious agents, you learn there are <b>six</b> types. Name <b>four</b> of these.	bacteria, viruses, prions, protozoa, fungi, helminthes
In the animation of bacteria, you learn that they are categorized according to shape--rod, sphere, or spiral. What are the three different shapes called?	bacilli, spirilla, cocci
Upon arriving in Prokaryon, Sirius shows you a graph of diarrhea cases. How does the graph indicate an epidemic is occurring?	It shows a dramatic increase in the number of diarrhea cases.
In the lab, Beta shows you what the wiggling menace looks like. What is the name of the wiggling menace?	<i>Vibrio cholerae</i>
After looking at the fecal slides, Beta shows you an animation on cholera. Describe the type of stool found in cases of cholera.	rice-water stool is the type of stool in cholera
In what body part does <i>V. cholera</i> colonize or grow?	cholera grow or colonize in the small intestines
What is the treatment for cholera?	the treatment for cholera is oral rehydration solution (ORS)
After determining that the two possible sources of contamination are tomatoes and water, Eureka is reminded of a mysterious cholera epidemic in which maps were used to pinpoint a water pump as the source of contamination. Who was the physician who solved this mystery?	Dr. John Snow
In order to verify the source of the contamination, a case control study is performed. In this study, a comparison is made between those who got sick with cholera and what other group of people?	patients who did not get sick with cholera
What ends up being the source of contamination? The tomatoes or the lake water?	the lake water
At the end, Beta and Sirius say that the epidemic can be stopped if the refugees do what two things?	stop using the lake water and wash their hands after going to the bathroom

# ***MISSION BRIEFING:*** Mission Log

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

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

Question	Answer
In the Arora II spacecraft, you learn of an outbreak of disease in Prokaryon. What type of disease is it?	
In the CyNN news article, a news crawler appears at the bottom of the story. It tells of a fringe group who are demanding the closure of the refugee camp. What is the name of this fringe group?	
Before arriving in Prokaryon, Eureka helps you review the Germ Theory first proposed by Louis Pasteur. What is this theory?	
Eureka also shows you information on Joseph Lister, a surgeon who believed in the Germ Theory and therefore insisted that doctors do what?	
In reviewing the infectious agents, you learn there are <b>six</b> types. Name <b>four</b> of these.	
In the animation of bacteria, you learn that they are categorized according to shape--rod, sphere, or spiral. What are the three different shapes called?	
Upon arriving in Prokaryon, Sirius shows you a graph of diarrhea cases. How does the graph indicate an epidemic is occurring?	
In the lab, Beta shows you what the wiggling menace looks like. What is the name of the wiggling menace?	
After looking at the fecal slides, Beta shows you an animation on cholera. Describe the type of stool found in cases of cholera.	
In what body part does <i>V. cholera</i> colonize or grow?	
What is the treatment for cholera?	
After determining that the two possible sources of contamination are tomatoes and water, Eureka is reminded of a mysterious cholera epidemic in which maps were used to pinpoint a water pump as the source of contamination. Who was the physician who solved this mystery?	
In order to verify the source of the contamination, a case control study is performed. In this study, a comparison is made between those who got sick with cholera and what other group of people?	
What ends up being the source of contamination? The tomatoes or the lake water?	
At the end, Beta and Sirius say that the epidemic can be stopped if the refugees do what two things?	



## **Activity 1: Disease Detectives**

An epidemiologist is like the Sherlock Holmes of the medical world. An epidemiologist acts like a disease detective and investigates a health problem by looking for clues. In this activity, the student will learn about epidemiology and the process epidemiologists use to determine the source of an unknown disease.

### **Background**

If a person enters a grocery store and robs the cashier, the question of, “Who stole the money?” is easy to answer. But what if nobody entered the store and the money had just disappeared, how would you find out who stole the money? In this case, you may need a super-sleuth to help uncover the culprit. Someone who knows certain details about the grocery store might be able to find hidden clues and draw connections between people, place, and time. Disease detectives or epidemiologists work the same way. Many illnesses have a clear path to the causative agent. We all know that if we cut ourselves, certain bacteria can enter our body and cause an infection. But some illnesses are tricky. Some infectious agents enter our body through less obvious methods. Just like the case of the disappearing money, some diseases require a more cunning and knowledgeable crime fighter, or in this case, a disease detective.

Epidemiology is the branch of science that tries to decipher the occurrences and causes of a health problem in a specific population. For instance, if an outbreak of a disease occurred on a university campus, a disease detective would try to find out not only what the disease is, but also why it occurred at the university. In order to answer these questions, disease detectives apply the scientific method as the basis for their investigation. Given a specific health problem, the epidemiologist will gather information and then make a hypothesis as to the answer to the problem. The epidemiologist must be able to test the hypothesis to see if it is true.

In this activity, students will learn about the different studies an epidemiologist uses in order to uncover the source of a mystery disease. Then, students will practice generating a hypothesis given a set of clues.

*This activity is an adaptation of *Detectives in the Classroom* by Mark Kaelin, Ed.D. Montclair State University: <http://www.montclair.edu/detectives/>*

## Disease Detectives

### Learning Objectives

The student will:

1. learn about the scientific field of epidemiology.
2. use the principles of the scientific method to investigate the cause of an unknown disease.

### Materials

1. *Student Guide*
2. *Disease Detective* slides
3. *Descriptive Epi Sheet*
4. “*What’s My Hypothesis?*” chart
5. index cards, one per student
6. *Pretend Disease List*

### Procedure

1. Before class, create the number of *Pretend Disease Cards* required (one per student). Do this by reviewing the *Pretend Disease List*. Write the disease on one side of a blank index card and number the card in the top right-hand corner. (For example, SUNGLASSES, #21)
2. At the beginning of class, introduce the study of epidemiology by using the *Disease Detective Slides* available on the MedMyst web site, <http://webadventures.rice.edu/ed/Teacher-Resources/games/MedMyst-Original/302/Teacher-Materials/Classroom-Activities.html>
3. The slides can be viewed with Microsoft PowerPoint© viewer. Use the notes option in PowerPoint© to view a detailed explanation of the slides.
4. After you have reviewed an epidemiology descriptive study and the activity, separate the class into groups. The activity can be done with the entire class, but this may take more time.
5. Give each student a *Pretend Disease Card*, a *Descriptive Epi sheet*, and a “*What’s My Hypothesis?*” chart.
6. Have the students write the number on their card in the bottom right-hand corner on the *Descriptive Epi sheet*. Make sure they do not show anyone what their card says.
7. Then have the students write clues as to: (1) type of person who would get their disease, (2) the place they would get their disease and (3) the time of day they would get their disease. Since other students will use these clues to guess the disease, prompt the students to write very descriptive clues.
8. After everyone has finished writing their *Descriptive Epi Sheet*, take up the *Pretend Disease Cards*.
9. Have the students within each group trade *Descriptive Epi sheets*. Each student should read each group members *Descriptive Epi Sheet*, and try to formulate a hypothesis as to what the cause of the disease is. The student should write each hypothesis in the *My Hypothesis* column on the “*What’s My Hypothesis?*” chart next to its corresponding number.
10. Have the students continue trading *Descriptive Epi sheets* until everyone has formulated a hypothesis for each *Descriptive Epi Sheet* in their group.
11. Then have the students review the hypothesis for each disease, and determine if it is a good hypothesis and discuss why. If a student likes someone else’s hypothesis, have them write it in the *Other Hypothesis* column.

12. The final step is to reveal the disease and which hypothesis was correct.

## **Disease Detectives**

### **Extension Activities**

- *History*: Investigate famous disease epidemics.
- *Social Studies*: Using your local newspaper, find examples of health problems found in your community. Conduct a discussion of these problems.
- *Language Arts*: Interview the local public health officer about the epidemiological studies with which he/she has been involved.

### **Related Standards**

National Science Education Standards, Grades 5-8

Science Content Standard A:

- All students should develop abilities necessary to do scientific inquiry
- All students should develop understanding about scientific inquiry

### **Books**

- Yount, L. (2001). *Disease Detective*. San Diego, CA: Lucent Books.
- Drexler, M. (2002). *Secret Agents: The Menace of Emerging Infections*. Washington, D.C.: Joseph Henry Press
- Tierno, P.M. (2001). *The Secret Life of Germs*. New York, NY: Pocket Books..

### **Web Sites**

- Excellence in Curriculum Integration Through Teaching Epidemiology  
<http://www.cdc.gov/excite/index.htm>
- Detectives in the Classroom  
<http://www.montclair.edu/detectives/>

## **Pretend Disease List IMAGINE THAT THESE ARE DISEASES**

Consider using the following on the 3 x 5 cards (Remember to number them so that the pretend disease can be identified by its number).

- AOL
- Aspirin
- Apples
- Being left-handed
- Braids
- Candles
- Cats
- Cellular telephones
- DVDs
- Dogs
- Donuts
- Eating breakfast
- Heavy backpacks
- Electric power
- Eye shadow
- Hairspray
- Headsets
- Lip gloss
- Leather
- MP3 players
- MTV
- Phone receiver
- Paint
- PlayStation2
- Razor scooter
- Snow
- Spray cans
- Swimming pools
- Tents
- Skateboards
- Violent video games



## Disease Detectives

An epidemiologist is like the Sherlock Holmes of the medical world. An epidemiologist acts like a disease detective and investigates a health problem by looking for clues. In this activity, you will learn about epidemiology and the process epidemiologists use to determine the source of an unknown disease.

### Materials

1. *Student Activity Sheet*
2. *Disease Detective slides*
3. *Descriptive Epi Sheet*
4. “*What’s My Hypothesis?*” *Chart*
5. *Pretend Disease Card*

### Procedure

1. After you have reviewed the study of epidemiology with the class, separate into groups.
2. Get a *Pretend Disease Card* from your instructor.
3. Write the number from the card in the bottom right-hand corner on the *Descriptive Epi Sheet*. Do not show anyone what your card says.
4. On your *Descriptive Epi Sheet*, think of clues that would describe a person who would get this disease, where they would contract this disease, and at what time they would get this disease. Try to use the “whistle” example that was described to you to shape your clues. Be as descriptive as you can, since the clues will be used so that other students can try to guess the disease.
5. After everyone has finished writing their *Descriptive Epi Sheet*, turn in your *Pretend Disease Cards* to your instructor.
6. Trade *Descriptive Epi Sheets* with the person on your right in your group. Each student should read each group member’s *Descriptive Epi Sheet*, and try to formulate a hypothesis as to what the cause of the disease is. You should write your guess for each disease in the form of a hypothesis in the *My Hypothesis* column on the “*What’s my Hypothesis?*” *Chart*, next to its corresponding number.
7. Continue trading *Descriptive Epi sheets* until you have formulated a hypothesis for each *Descriptive Epi Sheet* in your group.
8. After you have guessed the source of the disease for everyone in your group, review each entry with your group, and determine who has a good hypothesis and why. If you like someone else’s hypothesis, write it in the *Other Hypothesis* column of your “*What’s my Hypothesis?*” *Chart*.
9. Finally, take turns revealing the source of the disease for everyone in your group, and determine which hypothesis was correct.

**Disease Detective  
Descriptive Epi Sheet**

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

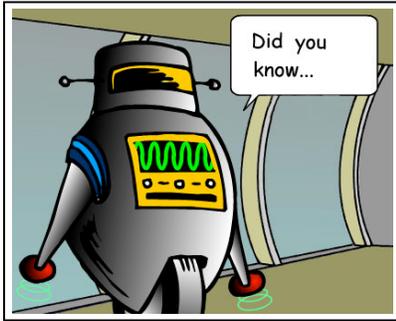
**Person:**

**Place:**

**Time:**

**Card #:** \_\_\_\_\_





## Activity 2: Water Is Everywhere, But Is It Safe To Drink?

Clean drinking water is often taken for granted. In many parts of the world, conditions are ripe for water-borne diseases to occur as a result of natural disasters or a lack of modern water systems. The use of maps and other epidemiological data can help pinpoint where accessibility to clean water is still a health problem around the world.

### Background

In the United States, it is assumed that tap water is safe to drink; however, in much of the developing world, clean, “safe” water can be difficult to find. According to the U.S. Centers for Disease Control and Prevention (CDC), 2-3 million children under the age of six worldwide die each year of diarrhea-related diseases. Much of the blame for these deaths can fall on the lack of safe, clean water. These developing countries with the help of international organizations have invested billions of dollars into digging deep-water wells and constructing piped water systems. Nevertheless, with the rapid shift of population to urban areas and the lack of infrastructure due to armed conflict and natural disasters, the need far exceeds the demand.

In order to meet the need for clean water, the CDC and the Pan American Health Organization have developed a simple, inexpensive, adaptable, and flexible intervention technique. The system is called the “Safe Water System.” The idea is to make water clean and safe through a disinfecting process and storage precautions. The contaminated water is cleaned with a chloride solution or commercial bleach. The water is then stored in plastic containers with a narrow mouth to prevent recontamination, such as when a person dips a dirty cup into a bucket. To treat people with diarrheal diseases, this decontaminated water is then used to make an Oral Rehydration Solution (ORS). ORS is one of the greatest lifesavers in the 20<sup>th</sup> century. Every year, ORS saves millions of people from death. Amazingly, anyone can make this solution, which consists of salt, sugar, and water. A packet of ORS ingredients can also be purchased at most camping or travel supply stores. One packet is added to one liter of water, which means clean drinking water is required to make it.

Although the ingredients to make ORS are simple, they are specific. Normally, the body absorbs water and salt in the intestines. During dehydration, due to diarrhea, the amount of water and salt secreted by the intestines far exceeds the amount absorbed. In order to rehydrate a person, a solution of water, salt, and sugar must be ingested quickly. Salt is important. Without it, the water will not be reabsorbed. Sugar is important because it is required in order for the salt to be absorbed into the intestines. Chemically speaking, this means that for every glucose (sugar) molecule, one sodium (salt) molecule is absorbed making rehydration possible.

In this activity, the student should understand the connection between a location’s basic water and sanitation systems and health, and they will be able to realize the association between clean water and disease. Additionally, they will learn how to make the life-saving ORS and develop methods for improving ORS when made in an area lacking clean, “safe” water.

## **Water Is Everywhere, But Is It Safe To Drink?**

### **Learning Objectives**

The student will:

1. define and identify key elements of infrastructure in the context of health prevention.
2. analyze data to draw conclusions about water and disease.
3. learn how to make Oral Rehydration Solution.
4. design steps that can be taken to prevent water-borne infectious diseases.

### **Materials**

1. *Student Activity Sheet*
2. dishwashing soap
3. clean paper towels
4. sponge
5. salt
6. sugar
7. 1 L clean, drinking water
8. 2 L pitcher
9. teaspoon
10. large spoon for mixing
11. disposable (unused) small cups for drinking

### **Procedure**

#### **Part I: Clean Water and Disease Prevention**

1. At the beginning of class, set the context for discussing clean water by raising questions such as “What parts of our community’s infrastructure help prevent disease?” This will help raise awareness that in many parts of the world, these essentials are simply not in place. Help the students define infrastructure, and talk about issues such as indoor plumbing, treated drinking water, sewage facilities, garbage collection, air quality, etc. An interesting site on plumbing can be found at <http://www.theplumber.com/plague.html>. There are other links at the end of the lesson, such as the EPA site, that may also be helpful.
2. Distribute copies of the Student Guide—“*Water is Everywhere, But is it Safe to Drink?*” and the *Questions*. Also distribute the Student Activity Sheet Access to Clean Water map.
3. Tell the students that this is actual data on past water quality measurements and cholera surveillance. Their task is to help analyze the information.
4. Divide the class into groups of two or three students and ask each group to report their conclusions to the questions raised in the activity sheet.
5. Discuss the answers based on the students’ analyses.

#### **Part II: Clean Water and Disease Treatment**

1. Discuss what ORS is and how it is used to treat cholera and diarrheal diseases.
2. As a class, make the oral rehydration solution. The students can taste it if they want. Afterward, discuss the problems with making ORS in developing countries, such as the risk of further infection due to the use of contaminated water.
3. Split the class into groups of three to four students. Have each group come up with ways that they could design a process to make ORS in a safe way. For example, the Safe Water System decontaminates the water with bleach and uses a container with a small opening so a cup cannot further contaminate the water. Students can write their changes on the Field Test Sheet.
4. Have each group present and lead discussion of their ideas with the class.

## **Water Is Everywhere, But Is It Safe To Drink?**

### **Extension Activities**

- *History*: Investigate the history of indoor plumbing.
- *Social Studies*: Using research tools and a world map, locate countries with cholera epidemics that are currently underway.
- *Language Arts*: Imagine you are going to Equatorial Guinea. Locate it on a map and research its history and conditions. Write a story about your imaginary trip to Equatorial Guinea and what health precautions you might take. Answer questions like, how did you get there, what did you eat, and what did you see? To learn more about the health conditions in Equatorial Guinea, or other places, check the Centers for Disease Control (CDC) and World Health Organization (WHO) web sites.

### **Related Standards**

National Science Education Standards, Grades 5-8

Science Content Standard F:

- all students should develop understanding of personal health
- all students should develop understanding of populations, resources, and environments
- all students should develop understanding of natural hazards

### **Books and Articles**

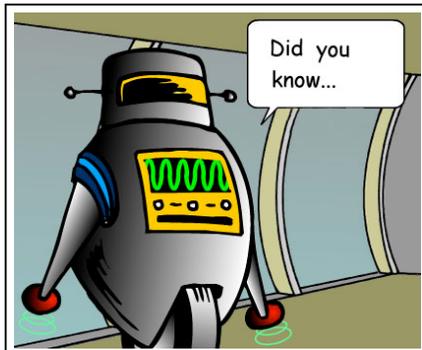
- McLeish, E. 1998. Keeping Water Clean. Austin, TX: Raintree Steck-Vaughn.
- Barss, K. 1993. Clean Water. New York: Chelsea House Publishers.
- Hoff, B., Smith, C, III. 2000. Mapping Epidemics: A Historical Atlas of Disease. New York: Franklin Watts.
- Platt, A. and Vetleseter, T. 1996. Infecting Ourselves: How Environmental and Social Disruptions Trigger Disease. Washington D.C.: Worldwatch Institute.
- Doyle, R. 1997. Access to Safe Drinking Water. *Scientific American* 277 (5) 38.

### **Web Sites**

Starred sites are geared toward students.

- Safe Water System  
<http://www.cdc.gov/safewater/>
- World Health Organization: Cholera  
<http://www.who.int/topics/cholera/en/>
- Explorer's Club: EPA for Kids\*  
<http://www.epa.gov/kids/>
- Medical Geography: 1998 Cholera Outbreak in Peru  
<http://www.reliefweb.int/rw/rwb.nsf/AllDocsByUNID/03364d9fb121f0a1c12565b80038Icea>

Articles by Rodger Doyle in *Scientific American* and The Program of the Foodborne and Diarrheal Disease Branch at the Centers for Disease Control and Prevention stress the importance of access to safe drinking water (<http://www.cdc.gov/safewater/>). Portions of this article are used with permission of the author.



## Water Is Everywhere, But Is It Safe To Drink?

Clean drinking water is often taken for granted. In many parts of the world, conditions are ripe for water-borne diseases to occur as a result of natural disasters or a lack of modern water systems. Clean water is important to both the prevention and treatment of disease.

### Making the Connection

#### Part I: Disease and Clean Water

- Using the *Access to Clean Water Map* locate the following countries:  
**Iran, Japan, Malaysia, Nigeria, Viet Nam, and Zimbabwe**
- Complete the chart below using the *Access to Clean Water Map*. Determine the percent of Urban Population in each country with access to clean water. Fill in the blanks of the chart by indicating whether the country is in **Group A** (greater than 95% clean water), **Group B** (75-94.9% clean water) or **Group C** (less than 75% with access to clean water).

<b>Connecting Cholera and Clean Water</b>		
<i>COUNTRY</i>	<i>NUMBER OF CHOLERA CASES (1986)</i>	<i>% OF URBAN POPULATION WITH ACCESS TO CLEAN WATER 1980-1990</i> <i>Group A, Group B, Group C</i>
Iran	20	<b>Group B</b>
Japan	26	<b>Group A</b>
Malaysia	55	<b>Group A, Group C</b>
Nigeria	91	<b>Group C</b>
Viet Nam	525	<b>Group C</b>
Zimbabwe	2	<b>Group A</b>

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

### **Water Is Everywhere, But Is It Safe To Drink?**

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

1. From this data alone, what hypothesis might you make?

**The hypothesis might be that when there is a higher access of urban populations to clean water, the number of cholera cases is lower (and conversely, when there is less clean water the cholera cases increase).**

2. What other factors should you take into account before assuming that your hypothesis is correct? (HINT: This data is only for URBAN areas of the country and only for ONE YEAR).

**There might be outbreaks in outlying areas during the one year that affect the data, for example, see Japan's numbers. Natural disasters, such as earthquakes or floods, could affect the data.**

3. What other things should you check to determine if your hypothesis is correct?

**I would need to check more countries to see if the pattern continued.**

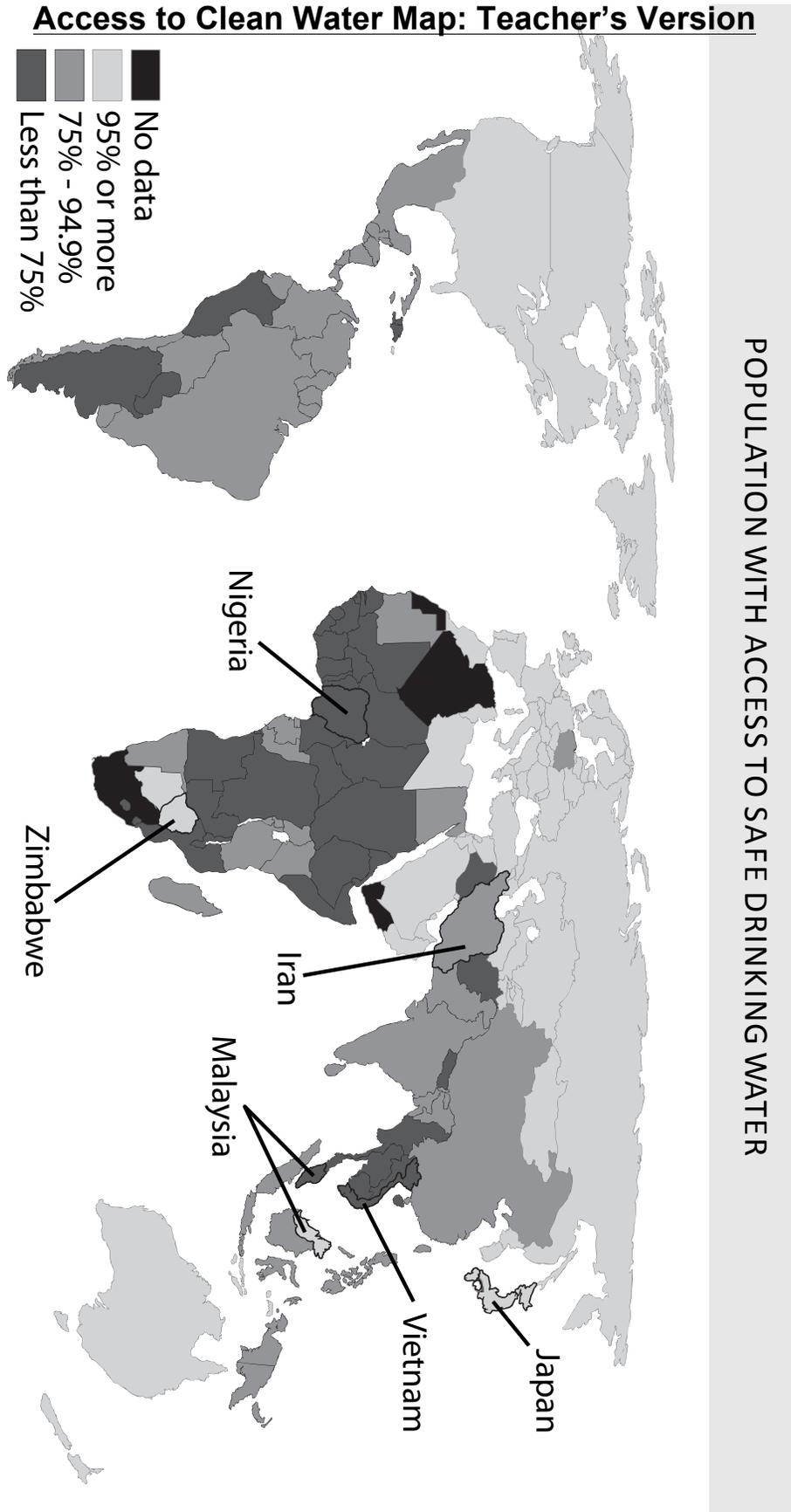
4. Which three areas of the world would you predict to have the highest incidence of cholera based on the *Access to Clean Water Map*?

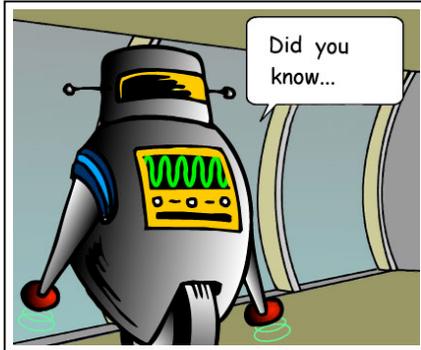
**Africa, South America, and Southeast Asia might have the highest incidence of cholera.**

5. Are you very concerned about the safety of your local water supply? Explain your answer.

**Answers will vary.**

# MISSION DEBRIEFING: Teacher Guide





## Water Is Everywhere, But Is It Safe To Drink?

Clean drinking water is often taken for granted. In many parts of the world, conditions are ripe for water-borne diseases to occur as a result of natural disasters or a lack of modern water systems. Clean water is important to both the prevention and treatment of disease.

### Making the Connection

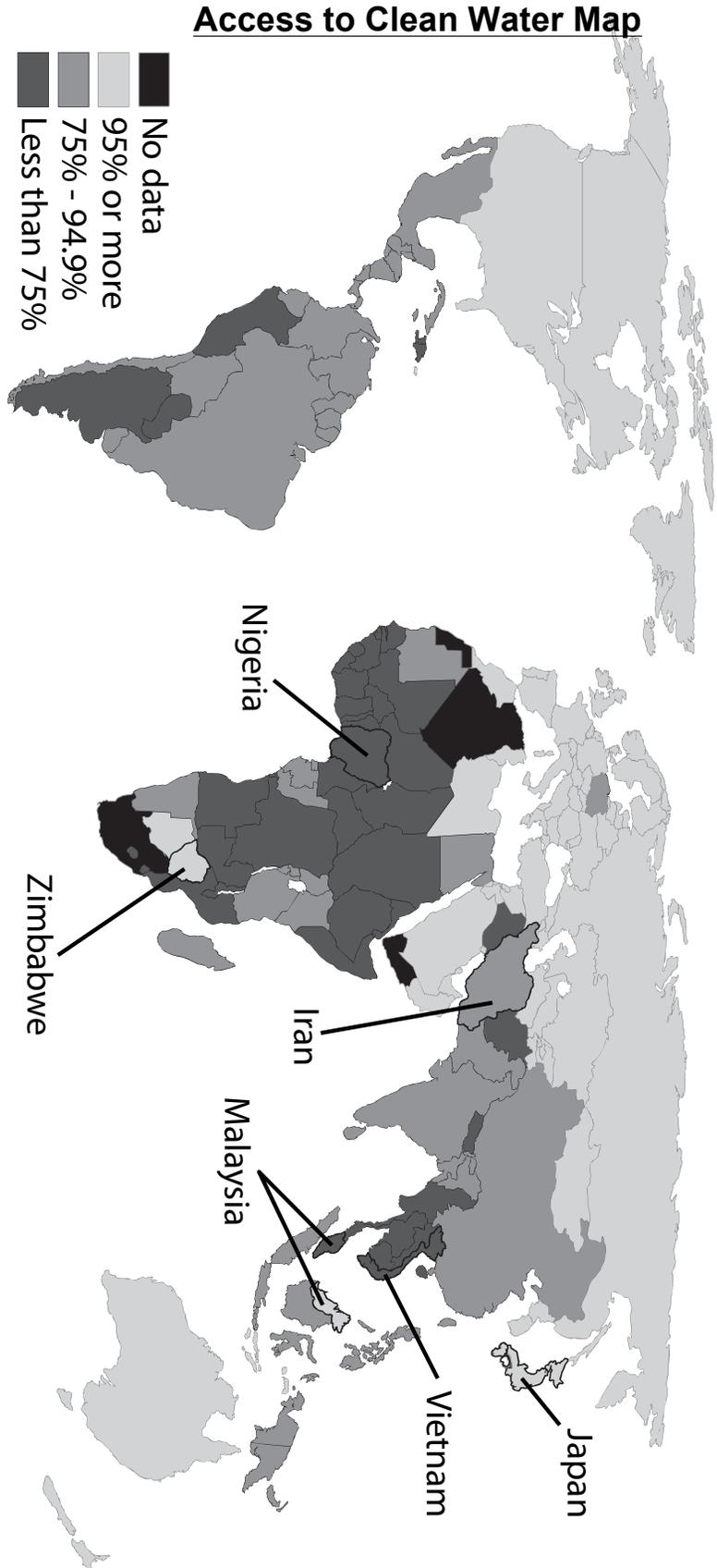
#### Part I: Disease and Clean Water

- Using the *Access to Clean Water Map* locate the following countries:  
**Iran, Japan, Malaysia, Nigeria, Viet Nam, and Zimbabwe**
- Complete the chart below using the *Access to Clean Water Map*. Determine the percent of Urban Population in each country with access to clean water. Fill in the blanks of the chart by indicating whether the country is in **Group A** (greater than 95% clean water), **Group B** (75-94.9% clean water) or **Group C** (less than 75% with access to clean water).

Connecting Cholera and Clean Water		
COUNTRY	NUMBER OF CHOLERA CASES (1986)	% OF URBAN POPULATION WITH ACCESS TO CLEAN WATER 1980-1990 <i>Group A, Group B, Group C</i>
Iran	20	
Japan	26	
Malaysia	55	
Nigeria	91	
Viet Nam	525	
Zimbabwe	2	



# MISSION DEBRIEFING: Student Guide



POPULATION WITH ACCESS TO SAFE DRINKING WATER

## **Water Is Everywhere, But Is It Safe To Drink?**

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

### **Part II: Treatment and Clean Water**

#### **Materials**

1. *Student Activity Sheet*
2. dishwashing soap
3. clean paper towels
4. sponge
5. 1 tsp salt
6. 8 tsp sugar
7. 1 L clean, drinking water
8. 2 L pitcher
9. teaspoon
10. large spoon for mixing
11. disposable (unused) small cups for drinking

#### **Procedure\***

##### **Making Oral Rehydration Solution:**

1. Thoroughly clean pitcher in the sink with dishwashing soap and a clean sponge.
2. Dry the pitcher with clean paper towels.
3. Thoroughly clean teaspoon and mixing spoon with dishwashing soap and a clean sponge.
4. Dry the spoons with clean paper towels.
5. Using teaspoon, add one level teaspoon of salt to the clean pitcher.
6. Rinse the teaspoon, and dry with clean paper towel.
7. Using cleaned teaspoon, add eight level teaspoons of sugar to the pitcher.
8. Add one liter of clean, drinking water to the pitcher.
9. Mix with clean mixing spoon.
10. Pour samples into disposable, unused, small cups (enough for everyone in the class).
11. Taste the ORS.
12. Discuss your thoughts on ORS solution.

##### **Field Test:**

1. After the class has been split into groups of three to four students each, complete the Field Test. In this section you are asked to imagine a situation where you have to make ORS in an area not containing clean water. What would you do?
2. Discuss your ideas from the Field Test with the class.

**Water Is Everywhere, But Is It Safe To Drink?**

**Field Test**

**Scenario**

Imagine that you have been placed in a small, isolated village in the southern part of India. This village is far from civilization, and their only source of water is a contaminated water well. There has been an outbreak of cholera, and the people are in desperate need of treatment. Oral rehydration solution would save many lives, and only you know how to make it. How would you change the procedure for making ORS in this village? **You can bring to the town anything you want except clean water.**

**What would you bring?**

	Item	Why?
1.		
2.		
3.		
4.		
5.		

**What changes to the procedure would you make?**

	Change	Why?
1.		
2.		
3.		
4.		
5.		



## **Activity 3: No Room For Rumors**

In this activity, students take on the role of a Reconstructor who needs to research information on an infectious disease.

### **Background**

Infectious diseases are the leading cause of death worldwide and are becoming an increasing threat in the United States. Not only are many of these diseases curable, but many can also be prevented due to advances gained from research. Therefore, it is essential that the public have an understanding of the pathology of infectious diseases and the methods used to prevent them.

Although we know much about certain infectious diseases, there are many newly emerged diseases as well as old ones that have re-emerged with which the public needs to become familiar. It is important to remember that this class of diseases is ever-changing. We must continue to learn and relearn the pathology and epidemiology of infectious diseases in order to make appropriate changes to deal with them.

During middle school, students become familiar with the idea that illnesses can be caused by microorganisms, genetic predisposition, health habits, and their environment. At this time, an introduction to information on infectious diseases can impact how they live the rest of their lives. Therefore, an understanding of infectious diseases, the infectious agents involved, the method of spread, symptoms, diagnosis, treatment, risk of infection, and prevention are vital to a healthy individual and community.

### **Learning Objectives**

The student will:

1. perform research on an infectious disease.
2. create a presentation on a specific infectious disease using a presentation software program.

### **Materials**

1. computer with Internet access and presentation software program
2. *No Room For Rumors Student Activity Sheet*
3. sample cholera presentation

## Procedure

1. At the beginning of class, hand out the *Neuropolis Center for Disease Control: No Room For Rumors Student Activity Sheet* **and** the sample cholera presentation.
2. Tell the students that they are researchers for the Neuropolis Center for Disease Control. Each of them is required to research an infectious disease and document the facts that the public should know.
3. Using cholera as an example, they are to describe the disease, its infectious agent, method of spread, symptoms, diagnosis, treatment, risk of infection, and prevention.
4. Discuss how the study of a disease can ultimately help in its prevention.
5. Inform students that the Center needs them to make a public presentation about an infectious disease in order to stop the spread of false rumors about it. The presentation will be made using the information gathered on the disease plus any images that would aid in the description of the ailment in a slide show, overhead, or poster presentation.
6. Divide the class into groups of two or three students and assign each group an infectious disease to research.
7. Suggested research topics are:
  - A. Examples of infectious diseases that affect the gut: *Escherichia coli* O157 infection, hookworm infection, salmonellosis, and shigellosis.
  - B. Examples of infectious diseases that affect the central nervous system: botulism, meningococcal disease, and rabies.
  - C. Examples of infectious diseases that affect the respiratory system: influenza, strep throat, and tuberculosis.
  - D. Examples of infectious diseases that affect more than one system: anthrax, chickenpox, legionellosis, Lyme disease, measles, and mononucleosis.
8. Have each group present a finished presentation to the class.

## **No Room For Rumors**

### **Extension Activities**

- *Language Arts:* Interview a scientist or physician about their job, their role in fighting infectious disease, or a specific disease.
- *Social Studies:* Create a timeline of the history of a specific infectious disease. Include information on where the disease originated, scientists who studied the disease and their findings, and where the disease occurs today.
- *Social studies:* Draw a map with the locations and dates of an infectious disease outbreak.
- *Language Arts:* Write a poem about a disease and its consequences.
- *Mathematics:* Calculate the percent infected population for different infectious diseases.

### **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 F: All students should develop understanding of personal health

### **Books**

- DeSalle R. (Ed.). 1998. Epidemic!: The World of Infectious Disease. New York: New Press.
- Farrell, J. 1998. Invisible Enemies: Stories of Infectious Disease. New York: Farrar, Straus, and Giroux.

### **Web Sites**

- Centers for Disease Control  
<http://www.cdc.gov/>
- World Health Organization  
<http://www.who.int/>
- The Plumber: Plagues and Epidemics  
<http://www.theplumber.com/plague.html>
- History of Disease: *Karolinska Institute*  
<http://www.mic.ki.se/HistDis.html>



## No Room For Rumors

Rumors are rampant about an infectious disease that is spreading in your area. The Neuropolis Center for Disease Control (NCDC) needs your help to research the disease and present the facts to the public to stop the rumors and public anxiety!

### Do the Research

Gather information on the infectious disease assigned to you from the library and/or using Internet sites and classroom reference materials. Record the name of the source of the information. The facts required for each disease are:

1. brief description of the disease
2. infectious agent
3. method of spread (water, food, insect, or person)
4. risk of infection
5. symptoms
6. method of diagnosis
7. treatment
8. prevention.

### Present the Material

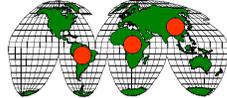
1. The presentation must contain these slides in the following order:
  - A. **Title Slide:** Contains the name of the disease, your name and class period.
  - B. **Disease Facts:** Use no less than five (5) “fact” slides to describe the disease facts. Graphics can be original artwork, clipart from free Internet sites, or images scanned from books and other sources. Report the source of all scanned images on the reference slide.
  - C. **Conclusion:** Use one slide to conclude what you have learned about the study of the disease. You may want to include the precautions the public should take to prevent the disease.
  - D. **Reference Slides:** List the names of the sources of the information presented including scanned graphics.
2. Suggestions for making the presentation:
  - A. When using a color printer or monitor, use a background and font color combination that works well together. When using a black and white printer, use white for the background and black for the font. Avoid wild, distracting colors, as well as colors that appear to “vibrate” or are out of focus when projected.
  - B. Use the same background and font color for each slide.
  - C. Use the same fonts throughout the presentation.
  - D. Use *no more than six* words per line of text and *six* lines of text per slide.

# MISSION DEBRIEFING: Student Activity Sheet

## Sample Cholera Presentation

**Cholera**  
By  
Sue Davis  
Ann Travis  
And Gary Barns  
  
Ms. Prescott's Life Sciences class 1-2pm

**Cholera**  
An infection of the intestines, most likely to occur in developing countries, where sanitary conditions are not very sophisticated.



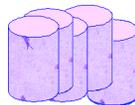
**Cholera**  
Infectious Agent:



*Vibrio cholerae*, a curve-shaped bacterium with a whip-like flagellum used for movement.

Invades the small intestines and secretes a poison.

**Cholera**  
Method of Spread:



- In areas of poor sanitation, human solid waste can contaminate the water supply with *Vibrio cholerae*
- If contaminated water is ingested, *Vibrio cholerae* can infect and cause the infectious disease cholera.

**Cholera**  
Risk of Infection:



- Age and health
- Vaccination status
- Amount of bacteria ingested
- Bacteria's virulence

**Cholera**  
Symptoms:



- Large amounts of diarrhea, vomiting, cramping in the legs and abdomen, but not usually a fever.
- If left untreated can produce as much as one liter of watery diarrhea per day which can eventually lead to death.

# MISSION DEBRIEFING: Student Activity Sheet

## Sample Cholera Presentation

### Cholera

#### Diagnosis:

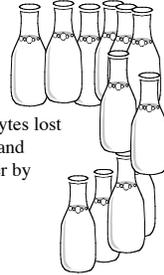
- Detection of symptoms
- Detection of *Vibrio cholerae* in stool samples
- Biochemical tests.



### Cholera

#### Treatment:

Replace the fluid and electrolytes lost through diarrhea. The fluids and electrolytes are replaced either by mouth or through a vein.



### Cholera

#### Prevention:

- Good public hygiene with safe and efficient sanitation systems
- Boiling or chemically treating tainted water
- Good personal hygiene, such as thoroughly washing hands after using the restroom, will also help limit cholera.



### Cholera

#### Conclusion:

##### Bad news Good news!

- Bad News: Cholera is a dangerous disease when left untreated.
- Good News: Cholera is completely preventable and treatable even if occurs!



### Cholera

#### References:

1. [Infectious Disease Information: Cholera](#) [Electronic Database] (2001). Atlanta, GA: National Center for Infectious Disease: [Producer and Distributor].
2. [The Bad Bug Book: Vibrio cholerae](#) [Electronic Database] (2001). Washington, DC: U.S. Food & Drug Administration Center for Food Safety & Applied Nutrition [Producer and Distributor].
3. Images: Personal Drawings or Microsoft PowerPoint clipart.





### **Activity 4: MedBay: One Cell, Two Cells, Four Cells, Eight**

In this activity, the student will learn about bacterial growth and personal health by culturing bacteria found on themselves and in their environment.

#### **Background**

Many different microorganisms live in, on, or around us. Two very different types can be grown in the classroom. Bacteria are single-celled prokaryotic organisms. These organisms lack membrane-bound organelles found in animal and plant cells. Fungi are either single-celled or multi-celled eukaryotic organisms found frequently in air, soil, or moist places inside buildings. Neither bacteria nor fungi can make their own food. Instead, they consume organic material.

Bacteria grow in almost all environments. Normally, millions of bacteria are found in the human body and trillions of bacteria are found in a single teaspoon of garden soil. Bacteria can live in many diverse environments and under conditions that are too severe for other living things. For example, some bacteria have adapted to the hot springs in Yellowstone National Park, where the water temperature can reach above the boiling point. Fungi are important decomposers in the environment. Most prefer dark, moist places. Some fungi also perform special jobs for humans. Yeast is involved in making bread, and the first antibiotic discovered, penicillin, is produced naturally by a mold fungus.

In addition to being able to live in many different environments, bacteria can reproduce quickly. Bacteria reproduce by a process called binary fission. During this process, a single cell will increase in size and divide into two new daughter cells. Therefore, one cell becomes two, two cells become four, four cells become eight, and so on. Different bacteria divide at different rates, but this process of doubling can take as little as 20 minutes to occur in ideal conditions. The bacterium usually divides in a way that the two daughter cells are exact copies of the parent cell. Fungi reproduce either asexually, by a process called budding, or sexually, by producing spores. Many fungi have complicated life cycles that depend on the environment.

So, why don't bacteria overpopulate and take over all other living things? First, bacteria are dependent on their environment to provide nutrients. When the nutrients run out, bacteria stop dividing. Second, there are many things that are able to kill bacteria. Simply using soap and water is one of the most effective methods of ridding your skin of bacteria. Third, many types of bacteria compete for the same resources. Finally, like all living things, different bacteria require different environments in which to live. Temperature, pH, sunlight, oxygen content, and food are a few factors that affect the growth of bacteria. Alter just one of these factors, and the bacteria may stop dividing or even die. Fungi also depend on their environment for nutrients. In many environments, fungi compete with bacteria for nutrients and space. Although spores are found in most places around the world, fungi do not grow everywhere.

## **MedBay: One Cell, Two Cells, Four Cells, Eight**

### **Learning Objectives**

The student will:

1. learn the phases of bacterial growth.
2. conduct an experiment to discover the presence of microorganisms in the environment
3. conduct an experiment to determine the effect of good hygiene on the growth of microorganisms.

### **Materials per Group of 3 Students**

1. *3 MedBay: MedBay: One Cell, Two Cells, Four Cells, Eight Student Activity Sheets*
2. *3 Phases of Bacteria Growth Student Activity Sheets*
3. *3 Microbe Growth Table Sheets*
4. **6** slices/chunks of boiled potato
5. **6** sterile Petri dishes
6. **6** clean cotton swabs
7. **1** new sandwich-sized zipper-top bag
8. **1** clean plastic fork
9. **1** clean cup or beaker
10. tap water
11. permanent marker

If your students will be boiling their own potatoes, each group will also need the following:

12. 500 ml beaker
13. rings and ring stands (Bunsen burner)
14. wire gauze (Bunsen burner)
15. raw, peeled potato
16. knife
17. **6** sterile Petri dishes
18. protective hand wear (kitchen mitt)
19. metal fork or tongs

For the whole class, you will also need:

20. water
21. hand soap
22. cleaning product such as dish soap, all-purpose cleaner
23. paper towels
24. duct tape
25. masking tape

To clean the Petri dishes after the activity

26. dishpan with soapy water
27. small sponge or brush
28. one 1 gallon-size sealable bag
29. one pair disposable gloves, optional
30. about 200 mL rubbing alcohol, preferably in a squirt bottle

## **Notes from the Trenches**

- Dishes from the dishwasher and freshly washed hands are nearly sterile.
- Potatoes can be sliced and boiled at home and stored covered in a clean dish overnight. Although raw potatoes can be sterilized using dish soap, they turn grey quickly, making it more difficult to see microorganism growth.
- At room temperature, bacterial growth can be observed beginning at Day two.
- If bacteria are particularly plentiful, a smear will be seen instead of individual colonies.
- It is easy to see the first three phases of growth (lag, log, and steady state). Seeing decline may require incubations longer than one week.
- Petri dishes can be washed on the top rack of the dishwasher.

## **Spotlight on Safety**

Have students observe good laboratory techniques. In addition, have students observe plates **WITH THE LIDS ON**. Depending on what they chose to swab, some of the bacteria can be harmful. If large amounts of fungi are growing, sensitive students could show an allergic reaction to breathing the spores.

## **Procedure**

### **Preparation**

1. Prior to class, place six cotton swabs into sealable sandwich bags without touching the ends, one bag for each student group. Close bags.

### **During Class**

2. Distribute the diagram of the *Phases of Bacterial Growth*.
3. Discuss the factors that may affect each stage.
4. Describe the investigation at hand. Public health officer Sirius requires everyone to test for the presence of microorganisms on themselves and in their environment. In addition, he wants to know how effective the Reconstructor's hygiene techniques are by culturing bacteria that appear after cleaning another surface and washing hands.
5. Using the diagram of the *Phases of Bacterial Growth*, describe how the bacteria that are grown in class will follow a pattern of phases.
6. Divide students into groups of three.
7. Distribute the *MedBay: One Cell, Two Cells, Four Cells, Eight Student Activity Sheet* and the *Microbe Growth Table Sheet*.
8. Have each student group brainstorm an additional surface they would like to test. Encourage each group to choose a different place. Suggestions include floor, door

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- knob/handle, computer mouse, pencil sharpener. Ask students to record their choice on the data sheet.
9. Have students follow the instructions on their sheet and have the groups record the necessary data in the microbe growth table.
  10. Alterations can be made to the procedure to test different growth environments. If a group chooses to alter the growing conditions, have them make a note on the data sheet.
    - a. Influence of UV light – bacteria grown in sunlight vs. the dark
    - b. Influence of temperature – bacteria grown in cold area or warm area
    - c. Influence of oxygen – bacteria grown with dish cover taped closed vs. not taped at all
  11. Stack the dishes from each group and tape the stack together using masking tape
  12. Store Petri dishes on the counter away from direct sunlight unless a group is testing sunlight.
  13. Have the groups analyze the colonies on Days Three through Six and answer the questions on the Data Analysis sheet. Ask them to **KEEP THE LIDS ON**.
  14. If you have time or want to introduce students to the vocabulary used by microbiologists to describe colonies, have them fill out the Colony Description Sheet for one colony.

### **Clean Up**

15. On Day Six or Seven, prepare a dishpan with soapy water
16. Set plastic bag open on the counter next to Petri dishes.
17. Dump contents of Petri dishes in plastic bag. Potatoes may stick, so grab using the plastic bag or wear gloves, if you feel more comfortable.
18. Seal bag and place in trash, or put in biohazardous waste if that is an option.
19. Put dishes in soapy water and scrub using sponge.
20. Drain water.
21. Rinse dishes with plenty of water and set out to dry.
22. Before next use, apply rubbing alcohol to all inside surfaces of each dish.
23. Alternatively, run through dishwasher on top rack.

### **MedBay: One Cell, Two Cells, Four Cells, Eight**

#### **Answers to Data Analysis**

1. *Why were the potatoes boiled in water?*  
Boiling the potatoes should kill off any bacteria that are currently living on the potato.
2. *How does incubation time affect the growth of bacteria?*  
According to the phases of bacterial growth diagram, bacteria undergo an initial lag phase. During this time the bacteria are getting used to their environment. Therefore, during a very short incubation period you do not see any growth. Once the cells have passed through the phase of exponential growth, longer incubation periods do not increase cell number. For example, during the Death Phase the number of cells decreases due to a reduction in nutrients.

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

3. *Which sample had the largest/most colonies in the shortest amount of time?*  
It will vary. (It should not be the control.)
4. *Do you think temperature would affect the growth of bacteria?*  
Yes, bacteria grow best at 37° C. Lower temperatures do not stop growth, but may slow it down. Higher temperatures can destroy the bacterial proteins and, thus, kill the bacteria.
5. *What is the purpose of the control plate?*  
The control is to show what types of bacteria grow on the potatoes, which were not killed by boiling.
6. *How did hand washing change the results?*  
Data will probably show that there is a decrease in the number of colonies on the plate of bacteria from hands that have been washed. If not, maybe the amount of time washing the hands or the amount of soap used should be increased.

### **Extension Activities**

- *Science:* Determine the effects of different detergents on the growth of bacteria or examine the effects of different mediums (potato, agar, bread) on the growth of bacteria
- *Visual Arts:* Identify the different shapes of bacteria that grow and then using household items try to create models of the different shapes.
- *History:* Research Robert Koch, who developed techniques for obtaining pure bacterial cultures.
- *Mathematics:* Calculate the growth rate of colonies in each plate (number or size of colonies over time).

## **Med Bay: One Cell, Two Cells, Four Cells, Eight**

### **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 structure and function of living systems
- Science Content Standard C: all students should develop understanding of reproduction and heredity
- Science Content Standard C: all students should develop understanding of regulation and behavior
- Science Content Standard F: all students should develop understanding of personal health

## **Books and Articles**

- Alexander, S.K., and Strete, D. 2000. Microbiology: A Photographic Atlas for the Laboratory. San Francisco: Benjamin Cummings.
- Brown, W.E., and Williams, R.P. 1990. “Cultured Taters.” Science Scope. Feb. 19-21.
- Collard, P. 1976. The Development of Microbiology. New York: Cambridge University Press.
- Sankaran, N. 2000. Microbes and People: An A-Z of Microorganisms in Our Lives. Phoenix: Oryx Press.

## **Web Sites**

Starred sites are geared toward students.

- CELLS alive! Dividing Bacteria\*  
<http://www.cellsalive.com/>
- Encyclopedia: Bacteria Reproduction  
[http://www.encyclopedia.com/html/section/bacteria\\_reproduction.asp](http://www.encyclopedia.com/html/section/bacteria_reproduction.asp)
- The Microbe Zoo\*  
<http://commtechlab.msu.edu/sites/dlc-me/zoo/>
- Scientist Hero: Robert Koch\*  
[http://www.myhero.com/hero.asp?hero=robert\\_koch](http://www.myhero.com/hero.asp?hero=robert_koch)
- Bacteriology  
<http://gsbs.utmb.edu/microbook/toc.htm>
- To help students talk about the characteristics of their colonies, look at  
[http://www.rlc.dcccd.edu/mathsci/reynolds/micro/lab\\_manual/colony\\_morph.html](http://www.rlc.dcccd.edu/mathsci/reynolds/micro/lab_manual/colony_morph.html)

### **Examples of Bacteria and Mold on Potato**

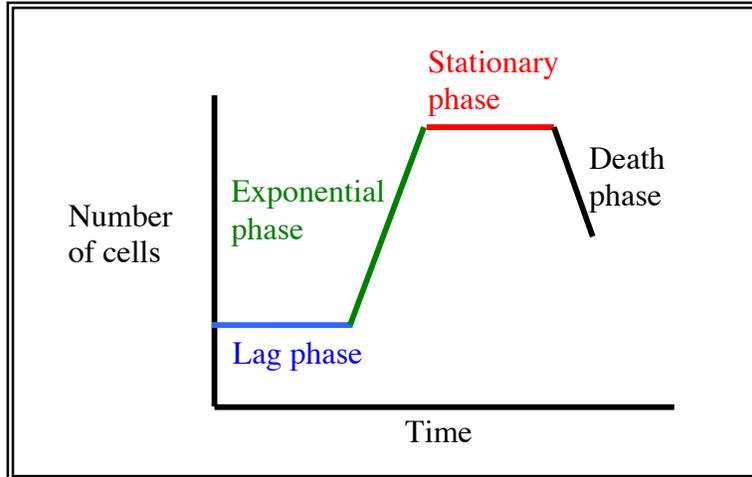


**Bacteria and possibly yeast**



**Mold**

## Phases of Bacterial Growth



The process by which bacteria reproduce is called binary fission. It is the division of one cell into two. When bacteria begin to grow, they normally proceed through four phases of growth.

1. **LAG PHASE**: During this phase the bacteria are adapting to a new environment. The number of cells does not change during this time.
2. **EXPONENTIAL or LOGARITHMIC PHASE** of growth: This is the phase where binary division occurs. During this phase, the number of cells doubles approximately every 20 minutes.
3. **STATIONARY PHASE**: During this phase, the number of bacteria remains essentially constant. This is because the dividing rate equals the rate of death. Cells begin to die due to the accumulation of waste and the depletion of the nutrients.
4. **DEATH or DECLINE PHASE**: During this phase, the death rate is greater than the dividing rate, and the number of cells decreases.



## MedBay: One Cell, Two Cells, Four Cells, Eight

Sirius requires all Reconstructors to test themselves and their area for microorganisms. Everyone must also show that he/she can perform basic hygiene.

### Materials

**Boldface** materials are required, others are only necessary if you will be boiling your own potato.

- 1. MedBay: One Cell, Two Cells, Four Cells, Eight Student Activity Sheet**
- 2. Phases of Bacteria Growth Student Activity Sheet**
- 3. Microbe Growth Table**
- 4. Colony Description Sheet (if your teacher decides to include it)**
- hot plate or Bunsen burner
- 500 ml beaker
- set of rings and ring stands (Bunsen burner)
- wire gauze (Bunsen burner)
- raw, peeled potato
- knife
- metal fork or tongs
- kitchen mitt or hot pad
- 13. six sterile Petri dishes**
- 14. sealable bag of cotton swabs**
- 15. six slices or pieces of boiled potato**
- 16. fork or tongs**
- 17. Hand soap and water**

### Procedure\*

#### Day 1:

#### Preparing Boiled Potato

**Note: If your teacher is providing you with potato slices already boiled, skip this section of the procedure.**

- Cut potato into six slices, each about 2 cm thick.
- Put slices in beaker and fill with water to 400 ml.
- Heat water and potatoes to boiling and boil for **four min.**
- Carefully pour water out of beaker. It's ok if there is a little left.
- Wearing a mitt, heat the fork or tongs until the tines turn red-hot. Use the fork to transfer each slice of potato to a separate, sterile, Petri dish. (slices may break; piece(s) will be fine).
- Cover the dish, and let the potato cool to room temperature (can cool overnight).

## Gathering Samples

7. As a group, look at the data sheet and decide which surface in the classroom you will test, for example, door knob, floor, pencil sharpener, etc.) Write it in the blank rows.
8. Using a clean fork or tongs, place some potato in each Petri dish.
9. Label the six Petri dishes: **Control**, **Table**, (your surface of choice), (your surface of choice cleaned), **Hands**, and **Clean Hands**.
10. Set the dish labeled **Control** aside. You will not apply anything to it.
11. Carefully remove on cotton swab from your bag by holding it in the middle. **DO NOT TOUCH** the end.
12. Dip the cotton swab in tap water and rub it over the surface you have chosen.
13. Open the Petri dish with the correct label and roll the cotton swab across the potato slice. Repeat to leave sufficient sample on the potato. Close dish immediately after finished.
14. Wash hands thoroughly. Collect sample from clean hands with swab, and place in proper dish.
15. Wash surface you have chosen using the cleaner provided by your teacher. Swab and apply to appropriate Petri dish.
16. Get a long piece of masking tape. Lay it sticky side up on the table.
17. Stack your dishes on top of one another.
18. Put the stack on top of the tape. See picture below.
19. Write the names of your group members and any other information your teacher requests on the tape.
20. Let plates sit at room temperature for 48 hours. Do not open the dishes, but do not seal because some bacteria and fungi need oxygen to grow.

### Day 3- 6:

1. Observe the Petri dishes for growth. **DO NOT OPEN THE DISHES.**
2. Record the observations on the provided table.
3. Fill out the Colony Description Page if instructed by your teacher.



Taped-together Petri dishes

# ***MISSION DEBRIEFING*** Student Activity Sheet

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

## Med Bay: One Cell, Two Cells, Four Cells, Eight

### Microbe Growth Table

Observations			
Plate	Day	Number of colonies	Color of colonies
Control	3		
	4		
	5		
	6		
Table	3		
	4		
	5		
	6		
_____	3		
	4		
	5		
	6		
Cleaned _____	3		
	4		
	5		
	6		
Hands	3		
	4		
	5		
	6		
Cleaned Hands	3		
	4		
	5		
	6		

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

Date \_\_\_\_\_

**MedBay: One Cell, Two Cells, Four Cells, Eight**

**Data Analysis**

1. Why were the potatoes boiled in water?
2. How does the incubation time affect the growth of bacteria?
3. Which sample had the largest/most colonies in the shortest amount of time?
4. Do you think temperature would affect the growth of bacteria? Explain.
5. What is the purpose of the control plate?
6. How did hand washing change the results?

**MedBay: One Cell, Two Cells, Four Cells, Eight**

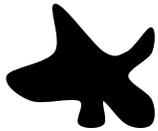
**Colony Description Page**

7. Use the following vocabulary words to describe 1 colony. Fill in your descriptions in the space provided. Remember, not all colonies will fit into these categories. Use your own words if the words below don't describe your colony.

Form - Refers to the overall appearance of the colony. View from the top.



Circular



Irregular



Filamentous



Punctate (less than 1 mm)

Elevation - How much the colony sticks up above the potato. Carefully turn plate and look sideways.



Raised

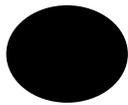


Flat



Has stalks (this goes for molds)

Margin - What the edge looks like. Look from the top and use a magnifying lens WITHOUT opening the lid, if available.



Entire (smooth)



Undulate



Filiform

**Colony 1**  
**Form**

**Elevation**

**Margin**

**Color**

**Appearance (shiny, waxy, dull, transparent, opaque, translucent)**