GRADE 11 | Interdisciplinary Global Health Curriculum

global health

WASHINGTON GLOBAL HEALTH ALLIANCE
AMBASSADORS PROGRAM

Washington Global Health Alliance

Washington Global Health ALLIANCE

ABOUT THE WASHINGTON GLOBAL HEALTH ALLIANCE

The mission of the Washington Global Health Alliance (WGHA) is to facilitate creative collaboration and initiatives with our partners. We also seek to expand research and development and educational opportunities, to improve health worldwide, and to inform the stakeholders and the public about global health.

Washington State is a premier center for work to discover and develop solutions to world health challenges. The state's global health leaders recognize that combining efforts to create life-saving technologies and train compassionate global health leaders is essential to make significant progress to save lives.

WGHA was formed in 2007 to foster new partnerships within the extraordinary concentration of global health nonprofits, research organizations, and educational institutions in Washington State. We focus on four areas: research, technologies, and programming; education, training, and mentoring; advocacy and outreach; and public-private partnerships.

WGHA's partner organizations have been collaborating for over 30 years to creatively address global health challenges. Hope for even more efficient and effective innovation stems from the combined efforts of our executive partners:

- Fred Hutchinson Cancer Research Center
- Global Alliance for the Prevention of Prematurity and Stillbirth, an initiative of Seattle Children's
- Infectious Disease Research Institute
- Institute for Systems Biology
- Pacific Northwest National Laboratory
- PATH
- Public Health—Seattle & King County
- Seattle Biomedical Research Institute
- University of Washington Department of Global Health
- Washington State University School for Global Animal Health
- Bill & Melinda Gates Foundation

Washington Global Health Alliance web site: http://www.wghalliance.org/

ABOUT THE WASHINGTON GLOBAL HEALTH ALLIANCE AMBASSADOR PROGRAM

The WGHA Ambassador Program is a pilot project designed to introduce global health into Washington State high schools. The program brought together a team of teachers and administration officials from four high-needs high schools to develop and pilot an innovative, problem-solving, interdisciplinary global health learning community. The Ambassador curriculum is designed for eleventh grade students and provides learning opportunities for the following three courses: U.S. History, Advanced Algebra and Chemistry. With support from the Bill & Melinda Gates Foundation, the Ambassador schools receive on-site mentoring opportunities, global health resources and student internships at participating WGHA organizations.

WGHA Ambassador Program Website: http://www.wghaa.org/

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TABLE OF CONTENTS

Overview for Advanced Algebra Teachers

This Global Health Curriculum provides advanced algebra teachers with 12 lesson plans, as well as two introductory lessons and four background readings. Each lesson plan provides an opportunity to bring real-world issues and problems into the math classroom. These activities will help your students understand the connections between advanced algebra content, and how mathematics can be used to analyze societal problems and develop viable solutions.

CURRICULUM MAP

A sample year-long curriculum map for a typical 11th grade Advanced Algebra course is provided below. The curriculum map shows connections between each of the global health lesson plans and math content.

SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY
Review of basic algebra Functions and relations	Linear functions Manipulating functions	Systems of linear functions Functions and relations	Quadratic functions	Exponential functions Logarithmic functions
Intro Lessons & **Pre-Test**	TB in Swaziland Influenza Swine Flu Case Study Influenza H1N1 Mortality Rates	Influenza Outbreak in Infectburg		TB Has Wings Take TB Seriously Malaria Climate Change & Malaria Cholera/Malaria Log Scales, Cholera & Malaria

FEBRUARY	MARCH	APRIL	MAY	JUNE
Polynomial functions Data filing	Rational functions	Irrational functions	Sequences Probability	Trigonometric functions
Malaria Bumba's Dilemma	Cholera Outbreak? Cholera Circle of Contamination	Malaria Bed Nets & Rewriting Irrational Functions		**Post-Test**

LESSONS AT A GLANCE ADVANCED ALGEBRA

The 14 advanced algebra lesson plans in this curriculum provide students with the opportunity to study math content within the context of cholera, influenza, malaria, and tuberculosis. A brief description of each of the lesson plans is provided below.

INTRODUCTION TO GLOBAL HEALTH

Student Background Readings

Four background readings are provided in this section: cholera, influenza, malaria, and tuberculosis. Each reading should be assigned prior to delivering a lesson related to that disease.

Lesson #1: Global Health Careers & Challenges

Activity Time: 50 minutes
(plus additional homework)

In this lesson, students will take a brief pre-test, read career case studies, and view a short video about the variety of global health careers.

Lesson #2: Global Health Facts

Activity Time: 50 minutes

In this lesson, students will view a video segment from *Rx for Survival*, participate in a team question and answer exchange, and explore career options using the BioQuest career website.

CHOLERA

Lesson #1: Log Scales, Cholera & Malaria

Activity Time: 50 - 100 minutes

In this lesson, students will become familiar with a Cholera Model Diagram that shows the path of the cholera bacterium, *V. cholerae*. Students will explore the mathematical model of $\lambda(B)$, which models the probability of a person catching cholera. Students will also find an association between poverty and the prevalence of malaria. In addition, students will change linear axes to logarithmic axes to better view data.

Lesson #2: Outbreak?

Activity Time: 100-150 minutes

In this lesson, students will take on the role of a consultant for the World Health Organization and will be challenged to recommend how Zimbabwe's Minister of Health should spend his money in order to protect a community from a cholera outbreak. Students will explore direct and indirect functions and their applications to a possible cholera outbreak.

Lesson #3: Circle of Contamination

Activity Time: 50 minutes

In this lesson, students will graph and interpret a graph of an inverse square variation function. Using the scenario of a water source contaminated with *V. cholerae*, students will calculate the spread of the bacteria in a circular pattern over time and calculate a person's probability of cholera infection.

INFLUENZA

Lesson #1: Swine Flu Case Study

Activity Time: 100 minutes

In this lesson, students will practice their skills in moving between the four representations of a linear set of data. Students will analyze rates of infections as one of the factors that determines if an influenza virus is considered as endemic, epidemic, or pandemic.

Lesson #2: H1N1 Mortality Rates

Activity Time: 100 minutes

In this lesson, students use CDC data to predict the severity of a H1N1 outbreak both in terms of infection rates and mortality rates.

Lesson #3: Outbreak in Infectburg

Activity Time: 100 minutes

In this lesson, students will solve systems of equations using graphing, equations, charts or pictures. They will use these solutions to guide their logistical planning to respond to an influenza outbreak in a rural town called Infectburg.

MALARIA

Lesson #1: Climate Change & Malaria (or Why Mosquitoes Don't Want You to Know about Climate Change)

Activity Time: 50 minutes

In this lesson, students will use an exponential graph and equation to determine the relationship between temperature and incubation time of the malaria-causing parasite, *Plasmodium falciparum*, in mosquitoes.

Lesson #2: Bumba's Dilemma—Malaria and Drug Resistance

Activity Time: 100 minutes

In this lesson, students consider a case study involving a district health officer from the Democratic Republic of the Congo who is considering whether to purchase new anti-malarial drugs, since the drugs he has been using are losing their effectiveness as the parasite develops drug resistance. Students use matrices and graphing calculators to find the coefficients of a polynomial that fits all of the data points given.

Lesson #3: Bed Nets and Rewriting Irrational Expressions

Activity Time: 55 minutes

In this lesson, students investigate the long-term effectiveness of bed nets treated with two different types of insecticide. Students evaluate an expression, and in doing so, they must simplify radical expressions.

TUBERCULOSIS

Lesson #1: TB in Swaziland

Activity Time: 60-90 minutes

In this lesson, students will learn about the high HIV and TB rates in Swaziland and determine the amount of aid that can be provided with a very strict health care budget. Students will set up and graph the solution to a system of inequalities.

Lesson #2: Tuberculosis Has Wings

Activity Time: 90 minutes

In this lesson, students will take on the role of WHO officials dealing with an airline passenger who is infected with Extensive Drug Resistant TB (XDR TB). Students will evaluate growth and/or decay data stemming from factors contributing to the growth and/or decay of tuberculosis.

Lesson #3: Take TB Seriously

Activity Time: 150 minutes

In this lesson, students will analyze TB data from different countries and then determine the mathematical model that the data fits. Students will analyze graphs of TB death rates and mathematically derive data/patterns within that can be used to inform and persuade a country to increase their TB prevention measures.

Overview for Chemistry Teachers

This Global Health Curriculum provides chemistry teachers with 11 lesson plans (including three wet labs), as well as two introductory lessons and four background readings. Each lesson plan provides an opportunity to bring real-world issues and problems into the chemistry classroom and laboratory. These activities will help your students understand the connections between chemistry content, societal problems, and scientific solutions.

CURRICULUM MAP

A sample year-long curriculum map for a typical 11th grade General Chemistry course is provided below. The curriculum map shows connections between each of the global health lesson plans and chemistry content.

SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY
Measurement Structure of matter	Nomenclature	Periodic properties of matter	Chemical bonding	The mole
Intro Lessons & **Pre-Test** TB Colony Measurement			TB Molecular Models Cholera Soap Lab	Cholera Oral Rehydration Therapy Challenge TB Colony Measurement

TB Article Review can be taught throughout the year

FEBRUARY	MARCH	APRIL	MAY	JUNE
Chemical reactions Stoichiometry	States of matter Intermolecular forces	Gas chemistry	Solutions Acids and bases	Organic chemistry
Malaria Stopping the Runs with Folk Medicine Malaria Column Chromatography Lab			TB Mg's Per Kg's Influenza Vaccine Chemistry Lab	Cholera Soap Lab Malaria Structure of DDT–Part I Malaria Structure of DDT–Part II **Post-Test**

LESSONS AT A GLANCE CHEMISTRY

The 11 chemistry lesson plans in this curriculum provide students with the opportunity to study chemistry content within the context of cholera, influenza, malaria, and tuberculosis. A brief description of each of the lesson plans is provided below.

INTRODUCTION TO GLOBAL HEALTH

Student Background Readings

Four background readings are provided in this section: cholera, influenza, malaria, and tuberculosis. Each reading should be assigned prior to delivering a lesson related to that disease.

Lesson #1: Global Health Careers & Challenges

Activity Time: 50 minutes
(plus additional homework)

In this lesson, students will take a brief pre-test, read career case studies, and view a short video about the variety of global health careers.

Lesson #2: Global Health Facts

Activity Time: 50 minutes

In this lesson, students will view a video segment from *Rx for Survival*, participate in a team question and answer exchange, and explore career options using the BioQuest career website.

CHOLERA

Lesson #1: Oral Rehydration Therapy Challenge

Activity Time: 100 minutes

In this problem-based activity, students will be challenged to offer solutions for a cholera outbreak in central Africa that requires the implementation of an oral rehydration program.

Lesson #2: Soap Lab

Activity Time: 100 minutes

In this hands-on lesson, students will learn about saponification, the chemistry involved in creating soap. Students will understand how soap is a simple, low-cost method of decreasing exposure to many communicable diseases, including diarrheal illnesses such as cholera. This lesson fits well within the study of organic chemistry and saponification.

INFLUENZA

Lesson #1: Vaccine Chemistry Lab

Activity Time: 60-120 minutes

In this lesson, students will learn how dilution calculations and titrations can play a role in the administering of the influenza vaccine. Students will also learn the process that is undertook in developing the flu vaccine and learn of current research in making the flu vaccine go further with the use of an adjuvant. Students will also participate in an acid/base titration lab.

MALARIA

Lesson #1: Stopping the Runs with Folk Medicine—An Exploration of Intermolecular Forces & Solubility

Activity Time: 50 minutes

In this lesson, students will explore the connection between molecular structure, intermolecular forces, and solubility by examining how guava leaf is used in folk medicine to treat diarrhea, a symptom of malaria. This lesson may stand-alone, or may be used as background and preparation for the *Column Chromatography of Plant-Leaf Extract Wet Lab.*

Lesson #2: Column Chromatography of Plant-Leaf Extract Wet Lab

Activity Time: 120 minutes

This experiment is intended to reinforce the lesson *Stopping the Runs with Folk Medicine*, in which the properties of intermolecular attraction are explored. In this experiment, an acetone extraction of plant leaves is performed, and the various components in the extract are separated using column chromatography. All of the required materials are relatively inexpensive, and can be purchased at grocery, drug, or hardware stores.

Lesson #3: Structure of DDT—Part I

Activity Time: 100 minutes

In this lesson, students will discuss the big idea of "science and technology in society." Students will learn about DDT as a way to prevent malaria. Students will categorize different molecules into polar/non-polar functional groups, including the DDT molecule.

Lesson #4: Structure of DDT—Part II

Activity Time: 55 minutes

In this lesson, students will discover the polar/non-polar qualities of DDT that make it interact with cell membranes, using soap for comparison. By examining DDT's functional group and structure, students will understand how it works as a pesticide.

TUBERCULOSIS

Lesson #1: TB Colony Measurement

Activity Time: 90 minutes

In this lesson, students will use black peas to model TB bacterium within colonies of various sizes and over different periods of time. Students will use the SI system and appropriate mathematical concepts to devise two methods for identifying how many bacterium are within their colony.

Lesson #2: TB Molecular Models

Activity Time: 90 minutes

In this lesson, students will construct molecular models of various functional groups and compounds that make up the tuberculosis bacterium cell membrane. This activity will show students that molecules are three-dimensional and that their different geometries are responsible for how they react with other molecules. Students will further study how the shape of these functional groups and compounds are effective at protecting the bacterium from immunological agents and antibiotics.

Lesson #3: Article Review

Activity Time: 60 Minutes

In this lesson, students will critically read articles about tuberculosis. The instructor will review technical reading skills including, but not limited to, interpreting graphics, using contextual clues, and building technical vocabulary. Students will select, read, and critically review one scientific article about tuberculosis.

Lesson #4: Mg's Per Kg's

Activity Time: 90 minutes

In this lesson, students will determine the appropriate amount of antibiotic to give to various member of their family in order to maintain a consistent mg/Kg concentration. This activity will provide students with the understanding that dosage varies between individuals in order to maintain consistent concentrations.

Overview for U.S. History Teachers

This Global Health Curriculum provides U.S. history teachers with 13 lesson plans (including three Classroom-Based Assessments), as well as two introductory lessons and four background readings. Each lesson plan provides an opportunity to bring real-world issues and problems into the U.S. history classroom, and to examine the U.S.'s role in global health. These activities will help your students understand the connections between history content, historical problems, and how we can develop successful outcomes for contemporary problems based on our knowledge of the past. Three of the lesson plans can also be used to satisfy the requirements of three Classroom-Based Assessments (CBAs).

CURRICULUM MAP

A sample year-long curriculum map for a typical 11th grade U.S. History course is provided below. The curriculum map shows connections between each of the global health lesson plans and history content.

SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY
Colonization (1492-1763) Creating a nation (1763-1815)	Growth & change (1790-1860)	War & ramification (1820-1900)	A nation transformed (1860-19190)	
Intro Lessons & **Pre-Test** Malaria & African Slavery–Part I Malaria & African Slavery–Part II	Cholera Blue Death in 5 Points NY			

FEBRUARY	MARCH	APRIL	MAY	JUNE
Immigration Urbanization Becoming a world power (1897-1920)	Prosperity & crisis (1898-1919) Roaring 20's Great depression	World conflicts (1921-1960) WWII Cold war conlicts 1950's	Changing home front (1954-1978)	Modern times (1968-Present)
	Influenza Spanish Flu Pandemic of 1918 Influenza 1918; What Worked and What Didn't	Malaria Eradicating DDT Malaria DDT Debate	Influenza Swine Flu: Lessons Learned from 1976 Historical Perspectives of TB Cholera Foreign Policy & Gobal Health	Influenza Recommendations for Public Health Influenza The Next Plague TB Flight **Post-Test**

LESSONS AT A GLANCE U.S. HISTORY

The 13 U.S. history lesson plans in this curriculum provide students with the opportunity to study history content within the context of cholera, influenza, malaria, and tuberculosis. A brief description of each of the lesson plans is provided below.

INTRODUCTION TO GLOBAL HEALTH

Student Background Readings

Four background readings are provided in this section: cholera, influenza, malaria, and tuberculosis. Each reading should be assigned prior to delivering a lesson related to that disease.

Lesson #1: Global Health Careers & Challenges

Activity Time: 50 minutes (plus additional homework)

In this lesson, students will take a brief pre-test, read career case studies, and view a short video about the variety of global health careers.

Lesson #2: Global Health Facts

Activity Time: 50 minutes

In this lesson, students will view a video segment from *Rx for Survival*, participate in a team question and answer exchange, and explore career options using the BioQuest career website.

CHOLERA

Lesson #1: Blue Death at 5 Points NY

Activity Time: 200 minutes

In this lesson, students will read an article about the 1832 cholera outbreak in NY. They will then generate questions based on the "big ideas" in the article. Students will then work in groups to research one of their own questions. Groups will write a brief regarding their question and present it to the class.

Lesson #2: Foreign Policy & Global Health

Activity Time: 300 minutes

In this lesson, students will complete the "U.S. Foreign Policy" Classroom-Based Assessment (CBA) while focusing on a global health issue. Students will examine the motivations that drive foreign aid.

INFLUENZA

Lesson #1: Spanish Flu Pandemic of 1918

Activity Time: 90 minutes

In this lesson, students will become familiar with the Spanish Flu pandemic of 1918. Students will see how governments, communities, and individuals struggled to cope with the staggering losses and challenges of this pandemic.

Lesson #2: 1918—What Worked and What Didn't

Activity Time: Two 50 minute periods

In this lesson, students will read about government and community responses to influenza pandemics. Students will research different cities' and states' responses to the 1918 pandemic, including Boston, San Francisco, Philadelphia, Washington, and Georgia.

Lesson #3: Swine Flu—Learning from 1976

Activity Time: 30-45 minutes

In this lesson, students will read news stories to learn about an unsuccessful public response to a possible influenza pandemic.

Lesson #4: The Next Plague

Activity Time: 90 minutes

In this lesson, students will view the film *The Next Plague: Avian Influenza* and will describe how governments have responded to avian influenza outbreaks.

Lesson #5: Recommendations for Protecting Public Health

Activity Time: 90 minutes

In this lesson, students will identify and evaluate recommendations for safeguarding public health in the case of an influenza pandemic. Students will communicate their recommendations in the form of a letter to a newspaper editor, a public health official, or an elected official.

MALARIA

Lesson #1: Malaria & African Slavery—Part I

Activity Time: 50 minutes

In this lesson, students will investigate the pragmatic reasons that led to Africans being chosen as slaves. Students will read excerpts from *Medical Apartheid*, *Mosquito: The Story of Man's Deadliest Foe*, and *A People's History of the United States*. In addition, they will be asked to complete a question and inference chart. Students will then answer one of their own questions that has been selected by the teacher.

Lesson #2: Malaria & African Slavery—Part II

Activity Time: 100 minutes

In this lesson, students will use a Socratic Seminar to examine the three readings that were introduced in the *Malaria & African Slavery—Part I* lesson. Students will gain an deeper understanding the issues, ideas, and principles contained in these documents, and how it conflicts with different perspectives and the students' own ideas.

Lesson #3: Eradicating Malaria

Activity Time: 150 minutes

In this lesson, students will conduct research on one of the seven methods used to control or eradicate malaria. After obtaining some mastery over their subject, the new "experts" will then teach the class their method through a presentation with a focus on how these methods balance the common good with the rights of the individual.

Lesson #4: DDT Debate

Activity Time: 200 minutes

In this lesson, students will engage in a debate over the use of DDT to control mosquitoes and malaria. Students will consider which treatment methods best balance the rights of the individual with what is best for society as a whole. This lesson can be used to fulfill the Classroom-Based Assessment (CBA) *Dig Deep*.

TUBERCULOSIS

Lesson #1: Historical Perspectives of TB

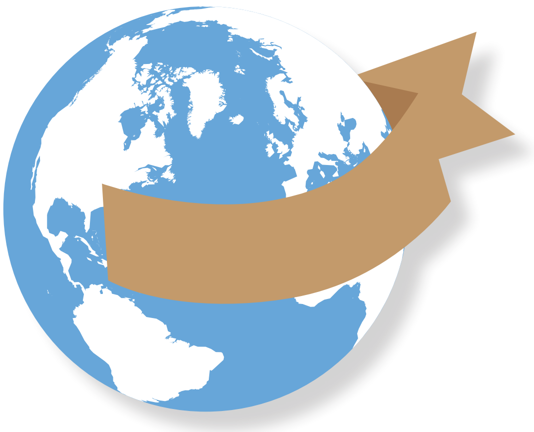
Activity Time: 250 minutes

In this lesson, students will explore the impact of sanatoriums on society through several different perspectives. Each student will be assigned a perspective (medical professional, political leader, or TB patient). Students will research how sanatoriums came to be, the conditions of the sanatoriums, and successes and failures of the sanatoriums in terms of curing TB. Once research is complete they will write a narrative for the Library of Congress to keep on file that tells their story from their perspective (similar to the slave narratives).

Lesson #2: TB Flight

Activity Time: 270 minutes

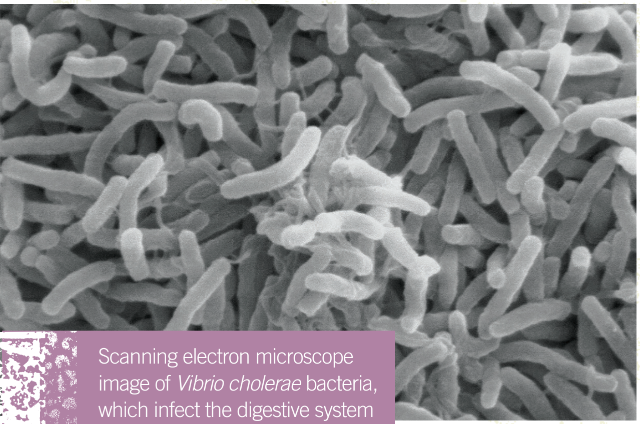
In this lesson, students will fulfill the Classroom-Based Assessment (CBA) *Constitutional Issues* by answering the following question: "Should the United States government have the right to quarantine infected individuals in order to protect the common good?"



global health INTRODUCTION

Name:______________________________ Date:___________ Period:_________

THE STORY OF CHOLERA



Scanning electron microscope image of *Vibrio cholerae* bacteria, which infect the digestive system

Source: http://remf.dartmouth.edu/, Zeiss DSM 962 SEM

HANDOUT

The pandemics of cholera also had a positive effect: the fear and horror of cholera promoted the establishment of a public health system within many countries, fostered the nursing profession, and inspired the formation of international bodies to monitor and control the global spread of all infectious diseases.

– Twelve Diseases that Changed our World

CHOLERA AT A GLANCE

Infectious Agent:	Cholera bacterium *(Vibrio cholerae)*
Transmission:	Human/environment transmission from contaminated water or food, often a result of poor hygiene, sanitation, and lack of clean water; also human-to-human transmission from a lack of proper hand washing
Symptoms:	Severe, acute diarrhea and vomiting; can lead to severe dehydration, shock, kidney failure, and respiratory failure
Prevention:	Good hygiene and hand washing practices, proper sanitation, access to clean water, cholera vaccine
Treatment:	Oral rehydration therapy, increased breastfeeding for infants

THERE'S SOMETHING IN THE WATER

Cholera is a horrible disease. At first, the symptoms produce no more that a surprised look as the bowels empty without any warning. Then surprise changes to agony as severe cramping pains begin. Copious quantities of liquid, resembling rice water, pour through the anus. As the pain intensifies, the only small relief is to draw oneself into a ball, chin held against the knees; the body cannot be unrolled and the victim has to be buried in the fetal position. Those who do not die from this first attack suffer a slow and painful decline. Then cheeks become hollow, the body liquids surge more slowly but still remain beyond control, and the watery stools contain fragments of the intestinal lining. As the hours pass, the skin darkens, the eye stare vacantly without comprehension, and then life ends.

~Twelve Diseases that Changed our World,

The Burden of Cholera

1.8 million	deaths per year globally from diarrheal diseases
131,943	cases of cholera reported worldwide in 2005
8,000	new cases per week reported during the height of the current Zimbabwe cholera epidemic
$770 million	Peru's economic burden from a 1991 cholera outbreak
$.02	cost per child for homemade oral rehydration therapy
1 Quart	amount of body fluid lost per hour from diarrhea and vomiting from cholera infection
2 drops	amount of bleach needed to purify one liter of water
50%	of people die with severe dehydration from cholera die if untreated
1%	of people die with severe dehydration from cholera die if treated with oral rehydration therapy

What is it?

Cholera is a diarrheal disease caused by ingestion of the bacterium *Vibrio cholerae*. Diarrheal diseases—which include cholera—cause 4.1% of the total global burden of disease and are most concentrated among infants and children in developing countries. Cholera can sicken and kill both children and adults. People with weak immune systems, such as people with HIV/AIDS or malnourished children, are at the greatest risk of dying from a cholera infection.

Cholera is also called "blue death," "blue cholera," or "Asiatic cholera." Outbreaks often occur in urban slums, in crowded refugee camps, or following a natural disaster where people do not have access to proper toilet facilities and clean water. Cholera is believed to have an aquatic reservoir, which means that the bacteria can live in lakes, rivers, streams, ponds, and bays.

Cholera is both an infectious disease and a societal disease because it is often linked with poverty, crowded living conditions, and poor sanitation.

Did You Know?

There have been seven cholera pandemics in the past 200 years. The seventh pandemic began in 1961 and is still going on right now.

Did You Know?

During the 1932 cholera outbreak in New York City, an artist visited hospital patients and drew their portraits. These grisly portraits show patients with blue skin, caused by respiratory failure.

How is it transmitted?

Cholera bacteria is shed in the feces of an infected person. Cholera is mostly caused by human/environment transmission when a person drinks water or eats food that is contaminated with cholera bacteria. Cholera can also be caused from human-to-human transmission when a person does not properly wash his hands with soap and clean water after toileting or changing a diaper.

How does it work in the body?

Once cholera bacteria is ingested, it produces a toxin inside the human body that prevents the body from being able to absorb liquids, while at the same time causing the body to dump fluids through acute, severe diarrhea and vomiting. Cholera kills by causing severe dehydration, which causes shock and kidney failure. It can also cause respiratory failure.

Cholera bacteria sticks to cell membranes inside the intestines and creates pores in the membranes, allowing water to leak through pores and out of the cells. Along with the water, the cells also leak nutrients—like sugar—and the salt ions sodium and chloride.

What are the symptoms?

Most people who become infected with cholera never present any symptoms. About 1 in 10 people will have mild symptoms, including some diarrhea and cramping. But for the 1 in 20 people who develop severe symptoms, they will quickly become ill and can die within hours. Any person who is infected with cholera sheds the bacteria in their feces for about 7-14 days after infection, whether or not they show any symptoms of the disease.

Cholera has a short incubation period, as the bacteria are able to multiply quickly inside the intestines. Within 24-48 hours of infection, the first symptoms appear.

Focus On:
Dr. John Snow (1813-1858)

London physician Dr. John Snow, is credited as being the father of epidemiology. Dr. Snow made his discoveries while studying a cholera outbreak in London in 1854. By drawing maps, interviewing residents, and collecting water samples, Dr. Snow was able to trace the cholera outbreak to its source: a water pump on Broad Street was providing residents with contaminated water. Dr. Snow was even able to determine that the entire outbreak began when a mother washed her infant's diapers, who was sick with cholera, in a backyard cesspool located next to a well.

Did You Know?
It is possible that sewage—and the diseases that it causes—has killed more people than smallpox and bubonic plague combined.

The tell-tale symptom of cholera is the sudden onset of severe, watery diarrhea. This diarrhea is unlike any other; copious amounts of fluid are released. The fluid often looks milky and is specked with white intestinal tissue, dead cells, and mucus, earning it the nickname "rice water stools." Nausea, vomiting, and severe stomach and muscle cramps follow. As the body becomes dehydrated, secondary symptoms appear, including thirst, sunken eyes, dry mouth, shriveled fingertips, little to no urine, and low blood pressure. If left untreated, the severe dehydration will cause shock, kidney failure, or respiratory failure. Respiratory failure causes the skin of some people who die from cholera to take on a blue hue. Death can come as quickly as a few hours after onset of symptoms.

How can it be prevented?

The most effective strategies for preventing cholera outbreaks is to stop its transmission. To prevent cholera outbreaks, people need to be provided with a clean water source, proper toilet facilities, good sanitation systems, encouraged to keep out of polluted waterways, and taught about proper hand washing and safe food handling strategies. However, these strategies can be costly and may be impossible for some rural villages, urban slums, and refugee camps to obtain.

For some people, it is impossible to gather or purchase enough fuel to boil water to kill pathogens. One strategy that has been employed in India is to teach people to take a household fabric, such as the cloth traditionally used in saris, fold it over four times, and pour water through the cloth. When folded four times, sari cloth effectively filters out cholera bacteria.

Halogen-releasing chemicals, such as bleach, are another strategy for treating water and killing pathogens. Just two drops of bleach are all it takes to make 1 liter of water safe to drink.

Women and children collect water from a neighborhood tap

Source: PATH

A cholera vaccine is available, but due to its low effectiveness, is usually used to help control existing cholera outbreaks, rather than as a prevention strategy. The vaccine is not used in the U.S.

What treatments are available?

The most effective, inexpensive, and simple way to treat cholera is to replace the salts, nutrients, and fluids lost through diarrhea and vomiting. An effective oral rehydration therapy (ORT) program involves mixing up a specific recipe of salt, sugar, and clean water and giving it in large volumes until dehydration symptoms diminish. Mothers of infants are encouraged to increase breastfeeding to keep their babies hydrated. In the most serious cases, intravenous fluid replacement and antibiotics may be necessary.

A pre-packaged oral rehydration therapy packet is mixed with clean water

Source: PATH

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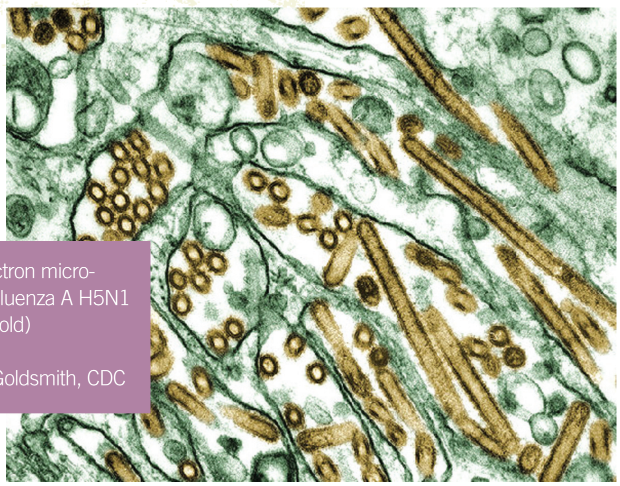
Name:__________________________ Date:__________ Period:_______

HANDOUT

THE STORY OF INFLUENZA

In the world of human afflictions, the general public often overlooks influenza, considering it an unwanted guest that must be endured during the winter months. But few diseases match the year-in, year-out power of this deadly viral infection.

~Rx for Survival



Transmission electron micrograph of Avian influenza A H5N1 viruses (seen in gold)

Source: Cynthia Goldsmith, CDC

INFLUNZA AT A GLANCE

Infectious Agent:	Influenza virus
Transmission:	Human-to-human transmission from airborne droplets in coughs and sneezes, or contact with body fluids
Symptoms:	Fever, chills, headache, muscle aches, weakness, sore throat, chest pain, nasal congestion, and cough; can cause pneumonia
Prevention:	Influenza vaccine for current strains, good hygiene, covering coughs and sneezes
Treatment:	Anti-viral drugs

SEASONAL VISITOR & GLOBAL PANDEMIC

What is it?

Influenza is a respiratory illness caused by a viral infection. It is also called "flu" and "grippe." Influenza affects birds and mammals, including pigs, dogs, horses, and seals. The influenza virus can jump and mutate between humans and animals.

There are three strains of the influenza virus—types A, B, and C. Type A is the most serious strain and can cause global pandemics. It includes H1N1 (Spanish flu of 1918 and current swine flu) and H5N1 (current avian flu). Type B is a less serious form and does not cause global pandemics. Type C is less common and less serious, usually only causing localized epidemics.

Two types of influenza have received much attention in the news: H1N1 and H5N1. H1N1 (originally called swine flu) is the influenza strain that caused a global pandemic that began in 2009. The virus spreads from person-to-person. It was originally called swine flu because the virus has genes from swine, birds, and humans.

The Burden of Influenza

$166.5 billion	estimated economic impact of the next severe influenza epidemic in the U.S.
50–100 million	estimated number of people who died from the 1918 flu pandemic
250,000–500,000	people who die worldwide each year from influenza
37,000	Americans who die each year from influenza

I had a little bird; its name was Enza.
I opened the window; and in-flu-enza.

~Children's rhyme from 1918

The young American soldier had been dispatched to fight in the "war to end all wars." He never fired a shot. Instead, he lay helpless on a hospital cot, wounded by a force more deadly than that launched by the enemy. It had begun innocently enough: headache, chills, and fever. Pains in his joints prevented him from standing. He became nauseated; he began to sweat and he vomited. The mucous membranes of this throat and nose were congested, and he had a persistent cough. Lips, ear, nose, checks, tongue and fingers – his entire body began to turn an indigo blue color. The stench of corruption filled his nostrils; it was the sweetish sickening smell of rotting flesh. It was the breath of death. Suddenly blood began to pour form his body – at first a trickle from the nose, mouth, and ear and around the eyes, and then it gushed. His lungs were being ripped apart. At autopsy the doctor said the soldiers' lungs resembled "melted currant jelly."

The disease that killed the young recruit that day in the fall of 1918 would over the next two years, kill another 22 million. They were all killed by influenza for this there was no cure. Influenza is an ancient disease that has caused worldwide outbreaks at irregular intervals throughout recorded history.

~Twelve Diseases that Changed our World

Did You Know?

Influenza is a zoonotic disease, meaning that some influenza strains jump from animals to people. Swine flu and bird flu are examples of zoonotic strains.

A poultry worker at a chicken farm in Thailand

Source: WSU

H5N1 (also called avian or bird flu) is an influenza strain that infects migratory birds and poultry, and has been known to jump from birds to people.

How is it transmitted?

Both seasonal and novel viruses like H1N1 are transmitted from human-to-human when a person inhales airborne droplets from the cough or sneeze of an infected person. The virus can also be transmitted when a person comes in contact with the body fluids of an infected person and then touches their mouth or nose. A person infected with the influenza virus can be contagious up to one day before any symptoms develop and up to five days after symptoms develop.

How does it work in the body?

An influenza virus can enter the body through the nose (inhalation) or mouth (ingestion). Once the influenza virus enters the body, it travels to the respiratory tract where it binds to the surface of cells. Like most viruses, the influenza virus enters the cell's nucleus, begins to replicate itself, and finally bursts out of

Did You Know?

All influenza strains are named with two letters and two numbers, such as H1N1 or H5N1. The letters “H” and “N” refer to the proteins hemagglutinin and neuraminidase that are located on the surface of the virus. The numbers refer to slight variations in each protein.

the cell in search of new cells to infect. The virus continues to travel through the bloodstream and respiratory tract until the immune system is able to fight off the virus.

What are the symptoms?

Symptoms of influenza first appear about 1-4 days after the virus has entered the body. Common symptoms include fever, chills, headache, muscle aches, weakness, sore throat, chest pain, nasal congestion, and cough. The infection can also cause pneumonia, which can be fatal.

Some people are at a higher risk of complications from seasonal influenza. This includes the elderly, children ages five and younger, pregnant women, and people with other serious health conditions. However, who is most at risk depends on the influenza strain. The influenza virus of 1918 caused the most problems among healthy young adults. The novel H1N1 virus that appeared in 2009 does not seem to place elderly people at heightened risk.

How can it be prevented?

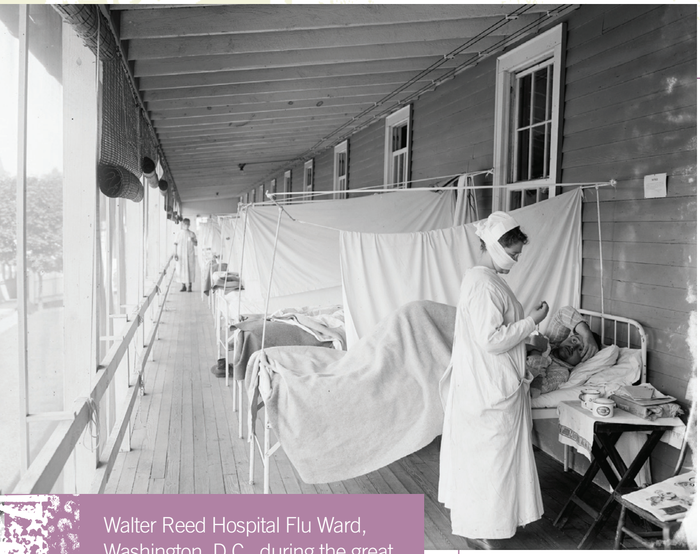
People can protect themselves from influenza by practicing good hygiene (hand washing!), covering coughs and sneezes, and by getting vaccinated for the current strain of the virus. There are two types of vaccines, a shot containing a killed virus and a nasal-spray containing live, weakened virus.

What treatments are available?

The symptoms of influenza can be treated with rest, plenty of fluids, and over-the-counter pain medicine. Influenza antiviral drugs can be prescribed by a doctor to reduce the severity and length of influenza symptoms.

Did You Know?

There were three influenza pandemics in the 20th century: 1918, 1957, and 1968.



Walter Reed Hospital Flu Ward, Washington, D.C., during the great influenza pandemic of 1918

Source: Harris & Ewing, Library of Congress website

Focus On:
The Great Influenza of 1918-19

In 1918, just as World War I was coming to an end, a silent killer began its march around the globe. It was known as Spanish Flu, La Grippe, the Great Influenza, and the Flu of 1918. Traveling along trade routes, and following the mobilization of military troops, the virus spread quickly around the world. This H1N1 avian influenza A virus was highly infectious, killing between 50-100 million people globally, including an estimated 675,000 Americans. Just as quickly as the virus appeared, it mutated into a milder form and quietly disappeared. More people died from the virus than from World War I. It is considered to be one of the worst pandemics in recorded history.

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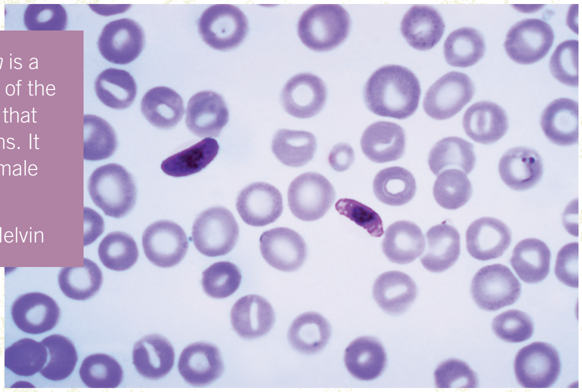
HANDOUT

THE STORY OF MALARIA

Malaria kills more children than AIDS, TB, or any other disease.

~Malaria No More



Plasmodium falciparum is a protozoan parasite, one of the species of *Plasmodium* that cause malaria in humans. It is transmitted by the female Anopheles mosquito

Source: CDC/Dr. Mae Melvin

MOSQUITOES DELIVER MALARIA

The female *Anopheles* mosquito may well be the most dangerous creature on Earth. When she lands on human skin, she sucks up blood through her needle-shaped mouth and injects saliva into the wound. If this saliva contains *Plasmodia* parasites, the victims will soon suffer severe fever, violent shivering, and profuse sweating — the telltale symptoms of malaria.

~Rx for Survival

MALARIA AT A GLANCE

Infectious Agent:	Parasite protozoa (*Plasmodium*)
Transmission:	Human/animal transmission from the bite of an infected Anopheles mosquito
Symptoms:	Fever, chills, and sweating that occur in a 1, 2, or 3 day cycle; anemia, jaundice, diarrhea
Prevention:	Mosquito prevention strategies including insecticides, bed nets, and insect repellants; A vaccine is in the development phase
Treatment:	Anti-viral drugs

Did You Know?

Currently, malaria is a serious problem in 90 countries/territories around the world. 90% of deaths from malaria occur in Africa south of the Sahara.

What is it?

Malaria is a serious disease caused by a bite from a certain type of mosquito that is infected with a *Plasmodium* parasite. It is considered a tropical disease because it occurs mostly in tropical regions of the world, where the temperature and climate are friendly to mosquitoes and the *Plasmodium* parasite. Malaria is a serious problem in Africa, as well as Latin America and Southeast Asia. Historically, it was once a serious problem in the U.S.

Malaria is categorized as an infectious disease, a tropical disease, as well as a societal disease because it is often linked with poverty.

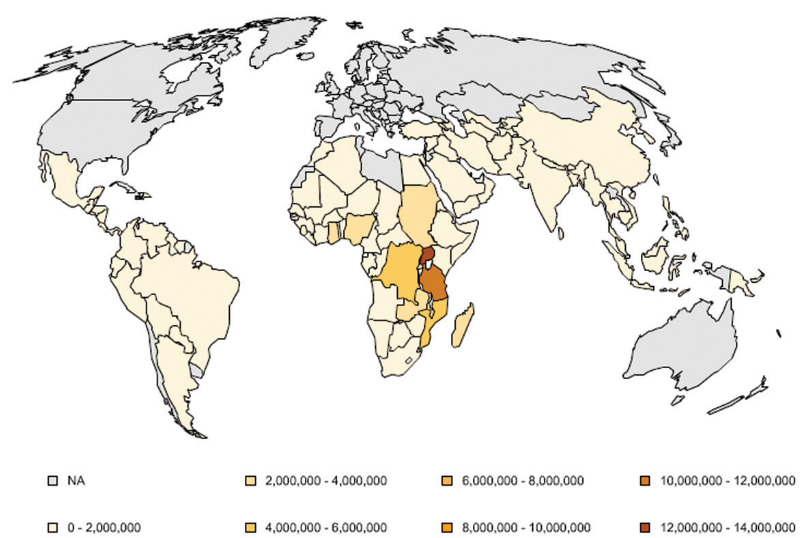
How is it transmitted?

Malaria is transmitted through the bite of a female Anopheles mosquito that is infected with the *Plasmodium* parasite. It all starts when a person with malaria is bit by a mosquito. When the mosquito sucks up her blood

The Burden of Malaria

350–500 million	cases of malaria occur each year
1 million	people die each year from malaria
3,000	children under 5 die from malaria each year
24 hours	maximum amount of time between onset of symptoms and treatment for a successful outcome
Every 30 seconds	an African child dies from malaria
$12 billion	annual economic loss in Africa due to malaria
$10	cost for long-lasting insecticide treated bed net
$4	cost per person for indoor residual spraying of insecticides inside homes and huts
$2	cost of one treatment of an effective anti-malarial drug

CASES OF MALARIA AROUND THE WORLD



meal, she also takes in *Plasmodium* parasites that are in the person's bloodstream. Inside the mosquito's gut and salivary glands, the parasite grows in several stages. Then, when the mosquito lands on another person and bites, she injects some of her saliva—along with parasites—into the person, who becomes infected with the parasite and becomes sick from malaria. Then, the cycle starts all over again.

The malaria parasites can also be transmitted by infected blood transfusions or by sharing needles with someone who is infected with the parasite.

Did You Know?

About 99% of malaria infected mosquitoes bite at night.

How does it work in the body?

Inside the human body, the parasite has a liver stage and a blood stage. Once the parasite gets in the human body via the bite of an infected mosquito, it travels along the bloodstream. Within about 30 minutes, the parasite enters the liver, where it rapidly reproduces. Some parasites may enter a dormant stage in the liver and won't become active for years. Usually, though, after 6-9 days, the parasite returns to the bloodstream, where it enters red blood cells. Inside the blood cell, the parasite again reproduces rapidly until the cell bursts, releasing thousands of new parasites into the bloodstream to infect other red blood cells or to be sucked up by another mosquito. Once inside the mosquito, the parasite goes through a mosquito stage in the gut and salivary glands.

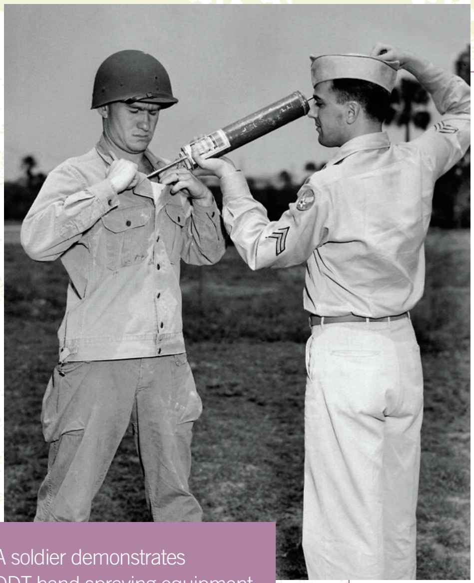
What are the symptoms?

The symptoms of malaria often present within 7-21 days of being bitten by an infected mosquito.

A person suffering from malaria often experiences symptoms in a cycle that occurs every 1, 2, or 3 days. The symptoms include a cycle of fever and sweating followed by chills, before starting over again. Other symptoms include anemia, jaundice, vomiting, and diarrhea. Pregnant women, infants, and children are the most vulnerable to malaria.

How can it be prevented?

The most effective ways to prevent malaria is either to eradicate Anopheles mosquitoes or to prevent them from being in contact with people during the nighttime, when they are most likely to bite. Some successful strategies include indoor residential spraying of insecticides inside homes and huts, sleeping underneath bed nets that are treated with



A soldier demonstrates DDT-hand spraying equipment while applying the insecticide

Source: CDC #2620

Focus On: DDT

In the 1940s, the U.S. government launched the National Malaria Eradication Program with the goal of eradicating malaria in the U.S. by wiping out mosquitoes. In 1955, the World Health Organization (WHO) followed suit by launching the Global Malaria Eradication Program.

Both programs involved a variety of mosquito control strategies, including draining the wetlands that served as mosquito breeding grounds. However, the true weapon in the fight against malaria was a chlorinated organic insecticide known as DDT. The chemical seemed like the perfect insecticide; it was cheap and had a low toxicity level to mammals. Soon, DDT was being used on wetlands and farm fields. DDT's reputation as the ideal insecticide began to crumble as scientists realized that it had a long biological half-life, was highly toxic to fish and bats, and caused bird eggshells to thin and break in the nest. Additionally, because DDT is chemically stable and soluble in fat, the chemical builds up in animals and is stored in fatty tissues. Because DDT has low solubility in water, it accumulated in lakes and other waterways.

DDT was banned in the U.S. in 1972, although it continues to be used in some parts of the world. The WHO and some other organizations believe that DDT should be returned to use, at low levels, for spraying the eaves of huts and houses to keep mosquitoes from entering people's homes at night.

Did You Know?

Malaria sickened troops during the Revolutionary War, Civil War, World War I, and World War II. During the Civil War, 50-80% of soldiers in the Union army became sick from malaria each year.

long-lasting insecticides, and using insect repellant. Tourists can take anti-malaria drugs as a preventive measure when traveling to malarious regions of the world.

Several organizations around the world are currently developing vaccines for malaria. For example, Seattle Biomedical Research Institute is focused on vaccine discovery for pregnancy malaria, severe malaria in children, and liver-stage malaria.

What treatments are available?

Malaria is treated using anti-malarial drugs. As the *Plasmodium* parasite becomes resistant to some of the commonly used drugs, scientists are challenged to discover new anti-malarials that will successfully treat malaria.

Did You Know?

About 1,200 Americans are infected with malaria each year, mostly from traveling to malarious regions around the world.

Did You Know?

Quinine is a native remedy discovered by indigenous people in South America. It is extracted from the bark of the cinchona tree. The synthetic version of quinine is called chloroquine.

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THE STORY OF TUBERCULOSIS

HANDOUT

Tuberculosis kills more people worldwide in a typical year than all wars, earthquakes, floods, tsunamis, airline accidents, terrorist attacks, and murders combined.

~Rx for Survival

AN ANCIENT DISEASE IN MODERN TIMES

Two famous characters in Verdi's opera "LaTraviata" (1853) and "La Boheme" (1895) are young, tall, thin, and pale faced with cherry-red lips and flushed cheeks, and their voices are those of the nightingale. But these female roles are also mysteriously ill with a wasting disease called consumption.

Consumption is more commonly called tuberculosis (TB). In the 1800's when epidemic TB reached its peak in Western Europe, infected persons were considered beautiful and erotic, with the their extreme thinness, long neck and hands, shining eyes, pale skin and red cheeks. Yet such "beauty" had its price: a painful death by drowning in one's own blood. Because it was neither recognized nor understood that TB was a chronic infectious disease, it was romanticized, mythologized, and regarded as a spiritualizing force.

~Twelve Diseases that Changed our World

What is it?

Tuberculosis (TB) is an infectious disease caused by an airborne bacteria. The disease has also been called "consumption" and the "white plague." TB is an ancient disease that has plagued humans since early times. Evidence of TB was found in Egyptian mummies dating 3700-1000 BC. It is likely that TB evolved from a disease of domesticated cattle.

TB is both an infectious disease and a societal disease because it is often linked with poverty, crowded living conditions, and HIV/AIDS infection.

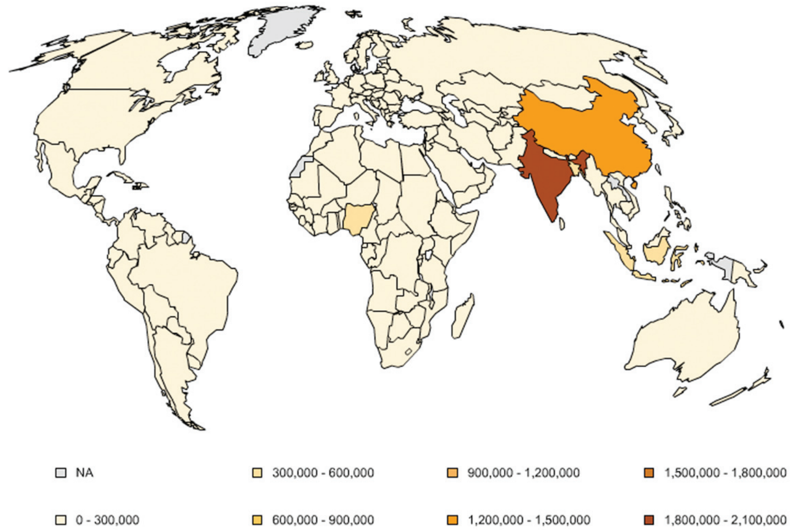
Transmission electron microscopy of *Mycobacterium tuberculosis*

Source: CDC, Elizabeth "Libby" White #8433

TB AT A GLANCE

Infectious Agent:	Bacteria (*Mycobacterium tuberculosis*)
Transmission:	Human-to-human transmission through inhalation
Symptoms:	Persistent cough, coughing up blood, fever, weight loss, paleness, fatigue
Prevention:	Face masks, good ventilation, quarantines, BCG vaccine
Treatment:	Antibiotics (6–12 month regime)

CASES OF TUBERCULOSIS AROUND THE WORLD



Did You Know?

One type of TB bacteria, *M. bovis*, can be transmitted from cattle to people by drinking milk. The discovery of pasteurization allowed for the protection of the food supply from TB. By the 1930s, milk-borne TB disappeared in the U.S.

How is it transmitted?

TB is spread through airborne bacteria expelled by one person and inhaled by another. The bacteria is transmitted in the water-droplets expelled by one person—as they talk, sneeze, cough, or even sing—which is then inhaled by another person.

While active TB is usually contagious, you need to have close contact with an infected person over an extended period of time in order to transmit the bacteria, such as occurs with family members, coworkers, or friends.

How does it work in the body?

Once inhaled, the TB bacteria settles in the lungs, grows, and becomes infectious. TB can also spread through the bloodstream to the brain, bone, spinal cord, and kidneys. Unlike TB in the lungs, these forms of TB generally are not contagious. A TB infection can be latent or active.

Latent TB. A latent TB infection occurs in most people who become infected with the TB bacteria. With a latent infection, a person breathes in the bacteria, but her healthy immune system keeps the bacteria from growing by surrounding the bacteria with scar tissue. She won't have any TB symptoms, won't feel sick, and isn't contagious, but may go on to develop an active form of the disease if she isn't treated and her immune system becomes weak at some point in the future. About 10% of people with latent TB later develop the active form. However, about 40% of people who have latent TB along with HIV/AIDS, which greatly weakens their immune system, will develop the active form.

Active TB. An active TB infection occurs in people whose immune system cannot prevent the TB bacteria from growing. Either a person's immune system is too weak to form scar tissue around the bacteria, or the weakened immune system allows the bacteria to break through the scar tissue and become activated. A person with active TB shows symptoms of the disease, feels sick, and is contagious. Without treatment, a person can die from active TB.

What are the symptoms?

The most common symptoms of TB include a persistent cough, coughing up phlegm and/or blood, chest pain, shortness of breath, fever, loss of appetite, weight loss, paleness, fatigue, and night sweats.

Did You Know?

German physician Robert Koch discovered the microbe of TB in 1882. Koch later developed an extract of the bacillus called tuberculin which is used today in the TB skin test.

The Burden of TB

2 billion	people are infected with TB
2 million	people die each year from TB
10–15	number of people a person with active TB will likely infect each year
1 in 3	people in the world have TB
98%	of new TB infections occur in deveoping countries
40%	of people with latent TB and HIV/AIDS will develop the active form
10%	of people with latent TB develope the active form

Did You Know?

European royalty claimed an ability to cure TB by touching afflicted people. Many Kings held Royal Touching ceremonies where they touched thousands of people at a time.

Public health campaign poster, 1921

Source: U.S. National Library of Medicine

How can it be prevented?

TB can be prevented if inhalation of the bacteria can be prevented. Some prevention methods include:

- Giving antibiotics to people with latent TB to prevent them from developing active TB
- Wearing face masks when around infected individuals
- Providing good ventilation in hospitals, clinics, and on airplanes
- Quarantining people with drug-resistant forms of the disease
- Giving infants the BCG vaccine.

BCG Vaccine. The World Health Organization (WHO) recommends that in countries where TB is common, infants receive the BCG vaccine. The vaccine doesn't prevent a child from breathing in the TB bacteria, but it does prevent the bacteria from spreading in the body. The vaccine has some drawbacks, and therefore is not recommended as a standard child immunization in the U.S.

Did You Know?

In the 1800s, buildings in England were taxed based on the number of windows. This led to the construction of buildings with few windows, causing poor indoor ventilation and higher TB transmission rates.

What treatments are available?

A TB patient must take a long course of special antibiotics. The treatment regime for TB can include taking a combination of drugs everyday for 6-12 months. These antibiotics can make the patient feel very sick.

Currently, there are only a handful of antibiotics to fight TB; the structure of the TB bacteria makes it difficult for scientists to develop new antibiotics. The cell wall of the TB bacteria has an unusual characteristic—it has three layers which form a waxy, nearly waterproof, protective barrier. This waxy layer has made it difficult for scientists to develop drugs that can permeate the bacteria while remaining soluble in the bloodstream.

Because the treatment course is so long, and the drugs can make patients feel sick, a treatment strategy called DOTS is recommended for treating TB. DOTS stands for "directly observed treatment, short course."

Postcard of Battle Creek Sanitorium, breathing exercises, circa 1900

Source: PD-US

With DOTS, the patient goes to a treatment center or clinic everyday, is provided with medication, and is watched by a healthcare worker to be sure that the patient actually swallows the drugs.

Drug-Resistant TB. Some people end up quitting the treatment regime early, either because they feel that the medicine is making them sick, they move and lose contact with their health provider, or they can't afford treatment. When people quit taking their antibiotics early, dangerous strains of drug-resistant TB can develop. There are two types of drug-resistant TB strains. **Multidrug-resistant TB (MDR-TB)** is resistant to two or more the first-line TB antibiotics. **Extensively drug-resistant TB (XDR-TB)** is MDR-TB that is also resistant to three or more of the six types of second-line drugs.

Focus On: The Sanatorium Movement

A tuberculosis sanatorium (also called a sanitarium) was a hospital or health retreat for TB patients. The sanatorium movement first developed in Europe, and then spread to North America in the 1800s. During this time, it was believed that fresh air, rest, good nutrition, and isolating infected individuals were key ingredients in helping people recover from the disease. Sanatoriums were often located in the mountains, forests, or dry climates and required patients to take outdoor treatments by spending time out in fresh air. Doctors and nurses prescribed a variety of treatments, including:

- bed rest
- sun bathing
- drinking a quart of cream everyday
- surgery to remove infected portions of the lung or to collapse the lung
- chemotherapy
- antibiotics

The sanatorium movement grew quickly in the U.S. In 1900, there were 34 sanitaria with 445 beds. Twenty-five years later, there were 356 sanitaria with 73,338 beds.

Did You Know?

In the early 1900s, TB was the leading cause of death in Seattle. In the 1950s, Seattle's Firlands Sanatorium housed over 1,200 TB patients.

SOURCES

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Sherman, I.W. (2007). *Twelve Diseases that Changed our World.* ASM Press.

World Health Organization. *Emergence of XDR-TB.* Available at: http://www.who.int/mediacentre/news/notes/2006/np23/en/index.html.

LESSON

LESSON 1: Global Health Careers & Challenges

Activity Time: 50 minutes (plus additional homework)

In this lesson, students will take a brief pre-assessment survey, read career case studies, and view a short video about a variety of global health careers.

This lesson should be delivered prior to the other global health modules and immediately prior to the delivery of the *Global Health Facts* lesson plan. This lesson can be tailored for individual subject areas.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Global Health:** Students will gain an introductory understanding of global health problems and solutions (especially careers). Educators will learn students' preconceptions of global health.

Essential Question:

- What are some common health challenges facing the majority of humans today?
- What types of people work to reduce suffering from global health diseases and illnesses?

Learning Objectives:

Students will know…

- Health challenges are numerous and diverse.
- Diverse skills and experts help advance global health.
- Everyone can make a difference in human suffering—from advocacy to specific point of care.

Students will be able to…

- Relay their preconceptions about global health.
- Identify global health challenges.
- Connect diverse careers to global health problems.

Vocabulary:

- Biosafety-Level-Three clinical laboratory
- Epidemic
- Epidemiology
- Global health
- Malaria
- Pandemic
- Parasitic infection
- Pathogen
- SARS influenza
- Tuberculosis
- Viral influenza infection

Careers mentioned in the reading:

Anthropologist, Microbiologist, Epidemiologist, Health Official, Scientist, Nurse, Pharmacist, Border Control Officer, Global Transportation Specialist, Public Health Official, Immunologist, Virologist, Educator, Veterinarian, Aeronautical Engineer, Government Official, Pharmaceutical Company, Bioengineer, Medical Technician, Biochemist, Entomologist, Tribal Medicine Man, Businessman, Flight Crew, Hospital Admittance Staff, Medical Anthropologist, Journalist, Biostatistician

Common Student Preconceptions:

- Nearly all diseases have been cured.
- Incurable diseases occur in other places, but not in America.
- You must be a scientist to work in global health.
- I do not possess the skills or interest to enter a global health field.
- Only some people deserve to be healthy.
- Infectious diseases are not that important; heart disease, cancer, and obesity are bigger problems.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *Pre & Post-Test* Handout (1 per student)
- *Pre & Post-Test Rubric* Handout (1 per student)
- *Dr. Sanchez Makes His Rounds* Handout (1 per student)
- *Faces of Malaria: Global Health Careers* Handout (1 per student)

Preparation:

- Make sure that you are able to play the **Faces of Malaria** video.
- Make copies of Student Handouts.

PROCEDURE

Hook

1. Explain to students that as part of their normal coursework in your class, they will also be studying the connections between the subject that they are studying (algebra, chemistry, history) and global health challenges. Explain that this will provide opportunities to see real-life connections between what they are studying and what is happening to prevent and control illness around the globe.

Preconceptions

2. Pass out copies of the *Pre-Test* Handout and the *Dr. Sanchez Makes His Rounds* Handout, one per student.
3. Explain that as a homework assignment, students need to first complete the Pre-Test Survey and secondly, read the story about Dr. Sanchez. Explain that the survey is designed to capture students' preconceptions about global health; it is okay if they don't know the answers to some of the questions. Tell students that the completed survey is their Entrance Ticket to class tomorrow, and that they need to arrive at class prepared to discuss the reading.

Activity

4. As students arrive, collect their completed Pre-Test. Keep these surveys, as you will later give students a Post-Test once you have delivered all the lessons in the global health curriculum.
5. Lead a class discussion about the assigned reading that featured Dr. Sanchez and his rounds around the hospital. Focus your discussion on each of the four diseases featured in the reading: cholera, influenza, malaria, and tuberculosis. For each disease, ask students the following questions:
   - What was the problem?
   - Who was most impacted by the problem?
   - What was the solution?
   - What are the related jobs involved in interpreting and solving this problem?

6. Explain to students that throughout the course, they will be using the skills and strategies learned in class to investigate global health challenges. In particular, students will be learning about the global impact of cholera, influenza, malaria, and tuberculosis, but global health is a broad area of study that involves many diseases and illnesses besides these four.
7. Show students the **Faces of Malaria Video** from the Bill & Melinda Gates Foundation Malaria Forum. This short video clip features a variety of people who work in multiple global health careers; in the case of this video, all the people have careers related to malaria.
8. Pass out copies of the *Faces of Malaria: Global Health Careers* Handout, one per student. Lead a brief class discussion about the careers that were mentioned in the video.
9. As a class, make a list of additional careers in the field of global health that weren't mentioned in the reading or video. Put a star by any careers that interest students.

Wrap-Up

10. In the **Faces of Malaria Video**, one woman is quoted as saying, "We come from different backgrounds so we learn from each other." Ask each student to interview a classmate as to what this sentence means to them and how they think that this connects to the field of global health.

STUDENT ASSESSMENT

Assessment Opportunities:

- Collect and assess student answers from the reading and the Pre-Test.
- The Pre-Tests should be kept and compared to the Post-Tests that will be administered at the completion of the global health curriculum.
- Gather students' ideas about global health careers.

Student Metacognition:

- The Pre-Test gets students thinking about what they already know about global health topics.
- Class discussions provide an opportunity for students to reflect on how they think global health impacts them.

Scoring:

- As this is an introductory lesson, little or no scoring is needed. The students are not expected at this point to have a comprehensive understanding of global health.
- The Pre & Post-Tests can be scored using the provided Scoring Rubric.
- Proficiency is measured as a reflection of: student participation, completeness of Pre-Test, completion of reading assignment questions, and participation in the final student interview (after the video).

EXTENSION ACTIVITIES

Extension Activities:

- Students can interview one another regarding their relative interest in global health and infectious diseases.

Adaptations:

- Provide an audio version of the reading for sight impaired students.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on global health can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum as well as by reading the *Dr. Sanchez Makes His Rounds* reading.

Resources:

Faces of Malaria Video
Bill & Melinda Gates Foundation Malaria Forum, 2007, 2:01 minutes
http://www.kaisernetwork.org/health_cast/player.cfm?id=3647#clip_1

Name:____________________________ Date:___________ Period:________

Pre & Post-Test

HANDOUT

Answer each question below as best you can. Your answers will allow your teachers to assess your understanding and to design activities in a way that will help you learn.

1. What do you think of when you hear the phrase "Global Health"?

Please circle the correct answer to the questions below:

2. The ten leading global health risk factors are: underweight births, unsafe sex, high blood pressure, tobacco consumption, alcohol consumption, unsafe water, sanitation and hygiene, iron deficiency, indoor smoke from solid fuels, high cholesterol and obesity. Worldwide, how many childhood deaths per year do you believe are connected to these factors?

A. over 100,000

B. over 300,000

C. over 1,000,000

D. over 3,000,000

3. How many deaths a year (worldwide) are attributed to just unsafe water and insufficient sanitation and hygiene?

A. 170,000

B. 17 million

C. 1.7 million

D. 7 million

Mark either Yes or No to the following:

4. Who do you think works on Global Health?

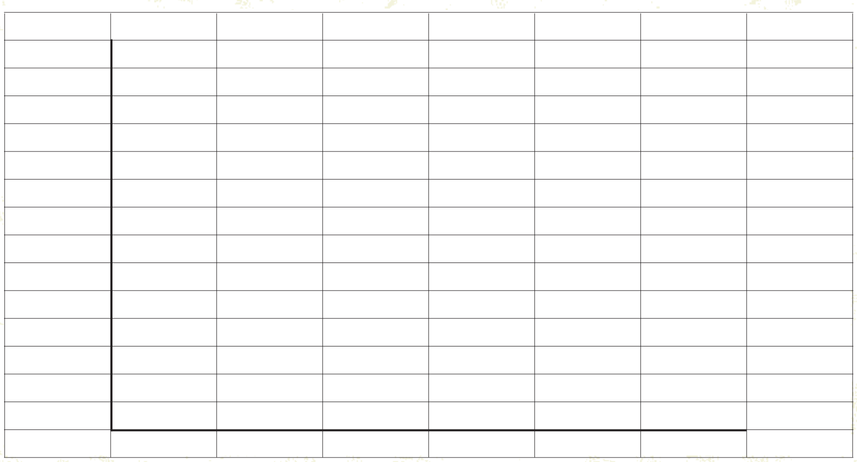
Washingtonians	☐ Yes	☐ No
People who wear lab coats	☐ Yes	☐ No
Non-scientists	☐ Yes	☐ No
Kids like me	☐ Yes	☐ No

5. Review the Global Health Statistics on the chart below.

Statistics	Bolivia	China	Kenya	Pakistan	United States of America
Malaria cases (2006)	73,796	99,938	11,341,750	1,498,882	1,564
Percentage of citizens with access to sanitation (2006)	43%	65%	42%	58%	100%
Percentage of population that is undernourished (2003–05)	22%	9%	32%	23%	<5%
Number of children per 1000 live births that die before their 5th birthday (2007)	57	22	121	90	8
GDP[1] per individual (2008)	$4,400.00	$5,400.00	$1,700.00	$2,400.00	$45,800.00

[1]GDP: The Gross Domestic Product is a fundamental measurement of production and is very often positively correlated with the standard of living of the people who live in that country.
Source: www.globalhealthfacts.org

Create a graph that compares the relationship of at least one of the "Statistics" with the 2008 GDP per individual.



GDP

What conclusions can you draw about how a government's response to public health challenges might be influenced by its GDP or overall economy?

6. Diarrhea is one of three major killers of children in developing worlds – in fact, a child dies every 14 seconds. Why do you think diarrhea is such a problem?

7. List all the careers you can think of that are related to Global Health:

8. Read the following information and then follow the directions to complete the activity below.

The ***Universal Declaration of Human Rights*** is meant for every individual in every nation. The Declaration states that "…recognition of the inherent dignity and of the equal and inalienable rights…" of all people "is the foundation of freedom, justice and peace in the world."

> *Everyone has the right to a standard of living that will prevent him or her from getting sick, which would disrupt his or her ability to work and get paid. People have the right to food, clothing, health care, and housing, which will help them stay healthy and lead productive lives. These are essential needs that are also specific--for example, right to food includes access to affordable, nutritious food as well as different ways to access the food such as growing your own.* (Article 25, Universal Declaration of Human Rights)

The ***Declaration of Alma-Ata*** was created to "…protect and promote the health of all people in the world…" The Declaration restates that health is a fundamental human right. The Declaration states that action is needed also by those from the social and economic areas, and not just by those dealing primarily with health. This recognizes that the factors affecting health are diverse—e.g., social, cultural, economic, environmental, etc.

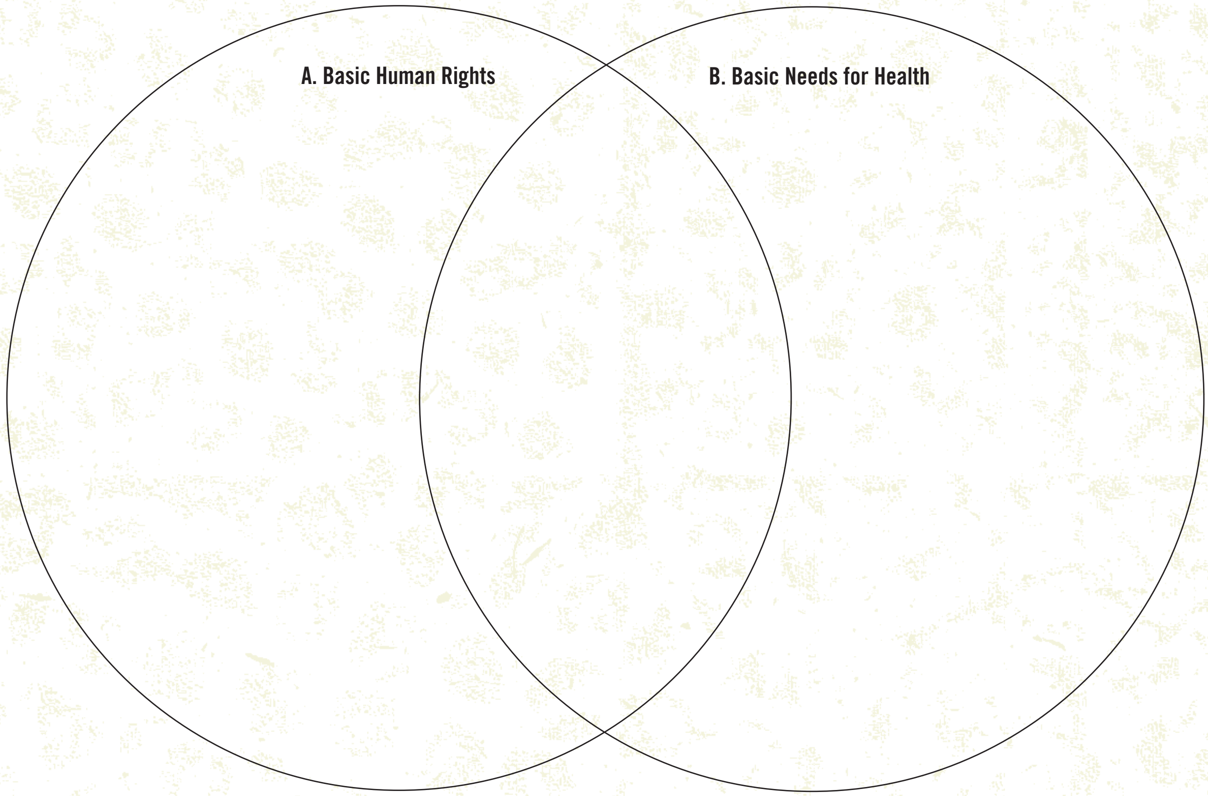
> *The Conference strongly reaffirms that health, which is a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector. (Declaration I, International Conference on Primary Health Care, Alma-Ata)*

Adapted from: http://apps.nlm.nih.gov/againsttheodds/online_activities/index.cfm

Directions: In the chart below, first list examples of basic needs for staying healthy on the **right side**. Then list examples of human rights that are related to health on the **left side**.

Basic Human Rights Related to Health	Basic Needs for Health
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.

Now, create a Venn Diagram to organize the relationships between the examples you wrote.



9. List actions (3 or more) that a high school student like you can take to make a difference and protect health-related human rights. Pick **one** that you would be interested in carrying out and justify why you chose it.

Name:___________________________ Date:__________ Period:________

HANDOUT

Grading Rubric – Pre & Post-Test

Exemplary: 4	Proficient: 3	Partially Proficient: 2	Developing: 1	Score
1. What do you think of when you hear the phrase "Global Health"?				
Student shows thoughtful consideration of a breadth of global health issues and organized thinking. The student's statements are clearly stated and elaborated upon.	Student shows clear thinking and consideration of some global health issues. Statements are clear but not elaborated upon.	Student shows unclear or disorganized thinking about global health issues. Statements may not be clearly stated. Some statements are inaccurate.	Student shows mistaken thinking about global health issues. Statements are not clearly stated, may be incomplete, or may be inaccurate.	
2. Worldwide, how many childhood deaths per year do **you** believe are connected to these factors? Correct Answer is D (over 3,000,000) – 3 pts.				
3. How many deaths a year (worldwide) are attributed to just unsafe water and insufficient sanitation and hygiene? Correct Answer is C (1.7 million) – 3 pts.				
4. Who do you think works on Global Health? Correct Answer is YES for all categories. **Scoring** – 1 pt. for each correct answer – 4 pts. possible				
5. What conclusions can you draw about how a government's response to public health challenges might be influenced by its GDP or overall economy?				
Student demonstrates organized thinking; conclusions flow logically from an accurate graph. Student demonstrates a solid understanding of cultural and economic contexts and thoughtful description of important health-related issues.	Student demonstrates clear thinking. States reasonable conclusion from interpretation of accurate graph. Cultural considerations are addressed and appropriately explained. The student provides accurate explanation of economic considerations and health-related issues.	Student demonstrates mostly clear and organized thinking, but portions of the answer may be unclear, disorganized, or incomplete. Graph may be inaccurate. Student conclusion may not be clearly stated. Cultural considerations mentioned but not clearly explained. The student demonstrates a general awareness economic considerations and health-related issues.	Student demonstrates disorganized thinking. Thinking may be incomplete and not clearly stated. Graph is inaccurate. Cultural considerations incomplete or illogical. The student lacks an awareness of economic and health-related issues. Irrelevant information may be included and student demonstrates some confusion.	

Exemplary: 4	Proficient: 3	Partially Proficient: 2	Developing: 1	Score
6. Diarrhea is one of three major killers of children in developing worlds – in fact, a child dies every 14 seconds. Why do you think diarrhea is such a problem?				
Student demonstrates thoughtful consideration of the topic. Able to apply scientific concepts to support answer. Provides relevant and insightful comments. Vocabulary is used correctly. Demonstrates exceptionally logical and organized thinking. Student demonstrates a solid understanding of the context, including a thoughtful description of important information.	Student demonstrates logical, organized, and clear thinking and demonstrates consideration of the topic. All scientific concepts are correctly presented. Provides relevant comments. Vocabulary is used appropriately. The main relevant facts are identified. Student exhibits some understanding of the context and important information.	Student demonstrates awareness of the topic but little reflection on it. Comments are mostly relevant. Thinking is mostly clear and organized. Shows limited ability to apply scientific concepts. Some facts are incorrect. At times, uses vocabulary inappropriately. Factual information relevant to the problem is described but some key facts may be missing and some irrelevant information may also be included.	Student demonstrates little or no consideration of the topic. Comments are off-topic or irrelevant or inaccurate. Thinking is confused, disorganized, or stays at a very superficial level. Facts often incorrect. Rarely uses vocabulary appropriately. Struggles to apply scientific concepts. Factual information relevant to the problem is incompletely described or is missing. Irrelevant information may be included and student demonstrates some confusion.	
7. List all the careers you can think of that are related to Global Health.				
Student lists over 15 accurate careers related to Global Health.	Student lists 11-15 accurate careers related to Global Health.	Student lists 5-10 accurate careers related to Global Health.	Student lists less than 5 accurate careers related to Global Health.	
8. Read the following information and then follow the directions to complete the activity below. (Chart & Venn Diagram)				
Student demonstrates thoughtful consideration of a breadth of global health issues by listing at least 7 accurate Rights and at least 7 accurate Needs on the Table. Demonstrates clear understandings of relationships on the Venn Diagram by correct positioning of the elements – all items in Basic Needs are not separate from Basic Human Rights.	Student demonstrates clear thinking of global health issues by listing 4-7 accurate Rights and 4-7 accurate Needs on the Table. Demonstrates clear understandings of relationships on the Venn Diagram by correct positioning of the elements – all items in Basic Needs are not separate from Basic Human Rights.	Student demonstrates limited understanding of global health issues by listing only a few (3 or less) accurate Rights and a few (3 or less) accurate Needs on the Table. Demonstrates limited understandings of relationships on the Venn Diagram by incorrectly positioning of the elements – some items in Basic Needs are separate from Basic Human Rights.	Student demonstrates little or no understanding of global health issues by demonstrating inability to list accurate Rights and accurate Needs on the Table. Demonstrates confusion on the Venn Diagram by incorrectly positioning of the elements – items in Basic Needs are separate from Basic Human Rights.	
9. List actions (3 or more) that a high school student like you can take to make a difference and protect health-related human rights. Pick **one** that you would be interested in carrying out and justify why you chose it.				
Student demonstrates a breadth of knowledge concerning actions students might take. Student's choice of option is clearly stated and justification thoroughly weighs alternate solutions and thoughtfully discusses its strengths and weaknesses. Writing is demonstrates depth of thinking.	Student demonstrates knowledge of actions students might take by listing a few possibilities. The student's choice of best option is clearly stated; justification includes alternate solutions and mentions some strengths and weaknesses. Student writing shows clear thinking.	Student demonstrates some knowledge of actions students might take by listing one or two possibilities. The student's choice of a best option may not be clearly stated and the justification may be unclear or disorganized. Student writing is unclear and incomplete.	Student demonstrates no knowledge of actions students might take because no possibilities were listed. The student's choice of a best option may not be clearly stated, may be incomplete, or may be missing. Student demonstrates disorganized thinking.	

Name:_________________________ Date:__________ Period:_______

DR. SANCHEZ MAKES HIS ROUNDS

HANDOUT

Dr. Jose Sanchez wondered if his walk around the hospital would be enough to wake him up for his afternoon patient appointments.

He chuckled to himself, thinking back to his high school days in Oaxaca, Mexico—the time in his life when he thought making a difference in global health meant working at a desk, in a room, all by himself.

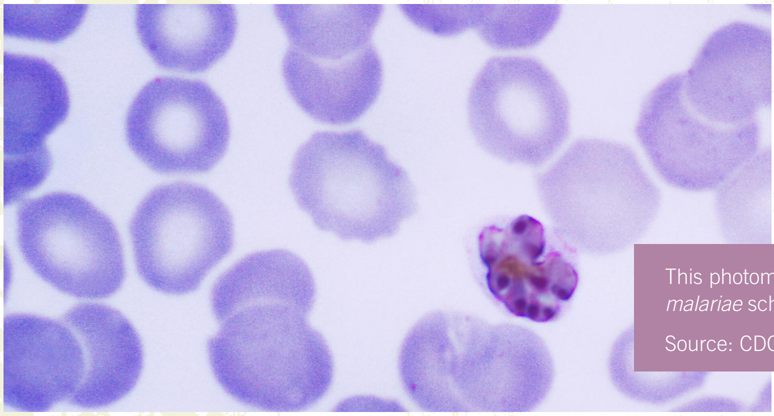
His path to becoming an **infectious disease doctor** with a specialization in **travel medicine** began with a baccalaureate degree (BS) in **bioengineering**, followed by four years of medical school (two years of classroom education, and then rotations in clinical settings where he learned patient care firsthand). His academic studies had given him the knowledge and experience he needed for his daily conversations with people who were preparing to travel to international destinations, and with people returning to Washington State with unusual infections. Each chat with his patients would lead to a handful of follow-up calls with **nurses**, **pharmacists**, **epidemiologists**, **border control officers** and possibly a **global transportation specialist**.

WINGED FEVER

Dr. Sanchez is still chuckling as he enters the exam room. A middle-aged woman is lying on the examination table, sweating lightly and slightly shivering. After a brief interview and check of her vital signs, Dr. Sanchez suspects that his patient likely has malaria. His clues include:

- She has a temperature of 100ºF. She has had this temperature, as well as headaches, for 2 days.
- She works for a global computer company and two weeks ago she returned from a business trip to Hyderabad, India.

He sends the woman to the laboratory to get a blood draw, the next step in identifying the cause of her illness. Using a syringe, the clinic **phlebotomist** takes a small blood sample. A **medical technician** in the clinic laboratory then will analyze the blood for changes in the blood with input from a **microbiologist**, a **biochemist**, and an **immunologist**. While he waits for the lab results, Dr. Sanchez acts on his hypothesis that his patient is suffering from malaria, which is caused by a parasitic infection that she received when a hungry female Anopheles mosquito in India bit her. The parasite that caused this disease is rarely found today in the United States, but was common here before 1950 and before a time when **entomologists** and health departments spent time and money controlling the population of mosquitoes that caused this disease.



This photomicrograph shows a mature *Plasmodium malariae* schizont within an infected red blood cell.

Source: CDC/Dr. Mae Melvin

Anopheles mosquito

Source: WSU

After a quick call to the Centers for Disease Control in Washington, DC, Dr. Sanchez learns that **doctors** in India are now giving their patients two medicines because the malaria infections that they are seeing in their clinics are not clearing using traditional malaria medicines. Centuries ago, South American **tribal medicine men** had learned to extract an effective malarial medicine from the bark of the Cinchona tree (the medicine is called quinine).

The attending nurse calls in the drug prescription request to the **pharmacist**. When the lab results are back, not only will Dr. Sanchez see his patient again to check on her health, but he will also call the Washington State **epidemiologist**, Dr. Dawud, to let her know that he is treating a malaria infection in a patient that got sick during a business trip to India. His patient will be one of the many Americans that get sick from "tropical diseases" while travelling for work and pleasure.

FIGURE 1

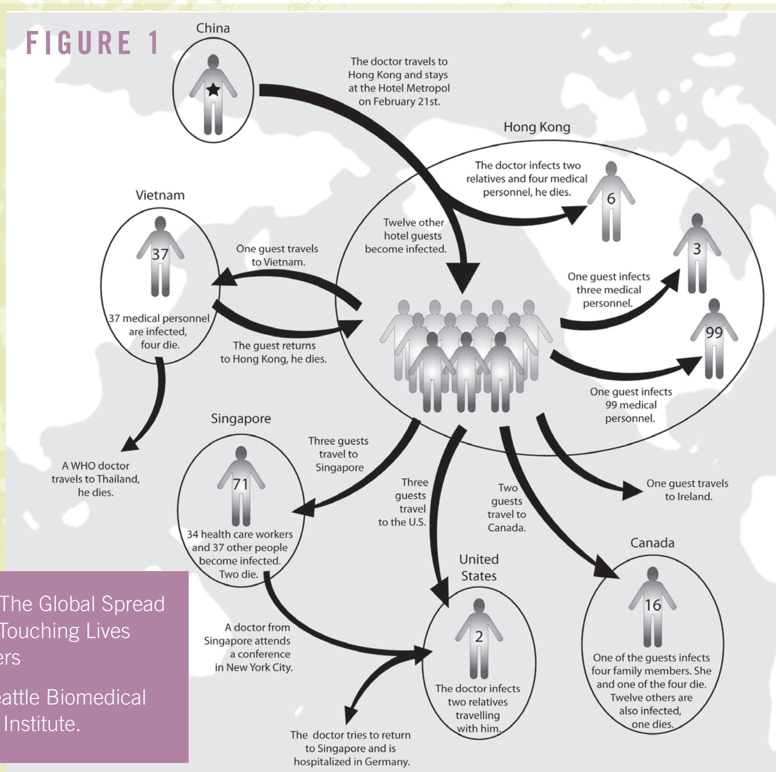


Figure 1: The Global Spread of SARS: Touching Lives and Careers

Souce: Seattle Biomedical Research Institute.

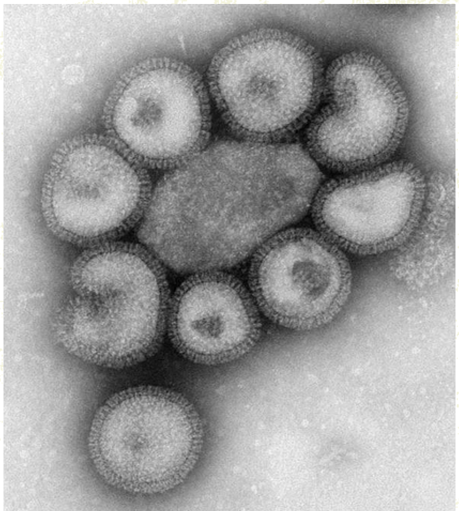
THE FLU FLIES IN

During his phone conversation with Dr. Dawud the epidemiologist, Dr. Sanchez gets caught up on the news of worldwide viral influenza infections. Dr. Dawud is an old friend and former medical school classmate of Dr. Sanchez's. After medical school, Dr. Sanchez met with patients as a career, but his classmate, Dr. Dawud, had chosen to head towards as medical career "outside of a hospital." As an epidemiologist Dr. Dawud examines global trends in infectious disease with a data-driven focus. Through Dr. Dawud's stories, Dr. Sanchez keeps informed about emerging diseases, healthcare practices in rural settings, and new technologies that are saving lives.

Today's call to Dr. Dawud gave Dr. Sanchez the chance to go back in time, to learn more about the 2003 SARS influenza virus outbreak that she had helped control.

"Well," she said, "in 2003 an American **businessman** flying from China was complaining of troubles breathing. The **flight crew** had him evacuated from the plane and the man subsequently died in a Vietnam hospital. Soon, the **hospital staff** that had been in contact with the man also suffered symptoms of influenza. With the same alarming speed, the mysterious illness then quickly spread to over two dozen countries in Asia, North America, South America, and Europe." (See Figure 1).

"In response to this outbreak," Dr. Dawud explained, "around the world principals closed schools, **hospital staff** refused to allow new patients entrance to emergency rooms, and landlords closed entire apartment buildings in an attempt to control the spread of this infection. The global health community began to refer to the cause of this disease as severe acute respiratory syndrome (SARS) and called it a worldwide threat to human and animal health. Eventually the outbreak's origin was tracked back to Southern China. While thousands had complained of SARS-related symptoms, overworked **health workers** in rural China had



This electron micrograph depicts the ultrastructural details of a number of influenza virus particles, or "virions"

Source: CDC/Dr. F. A. Murphy

failed to notify **government officials** in time to stop the pandemic."

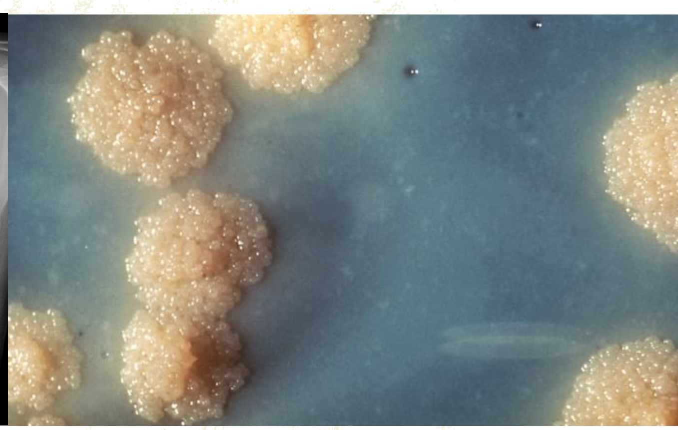
Taking a breath, Dr. Dawud added, "Honestly Jose, a few more biosafety-level-three clinical laboratories (used for studying organisms which may cause serious or lethal infections), would have really speeded up our work. Eventually, an international response of **public health officials**, **immunologists**, **virologists**, **educators**, **veterinarians**, **aeronautical engineers**, **government officials**, and **pharmaceutical companies** helped us identify the cause of the disease, build a rapid and affordable test for health care workers, and manufacture new medicines that eventually helped control the global pandemic."

After hanging up the phone, Dr. Sanchez thought aloud, "The sudden outbreak and spread of SARS in 2003 reminds us of the severity and frequent reoccurrence of influenza on our planet—and the importance of a strong, well connected **global health community**." As he walked down the hall to his next patient, Dr. Sanchez thought about the global influenza pandemics of 1918 and 2009.

TUBERCULOSIS: OLD SCHOOL DISEASE, NEW SCHOOL RESPONSE

Dr. Sanchez moved to his next patient, which turned out to be an entire family! A month prior, a **public health nurse** from the State Health Department had introduced him to this family when their eldest son was exposed to the tuberculosis bacteria (TB) during a small outbreak of TB at his high school. Five students had complained of exhaustion, coughing, fever, and weight loss. The **school nurse** and the **anatomy teacher** suspected that they had TB, a disease easily spread by merely breathing in the TB bacteria. Because many people die of tuberculosis infections, Dr. Sanchez and local **TB caseworkers** had met with many school families and friends to perform the first tests. Fortunately the **medical technologist** and the **radiologist** had looked at the medical results and informed the community (including families, friends, **teachers**, **bus drivers**, **coaches**, etc.) that the bacteria had only infected a total of twelve people. All of these patients had started taking their four TB medicines.

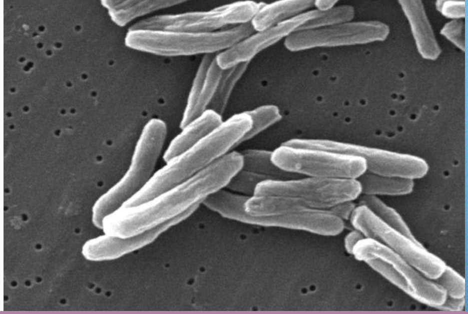
While the family's oldest son was doing well, the health of the family's youngest child, a one-year old, was still a concern. Doctors often have a difficult time determining if a baby or young child has TB because the baby's early symptoms are minor and the common lab tests do not work well with infant samples (e.g., the skin test is often



Left: Digital chest x-ray showing typical features of active pulmonary tuberculosis in the left lung (right for the viewer) with enlarged lymph nodes

Right: Close up of a *Mycobacterium tuberculosis* culture. Note the colorless rough surface, which are typical of *Mycobacterium tuberculosis* colonial growth

Source: CDC/Dr. George Kubica.



Above: Scanning electron micrograph image of rod-shaped *Mycobacterium tuberculosis* bacteria

Source: Centers for Disease Control and Prevention's Public Health Image Library (PHIL),

APOPO trains sniffer rats to detect TB bacteria. This unusual idea has been developed into a competitive technology by a group of Belgian and Tanzanian researchers and animal trainers

Source: Apopo

wrong, and you cannot check their sputum for bacteria). As a result, a quarter of a million children still develop contagious TB every year.

Now as Dr. Sanchez read the lab results for the baby, he is still unsure if the infant has TB. Given the risk that the baby had TB and could die of the infection if untreated, he directs the family to begin giving the child the three TB medicines that the Centers for Disease Control recommend for infants.

Dr. Sanchez sat down at his desk, feeling frustrated. Even though **medical anthropologists** had found evidence of TB in mummies from thousands of years ago, detecting and treating TB in the 21st century felt like using technology from ancient times. As the family left his office, Dr. Sanchez recalled a newspaper article that a **journalist** had written about an amazing and surprising new way to detect TB bacteria. He had read about an African organization in Tanzania that was training HUGE rats to sniff patient samples to detect TB bacteria . A quick visit to the internet told Dr. Sanchez that the Tanzanian team had hired **biostatisticians** and were currently analyzing the responses of the rats to greater numbers of patient samples to look for trends. *"Who thinks of such things!?* Innovation, statistics and **animal husbandry** might be the partnership needed to battle a disease that infects a third of our planet's inhabitants!"

Transmission electron microsope image of *Vibrio cholerae*, the bacteria responsible for the gastroinestinal disease cholera

Source: Public Domain, Dartmouth

CHATTING ABOUT CHOLERA

Dr. Sanchez's daydreams of faster cures for tuberculosis are interrupted by a pop-up message on his computer from his wife, Maria. Maria is part of the International Federation of the Red Cross relief team that is currently stationed in Zimbabwe. Dr. Sanchez reaches for his keyboard, eager to find out how his wife, and her project, are faring.

MARIA: "Good news! **Health officials** here have declared the 2009 Zimbabwe cholera outbreak under control."

JOSE: "Fantastic news! 4,000+ deaths this year is far too many! When will you come home?"

MARIA: "Not too soon. They need my expertise in battling this bacterial infection (and subsequent devastating diarrhea). It is being spread in the drinking water that is contaminated with sewage."

JOSE: "Why do they need the Red Cross to stay?"

MARIA: "Over the last six years Zimbabwe has been experiencing a cholera outbreak every year. **Epidemiologists** are concerned about the approaching rainy season. They fear that the floods could trigger another outbreak."

JOSE: "What is being done to prepare and reduce the size of the next, likely outbreak?"

MARIA: "**International aids groups** are helping. **Hydrologists** are drilling wells. **Civil engineers** are working frantically to ensure that the sewage and water systems are repaired before the rains arrive. The World Health Organization has also started training community **cholera surveillance teams** to help in the early detection of, and response to, a fresh outbreak, if that happens."

JOSE: "And you? Why do they need a **chemist** like you there?"

MARIA: "They need our advice with the water purification chemicals, the school hygiene kits, and the emergency oral rehydration therapy kits. We have to be sure to get the proportions and compositions just right, when the kids have been so sick here!"

JOSE: "Gotta run to my next appointment. Glad to know that you are doing ok on the other side of the globe. Chat with you tomorrow!"

MARIA: "I am off to eat with the team – more yummy Zimbabwean Sadza!"

Village residents receive insecticide-treated bed nets to help prevent the spread of malaria

Source: PATH

QUESTIONS FOR READING:

1. As you read the stories about Dr. Jose Sanchez, you were introduced to over 30 different global health careers. Name two careers, not including a doctor or a nurse, that you might want to know more about.
2. For each of the two careers that you listed, go online and see what you can find out about those careers. What does a person in that job do? What kind of training and education do they need? What is their work environment like?

Name:___________________________ Date:__________ Period:________

Global Health Careers

HANDOUT

Global Health Careers Featured in the *Faces of Malaria* Video

JOB TITLE	CAREER DESCRIPTION
District Director of Health	A district director reduces levels of hunger, poverty, social inequalities, reproductive, gender, malnutrition, and diseases in deprived communities. 10+ years working experience in the fields of sanitation, epidemiology, advocacy, project management, nutrition, and health.
Pediatrician with Infectious Disease (ID) focus	Doctors can train specifically to tend to young patients with infectious diseases. Their responsibilities include investigating outbreaks of infections that occur in hospitals and other health care settings, addressing the causes of the outbreaks, and implementing changes that will prevent them from happening again.
Medical Trauma Nurse	Educated and trained to care for patients at the point of care and in health facilities. Nurses use their problem-solving skills to assess a patient's condition and manage respiratory, cardiac, and trauma emergencies.
Medical Director for Global Issues and Projects	Leads fundraising, advocacy, and practical health response related to a specific global health topic. The Director is a strong writer, debater, public speaker, and project manager.
Minister of Health	A Minister must have proven managerial experience. They must be competent, confident, articulate, result-oriented, and able to deal with international partners—with an ability to see the link between health, government, and development.
Health Inspector	Promotes and maintains a high standard of public health and enforces applicable regulations and by-laws. Carries out a wide variety of public health and environmental control inspectional duties; performs education, research, assessments, analytical tasks, and prepares relevant reports.
Drug Developer	Developers work with other scientists across expertise areas to design, plan, and implement advanced scientific studies aimed at developing safe, potent, and specific drug therapies. Requires innovation, creativity, and self-initiative.

JOB TITLE	CAREER DESCRIPTION
Mosquito Dissector	Candidates with a degree in biology or related discipline with responsible lab habits and microscopy skills have a unique ability to join teams working on mosquito-related diseases (e.g., malaria, encephalitis, and yellow fever).
Information, Education, and Communication Officer	The Officer works in close partnership with a variety of stakeholders (e.g., doctors, learning audiences, scientists, universities, and directly with countries themselves) to develop and implement the necessary strategies, policies, protocols, and infrastructure to accelerate introduction and uptake of these lifesaving technologies. Professionals will manage project communications activities and materials (e.g., publications production, records retention, meeting coordination, and infrastructure resources).
Volunteer Coordinator	Focuses on inquiries, scheduling, orientation, and daily management of project volunteers. As a member of senior staff he/she will attend meetings, host visitors for tours, visit international sites, and assist with the receiving and storage of donated supplies.

Faces of Malaria Video
Bill & Melinda Gates Foundation Malaria Forum, 2007, 2:01 minutes
http://www.kaisernetwork.org/health_cast/player.cfm?id=3647#clip_1

LESSON

LESSON 2: Global Health Facts

Activity Time: 50 minutes

In this lesson, students will view a video segment from *Rx for Survival*, participate in a team question and answer exchange, and explore career options using the BioQuest career website.

This lesson should be delivered prior to the other global health modules and immediately following the *Global Health Careers and Challenges* lesson plan. This lesson can be tailored for individual subject areas.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Global Health:** High school content (advanced algebra, chemistry, and US history) and student empathy/passion can be used to understand, prevent, and solve global health problems.

Essential Question:

- How do the subject areas of advanced algebra, chemistry, and US history interrelate and provide robust, long-term solutions to global health problems?

Learning Objectives:

Students will know…

- Specific facts and concepts related to math, science, and social studies within the context of global health.

Students will be able to…

- Use their fact-based understandings to evaluate information source, for the purposes of enhancing their decision-making skills.
- List a variety of jobs available in the field of global health.

Vocabulary:

- Epidemic
- Epidemiology
- Global health
- Globalization
- Pandemic
- Pathogen

Common Student Preconceptions:

- Global health issues are old and non-existent.
- Distant health issues are not my concern.
- High school classes have no application in the real world that the student would ever use.
- There is no relation between the various subjects the student studies in school.
- Average people cannot learn these subjects.
- You have to be born smart or affluent to make a difference.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *Rx for Survival* DVD
- Two different types of items used to identify a student as on one of two teams (armband, sticker, etc.) or use different colored paper for the Question and Answer Cards
- Question and Answer Cards
- Vessels to hold cards (2)

Preparation:

- Print out and cut up one set of the global health Question and Answer Cards. You will need to have as many matched sets of questions/answer cards as you do students. You may want to copy the questions onto one color of paper and the answers onto another color of paper.
- Alternate form (quicker for larger classes): Cut up question cards. Make two copies of the sheet of answers.
- Place questions in one vessel (envelope, basket, hat, etc.) and answers in a separate vessel.

PROCEDURE

Hook

1. Show students episodes 1-4 of the *Rx for Survival* DVD, Disc 3: Back to the Basics which tells the stories of vitamin deficiencies with a focus on Vitamin A and blindness, and Vitamin B3 and pellagra.

Preconceptions

2. Lead a brief class discussion about how a knowledge of math, chemistry, and US history helped people learn how to prevent and treat vitamin deficiencies and other illnesses.

Activity

3. Explain to students that they are going to participate in a questions and answer matching game. The questions are related to the *Rx for Survival* video and the reading from yesterday's class, *Dr. Sanchez Makes His Rounds*.
4. Divide the students into two groups. Have the students develop their own way of identifying each team, the Questions and the Answers. Give the Questions team the vessel with question cards and the Answers team the vessel with answer cards.
5. Have each student pull a card from their respective vessels.
6. Set a timeline, and challenge the students to find the card that matches their card (i.e. match each Question with an Answer).
7. When time is up, or everyone has found their match, gather the class back together. Call out a number, starting with 1 and going through 32. The student with that number's question reads the question aloud and the student with the matching answer reads the answer.

Alternate form (for quicker activity)

8. Divide the students into two teams.
9. Give each team one answer sheet, and have each student draw one question card from the vessel.
10. Have each team work together to match the questions with the answers.
11. Bring both teams back together as a whole group. Ask each team to present their three most interesting questions and answers.

Wrap-Up

12. Show the **BioQuest Career Possibilities** website. Ask for a few student volunteers to call out their interests and as you complete the interactive quiz. Explore some of the suggested global health careers chosen for each volunteer.
13. Review the jobs that come up by discussing vocabulary, job setting, education requirements, and salary information.

STUDENT ASSESSMENT

Assessment Opportunities:

- The students' level of interest and understanding can be assessed during the class discussions.

Student Metacognition:

- During the class discussion around the **BioQuest Career Possibilities** website, the students will talk about how their skills and interests match those indicated on the website.

Scoring:

- As this is an introductory lesson, little or no scoring is needed. The students are not expected at this point to have a comprehensive understanding of global health.
- Success is defined as increased student interest as evaluated by identification of jobs and ability to tie math, science, and social studies to real-world issues.

EXTENSION ACTIVITIES

Extension Activities:

- Ask students to each explore the **BioQuest Career Possibilities** website and choose one of the suggested careers to research and find out more information.
- Ask students to interview someone in one of the global health professions suggested by the **BioQuest Career Possibilities** website.
- Watch the life sciences career videos at **Life Sciences Central** and the **Washington Global Health Alliance** video.
- Explore the bios of some global health champions at the Rx for Survival website.

Adaptations:

- The suggested alternate format of the question and answer exchange can be used with larger groups and to shorten the activity time.
- If you do not have an even number of students, then the teacher can participate, or one student can be given two cards.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on global health can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. Additional resources on global health careers can be found from the websites and books listed in the Resources section below.

Resources:

Rx for Survival DVD
Disc 3 Back to the Basics; Episodes 1 – 4

BioQuest Career Possibilities
http://www.bioquestacademy.org/future/possibilities.php

Life Sciences Central Career Videos
http://www.ls-central.com/careervideooverview.html

Washington Global Health Alliance Video
http://www.wghalliance.org/about

Global Health Champions
http://www.pbs.org/wgbh/rxforsurvival/series/champions/index.html

Finding Work in Global Health
By G. Osborn and P. Ohmans, Health Advocates Press, 2005

Caring for the World: A Guidebook to Global Health Opportunities
By P. Drain, S. Huffman, and S. Pirtle, University of Toronto Press, 2008

A Practical Guide to Global Health Service
By E. O'Neil Jr., American Medical Association Press, 2006

Name:____________________________ Date:___________ Period:________

Question & Answer Cards

HANDOUT

QUESTIONS	ANSWERS
1. Q: Why is malaria rarely found in the United States today?	A: After 1950 the National Malaria Eradication Program focused on controlling the population of mosquitoes that caused this disease
2. Q: Why is it that diseases are more easily spread around the world today than in previous decades?	A: International travel has increased due to technological advances
3. Q: What evidence do we have that tuberculosis has been around for thousands of years?	A: Evidence of tuberculosis in Egyptian mummies
4. Q: What is the most common way that a cholera outbreak begins…it has to do with the water supply?	A: Cholera-contaminated sewage enters the drinking water supply
5. Q: What was the name of the doctor from Johns Hopkins who studied night blindness in impoverished Southeast Asia?	A: Dr. Alfred Sommer

QUESTIONS	ANSWERS
6. Q: What is an ophthalmologist?	A: A doctor who specializes in treatment of diseases of the eye
7. Q: What is night blindness?	A: A disease that makes it difficult to see at night. It is caused when the rod cells in the eyes cannot produce rhodophsin, a light sensitive chemical which allows people to see in dim light
8. Q: What ultimately happens when a child with night blindness is not treated?	A: When left untreated, the child becomes completely blind because the cornea degenerates
9. Q: What vitamin deficiency causes night blindness?	A: Lack of Vitamin A in the diet
10. Q: What other health issues can result from a lack of Vitamin A?	A: Diarrheal diseases
11. Q: What is an obstacle that Dr. Sommer encountered in Nepal while studying night blindness?	A: Parents were mistrustful of Western medicine, so they would not let their children be treated

QUESTIONS	ANSWERS
12. Q: Who was Joseph Goldberger?	A: He was the first person to have the idea that disease could be caused by poor nutrition instead of an infectious agent
13. Q: In what two settings was pellagra most often found?	A: Prisons and orphanages
14. Q: What is the main symptom of pellagra?	A: A skin rash that can be fatal
15. Q: When he was investigating cases of pellagra in orphanages and prison, how did Joseph Goldberger discover that pellagra was not an infectious agent?	A: Because the administrators of the orphanages and prisons were not sick, even though the orphans and prisoners were sick
16. Q: What four foods did children in orphanages eat that led to them developing pellagra?	A: Corn meal, corn mush, cheap pork and white rice
17. Q: Where did Goldberger test his theory about pellagra?	A: Rankin Prison in Mississippi

QUESTIONS	ANSWERS
18. Q: What is pellagra actually caused by?	A: A lack of B3 and Niacin in the diet
19. Q: In what three foods is Vitamin B3 (Niacin) most commonly found?	A: Vegetables, eggs and meat
20. Q: How did we get rid of pellagra in the US?	A: The FDA starting enriching flour with Vitamin B3
21. Q: When did the USA start enriching food with Vitamin B3?	A: 1950's
22. Q: What does an epidemiologist do?	A: Investigates and describes the causes and spread of disease, using mathematical analysis
23. Q: How often did Dr. Sommer give Vitamin A to treat his patients' night blindness?	A: He gave his patients a few drops of Vitamin A every 6 months

QUESTIONS	ANSWERS
24. Q: How did Dr. Sommer set up the design of his experiment to make sure that Vitamin A really worked to treat night blindness?	A: His study had 20,000 children. He gave half of them Vitamin A and the other half received a placebo
25. Q: What is a "placebo"?	A: An inert, inactive substance that may be used in studies (clinical trials) to compare the effects of a given treatment with no actual treatment. In common speech, a "sugar pill."
26. Q: How long did it take for pellagra symptoms to appear in the prisoners being tested?	A: About 5 months
27. Q: What is the field of study that applies statistics to biomedical issues?	A: Biostatistician
28. Q: What animal were biostatisticians working with to help identify tuberculosis from patient samples?	A: Giant African rats
29. Q: What is the term for a scientist who studies insects?	A: Entomologist

QUESTIONS	ANSWERS
30. Q: What grain is the main food eaten by children in developing countries?	A: White rice
31. Q: How did South American tribes treat malaria prior to the introduction of modern Western medicine?	A: Medicine was extracted from the bark of the Cinchona tree
32. Q: What are four sicknesses that can be caused by poor nutrition, and which have been cured by enriching our foods?	A: Iodine in salt cures cretinism. Vitamin D in milk cures rickets. Vitamin C cures scurvy. Vitamin B3 cures pellagra.

RESOURCE:

Suggested Books: A Primer for Learning

THE INTERSECTION OF HISTORY & DISEASE

- Bollet, Alfred. Plagues and Poxes: The Impact of Human History on Epidemic Disease. *Covers the history of major outbreaks of disease and how they are in many cases caused inadvertently by human activity.*
- Davis, Kenneth. America's Hidden History. *A review of surprising, eccentric and less-well known characters, diseases and events from our nation's history.*
- Fenn, Elizabeth. Pox Americana: The Great Smallpox Epidemic of 1775-82. *Excerpts from diaries, letters, presidential papers and church and burial records provide first-hand accounts of the spread smallpox at the time of the American Revolution.*
- Lamond, Magrete. Plague and Pestilence: Deadly Diseases That Changed the World. *A middle-schooler's review of some our planet's deadliest scourges.*
- Le Couteur, Penny et al. Napoleon's Buttons: How 17 Molecules Changed History. *A review of 17 molecules that have radically influenced man's history (e.g., including quinine, antibiotics and salt.*
- Sherman, Irwin. Twelve Diseases That Changed Our World. *The American Society for Microbiology takes disease review to a higher caliber of science.*

AIDS

- Brown, Rebecca. The Gifts of the Body. *Local author recalls relates her experience as a healthcare worker for homebound patients with AIDS in this fictional memoir.*
- Courtemanche, Gil. A Sunday at the Pool in Kigali*. *An explicit and unforgettable journalist's eyewitness report of love, genocide and AIDS in Rwanda. Highly recommended!*
- Ellis, Deborah. The Heaven Shop. *A poignant peek into the destructive impact of AIDS on family life, through the eyes of 13-year old Malawian girl.*
- Radetsky, Peter. The Invisible Invaders: Viruses and the Scientists Who Pursue Them (Invisible Invaders). *An excellent reference for anyone who is curious as to how a virus works and overcomes body's immune system.*
- Stratton, Allan. Chanda's Secrets.* *The reality of the AIDS epidemic and its impact in Africa comes powerfully to light through the voice of a 13 year girl.*
- Wooten, Jim. We are all the Same. *The tale of young AIDS sufferer Nkosi Johnson serves as a framework for further insights into the early days of the epidemic in South Africa.*

EPIDEMIOLOGY

- Johnson, Steven. The Ghost Map. *A masterful review of cholera and the father of epidemiology, John Snow, 150 years after the London's deadliest outbreak.*
- Koch, Tom. Cartographies of Disease: Maps, Mapping, and Medicine. *Highlighting the connections between geography and public health, "Cartographies" is a fabulous find for fans of the technology of mapping.*
- Leavitt, Judith W. Typhoid Mary, Captive to the Public's Health. *A new look on a well-known character in infectious disease and public health history.*

ASSORTED MICROBIOLOGY, SCIENCE & PATHOGENS

- Biddle, Wayne. A Field Guide to Germs. *A colorful and handy reference guide to over 70 infectious microbes, from the adenovirus to Zika Fever.*
- Brennert, Alan. Moloka'i*. *The compassionate tale of Hawaii and leprosy internment through the eyes of 13 year old Rachel Kalama.*
- Brooks, Geraldine. A Year of Wonders*. *This well-written fictitious tale tells of life in the time of plague (1600s), inclusive of quarantines, class issues and infectious disease.*
- Drexler, Madeline. Secret Agents: The Menace Of Emerging Infections.
- Holman, Sherri. The Dress Lodger.* *Holman's historical fiction explores through 19th century characters, the intersection of poverty, cholera and health care.*
- Lattaa, Sara L. The Good, the Bad, the Slimy. The Secret Life of Microbes. *Beautiful images from Dennis Kunkel woven with middle school-focused reviews of the microbial world.*
- Lax, Eric. The Mold in Dr. Florey's Coat. The History of the Penicillin Miracle. *The history of the world's first antibiotic that changed modern medicine.*
- Le Couteur, Penny et al. Napoleon's Buttons: How 17 Molecules Changed History. *A review of 17 molecules that have radically influenced man's history (e.g., including quinine, antibiotics and sa*lt).
- Liparulo, Robert. Germ. *Suspense, genetic engineering, CDC, FBI and the Ebola virus add to the excitement of this (science sketchy) thriller.*
- Maczulak, Anne. The Five-Second Rule and other Myths about Germs. *A fun and friendly introduction to common "germ myths" and recommended sanitary precautions.*
- Markel, Howard. When Germs Travel. *Reviews the American reaction to six major illnesses that struck the US in the last century (tuberculosis, typhus, trachoma, bubonic plague, AIDS, and cholera), with a large focus on the impact upon immigrants.*
- Miller, J. et al. Biological Weapons and America's Secret War. *A collection of journalistic essays on bioterrorism and germ warfare. Beware of the hyperbole!*
- Nagami, Pamela. The Woman with a Worm in her Head. *A collection of infectious disease essays, including AIDS, chickenpox and flesh-eating bacteria.*
- Nagami, Pamela. Bitten: True Medical Stories of Bites and Stings. *A collection of essays reagarding diseases contracted through bites-including terrific reviews of Trypanosomatid diseases.*
- Preston, Richard. The Hot Zone. *The tale of an actual Ebola virus outbreak in a suburban Washington, D.C. laboratory.*
- Preston, Richard. Panic in Level 4: Cannibals, Killer Viruses, and Other Journeys to the Edge of Science. *The ideal weekend getaway read for lovers of science essays. And yes, it covers Ebola.*

- Rabinow, Paul. Making PCR: A Story of Biotechnology. *An extensive review of a company and its revolutionary discovery in the dawn of the biotechnology era.*
- Rhodes, Richard. Deadly Feasts: Tracking the Secrets of a Terrifying New Plague. *A sobering, review of meat-borne illnesses (e.g. Creutzfeldt-Jakob disease, mad cow disease, Ebola and HIV).*
- Rosen, William. Justinian's Flea. The First Great Plague and the End of the Roman Empire. *Forget the Achilles tendon! See how a tiny flea and its bacterial hitchhiker contributed to the fall of the Roman Empire.*
- Sherman, Irwin. Twelve Diseases That Changed Our World. *The American Society for Microbiology takes disease review to a higher caliber of science. Check it out!*
- Shreve, Susan Richards. Warm Springs: Traces of a Childhood at FDR's Polio Haven. *This autobiography evoke a time when the U.S. was desperate for solutions to the polio pandemic.*
- Talarigo, Jeff. The Pearl Diver. *A sad glimpse into a Japanese leprosy colony (Nagashima), and the fictional prejudicial experiences of a 19-year old pearl diver interned in the late 1940s.*
- Taymon, John. The Colony: The Harrowing True Story of the Exiles of Molokai. *Drawing upon documents and interviews, Tayman describes life in Hawaii's infamous leprosy settlement.*
- Thomas, Lewis. The Lives of a Cell. *A National Book Award winning collection of science essays – a science classic from 1972!*
- Yorath, Chris. Measure Of Value: D'Arcy Island. *A fictionalized historical view of an island Leper Colony in British Columbia.*

INFLUENZA

- Davis, Mike. The Monster at the Door. *The science, threat and hysteria related to mankind's efforts to control the global threat of flu.*
- Goldberg, Myla. Wickett's Remedy. *Ethics, false elixirs and the 1918 Spanish Flu epidemic feature prominently in this tale of redemption.*
- Kolata, Gina. Flu: The Story Of The Great Influenza Pandemic. *The history and epidemiology of the influenza epidemic and the recent work by scientists to better understand the virus.*
- O'Keefe Betty & Ian McDonald. Dr. Fred and the Spanish Lady. *A fact-filled local recollection of the impact of the 1918 Spanish Flu and the response of British Columbia clinicians.*

CHOLERA

- Taylor, Liza Pennywitt. The Drummer was the First to Die*. *Historical fiction surrounding John Snow's epidemiologic efforts with cholera, with nice links to industrial Europe and a vivid romance.*
- Johnson, Steven. The Ghost Map. *A masterful review of cholera and the father of epidemiology, John Snow, 150 years after the London's deadliest outbreak.*

MALARIA

- Brown-Waite, Eve. First Comes Love, Then Comes Malaria. *Follows the life, love and symptoms of an ex-pat (and a Peace Corps worker) in developing nations such as Uganda.*
- Desowitz, Robert S. The Malaria Capers: More Tales of Parasites and People, Research and Reality. *Desowitz discusses the afflictions of tropical diseases and the politics behind combating them. Keep looking under Desowitz to find many titles on pathogens.*
- East, Phyllis. The Early Life of Jeomie East: Struggling with Sickle Cell Anemia. *A tender memoir of a teenager's courageous, painful and fatal battle with sickling.*
- Farrell, Jeanette. Invisible Enemies: Stories of Infectious Disease. *A highly readable review of some of our planet's worst scourges (e.g., tuberculosis, leprosy, cholera, bubonic plague, AIDS, smallpox, and malaria).*
- Ghosh, Amitav. The Calcutta Chromosome*. *A time-traveling science fiction thriller, that revolves around the key players that determined the link between malaria and mosquitoes.*
- Heath, Roy. The Shadow Bride. *A young Indian physician battles malaria in Guyana, amidst a myriad of cultural, medical and family conflicts.*
- Honigsbaum, Mark. The Fever Trail. *An engaging history of the hunt for a cure for malaria.*
- MacAllister, V. A. Mosquito War*. *A fictitious thriller, involving malaria. While inflammatory and only fairly written, it includes extensive malaria science content.*
- Siy, Alexandra et al. Mosquito Bite. *A picture book full of stunning B&W and stained mosquito photomicrographs.*
- Spielman, Andrew et al. Mosquito: the Story of Man's Deadliest Foe. *An engaging review of the historical and worldwide impact of this tiny animal.*
- Wailoo, Keith. Dying in the City of the Blues. *A historical, civic, medical and anthropological review of the impact of sickle cell disease the American South.*
- Wilder, Laura Ingalls. Little House on the Prairie. *The well known American homesteading family battles malaria on the prairies of Kansas.*
- Zimmer, Carl. Parasite Rex. *A collection of well-researched (and amusing) essays on numerous parasites, including the agents that cause malaria and African sleeping sickness.*

TUBERCULOSIS

- Barrett, Andrea. Servants of the Map. *Well known science-based author portrays in the last chapter, life within an Adirondack tuberculosis sanatorium. Also check out Barrett's Ship Fever or The Air We Breathe for other well-written global health works.*
- DeFelice, Cynthia. The Apprenticeship of Lucas Whitaker. *A 12-year-old, orphaned by TB, becomes an apprentice to a kind physician and must choose between applying medical knowledge and following macabre superstition.*
- Ellis, Ella Thorpe. The Year of My Indian Prince. *16 year-old April discovers the isolation and stigma of a San Francisco TB sanatorium; in addition to forming powerful new friendships.*
- Kidder, Tracy. Mountains Beyond Mountains: Healing the World: The Quest of Dr. Paul Farmer. *The biography of a man who fought to over come insurmountable situations to increase awareness of the state of poverty and infectious disease in Haiti and elsewhere.*
- MacDonald, Betty. The Plague and I. *The biography of a Roosevelt High School graduate and her adult experience as a patient in Seattle's Pine Tuberculosis Sanatorium.*
- Patterson, Kevin. Consumption. *A book that appears to be about tuberculosis revolves around themes of isolation—personal, cultural and geographical.*

- Tsukiyama, Gail. The Samurai's Garden. *A young Chinese man, exiled to Japan for tuberculosis treatment, discovers new friendships in the backdrop of World War II.*
- Whelan, Gloria. Homeless Bird. *An empowering book of survival about a 13 year old bride's experience married to a stranger suffering from tuberculosis.*
- White, Edmund. Hotel de Dream*. *A fictionalized historical peak into the life of tuberculous patient and American literary phenomenon Stephen Crane (Red Badge of Courage author).*
- Yamanaka, Lois Ann. Behold the Many*. *A tragic and unrelenting tale of a Hawaiian woman's numerous family losses and hardships as result of tuberculosis.*

RELATED GLOBAL HEALTH & EQUITY

Beah, Ishmael. A Long Way Gone. Memoirs of a Boy Soldier

Clarke, Conor et al. Creative Capitalism: A Conversation with Bill Gates, Warren Buffett, and Other Economic Leaders

Eggers, Dave. What is the What

Farmer, Paul. Infections and Inequalities: The Modern Plagues & Pathologies of Power: Health, Human Rights, and the New War on the Poor

Friedman, Thomas. The World is Flat

Mathabane, Mark. Kaffir Boy

Mendenhall, Emily. Global Health Narratives: A Reader for Youth

Mortenson, G. et al. Three Cups of Tea

Sachs, Jeffrey D. The End of Poverty

Wagner, Tony. The Global Achievement Gap

Yunus, Muhammad. Banker to the Poor

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* This book contains material not suitable for younger audiences.

cholera

LESSON 1: Log Scales, Cholera, & Malaria

Activity Time: 50 – 100 minutes

In this lesson, students will become familiar with a Cholera Model Diagram that shows the path of the cholera bacterium, *V. cholerae*. Students will explore the mathematical model of $\lambda(B)$, which models the probability of a person catching cholera. Students will also find an association between poverty and the prevalence of malaria. In addition, students will change linear axes to logarithmic axes to better view data.

This lesson should be delivered prior to the *Outbreak?* lesson plan.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Logarithmic Scales:** Axes are often scaled logarithmically to represent data which spans a large range.

Essential Question:

- How are logarithmic scales helpful in displaying data?

Learning Objectives:

Students will know…

- When it is appropriate to use a logarithmic scale.
- Diseases can be represented with mathematical models.

Students will be able to…

- Plot data on logarithmic axes.

Vocabulary:

- Cholera
- Epidemiologist
- Logarithm
- Malaria
- Probability
- Scientific notation
- Susceptible
- *V. cholerae*

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.D** Solve problems that can be represented by exponential and logarithmic functions and equations.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.

Common Student Preconceptions:

- Axes must be the same scale and must be linear.
- Large numbers and scientific notation are difficult to understand and use.
- A correlation among data is the same thing as a causation.

TEACHER PREPARATION

Materials:

- Computer with internet access and projector
- *Cholera Model Diagram* Handout (1 per student)
- *robability of Cholera Infection* Handout (1 per student)
- *Malaria and Income* Handout (1 per student)
- Teacher Answer Key for Student Handouts

Preparation:

- Familiarize yourself with the *Cholera Model Diagram*.
- Make photocopies of Student Handouts.
- Visit the Gapminder website at www.gapminder.org. Choose some gapminder data sets to explore with the students, such as "life expectancy at birth" vs. "income per person." Toggle the x-axis between "lin" and "log."
- Students will need to read the Student Background Reading on cholera from the Introduction to Global Health section of the curriculum prior to participating in this math activity.

PROCEDURE

Hook

1. To engage students in thinking about the use of logarithmic scales, show students various comparative data from the Gapminder website. Change the scale to show logarithmic.
2. As an example, view "Life expectancy at birth" vs. "Income per person." Ask students to examine the scales on the x and y-axes. Ask students if there is anything "wrong" with the x axis. Ask if they can think of why the x-axis is the way it is (logarithmic). Change the axis to linear by clicking the toggle button labeled "log." Challenge students to think of other situations where it might be useful to have a logarithmic scale.

Preconceptions

3. You may want to check students' understanding and skills with scientific notation before proceeding with the activity. Students may have difficulty plotting the first few points on the handout because the x axis contains such large numbers. This is a good opportunity to discuss magnitudes of numbers.

Cholera Model Diagram

4. Pass out copies of the Cholera Model Diagram, one per student. Talk students through a brief overview of the diagram. There is no need to focus too specifically on any one element of the diagram.
5. Show the table of symbols used in the model. Point out the value "k" to show the need for this value in the model. The basic idea is that mathematicians need to determine the concentration of bacteria that will give someone a 50% chance of catching cholera. The actual curve is logistic (this is not necessary for students to understand), but a few data points are provided to show the need for a logarithmic scale.

Part One: Cholera Infection

6. Break students into groups of 2 or 3. Distribute copies of the *Probability of Cholera Infection* Handout, one per student.
7. Monitor students' progress as they work through the problems in the handout.
8. When students have completed the handout, ask the groups to share their answers to the last question. What are the students' recommendations for a scaling strategy to best represent their findings?

Part Two: Malaria and Income

9. Distribute copies of the *Malaria and Income* Handout, one per student. Ask students to continue to work in their small groups to complete the problems on the handout.
10. Monitor students' progress as they work through the problems in the handout.
11. When students have completed the handout, ask the groups to share their answers to the last question. If students make any comments about poverty causing malaria, or malaria causing poverty, point out that a correlation among data is not necessarily a reflection of a causation. The data shows a relationship between poverty and cases of malaria, but more information is needed to understand the specific nature of that relationship. What additional information would be needed to be understand this relationship?

Wrap-Up

12. Discuss how log scales make it easier to display and understand some sets of data. If log scales weren't used, in what ways would it be difficult to display some sets of data?

STUDENT ASSESSMENT

Assessment Opportunities:

- As students work in their groups, listen in on the groups' discussions. Provide just-in-time instruction to help clarify any misunderstandings.
- The Student Handouts can be scored using the Teacher Answer Key.

Scoring:

- Points can be assigned to the questions on the Student Handouts. Participation points can also be assigned for working in groups and contributing to class discussions.

EXTENSION ACTIVITIES

This activity can be used in conjunction with the other cholera lesson plans or malaria lesson plans in this curriculum.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera and malaria can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Gapminder
http://www.gapminder.org

WHO Cholera Fact Sheet: http://www.who.int/mediacentre/factsheets/fs107/en/index.html

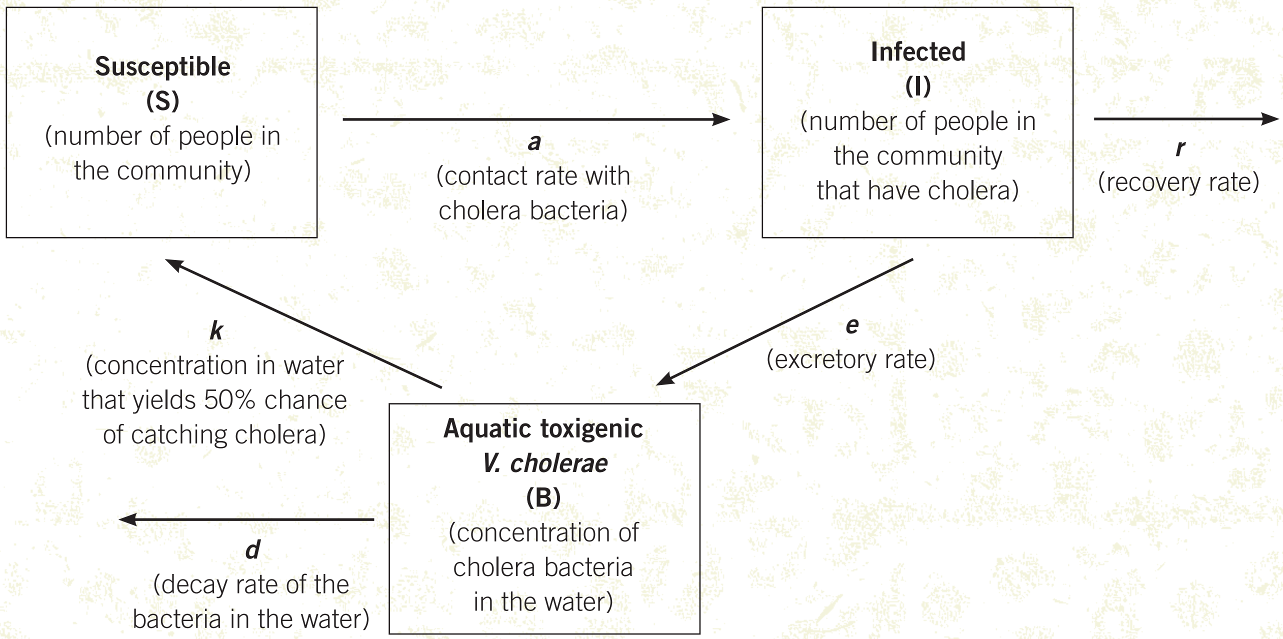
WHO Malaria Fact Sheet: http://www.who.int/mediacentre/factsheets/fs094/en/index.html

Credit:

Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases*. 1:1doi:10.1186/1471-2334-1-1.
Available at http://www.biomedcentral.com/1471-2334/1/1.

Name:_______________ Date:__________ Period:________

Cholera Model Diagram



Parameter	Description
r	Rate at which people recover from cholera (day^{-1})
k	Concentration of *V. cholerae* in water that yields 50% chance of catching cholera (cells/ml)
d	Decay rate of *V. cholerae* in the aquatic environment (day^{-1})
a	Rate of exposure to contaminated water (day^{-1})
Variable	**Description**
S_c	Critical Number of Susceptibles (if this number is bigger than the number of susceptibles in your community, an outbreak will occur)
e	Contribution of each infected person to the population of V. cholerae in the aquatic environment (cell/ml day^{-1} $person^{-1}$)

Credit: Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases.* 1:1doi:10.1186/1471-2334-1-1. Available at http://www.biomedcentral.com/1471-2334/1/1.

Name:______________________________ Date:___________ Period:________

Probability of Cholera Infection

HANDOUT

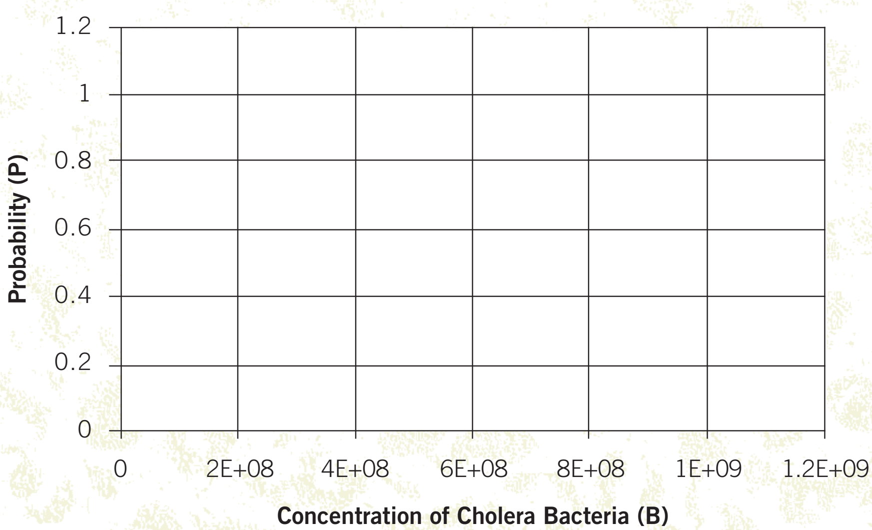
You are an epidemiologist trying to understand the impact of an ongoing cholera outbreak in Zimbabwe.

Cholera is an infectious disease that can cause severe diarrhea which, if untreated, can quickly become fatal. People can become infected when they drink water that is contaminated with the cholera bacterium, *V. cholerae*. This bacterium is measured by taking a sample of water and measuring the concentration of cholera cells per milliliter (ml) of water. The higher the concentration, the greater probability that a person will become infected with the bacteria from drinking that water.

You wish to present information to your peers regarding the concentration of *V. cholerae* in water which will cause a 0.5 (50%) probability of catching cholera.

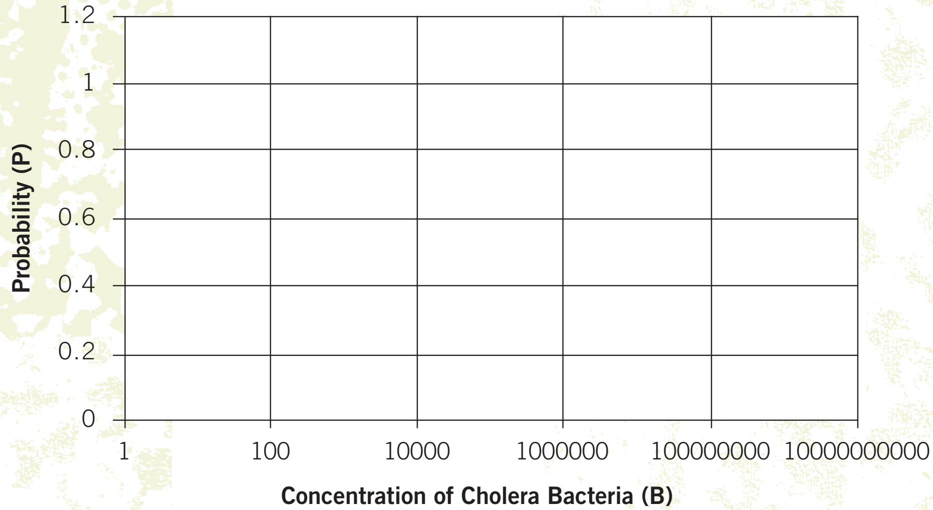
1. Plot the following points on the graph below.

	B (concentration of cholera cells/ml)	P (probability of catching cholera)
1	10	0.00
2	1000	0.04
3	100000	0.08
4	10000000	0.96
5	1000000000	0.98

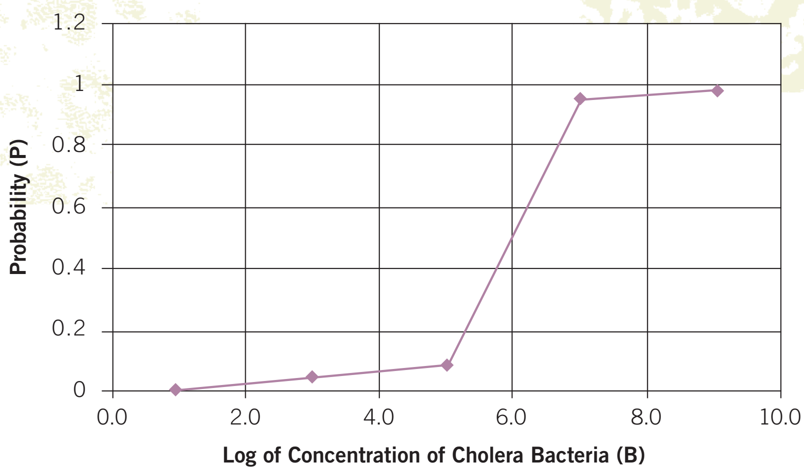


2. Are you able to easily find the concentration at which there is a 0.5 probability of catching cholera by looking at your graph?

3. Now plot the same points on a graph using a logarithmic scale for the x-axis.



4. Are you able to easily find the concentration at which there is a 0.5 probability of catching cholera by looking at your graph? What is the concentration?



Another way of showing data using logarithms is to take the log of the large numbers and then plot the information. Here is what the graph would look like.

5. Notice the title of the x-axis is now "Log of Concentration of Cholera (B)." So if you follow the 0.5 probability horizontally until you intersect the graph, you obtain a value of about 6. What does this "6" really mean?

6. You have been asked to present your findings at a meeting with scientists and policymakers at the World Health Organization (WHO) who are interested in understanding the outbreak in Zimbabwe. What scaling strategy would you use to present your data? Why?

Name:_______________ Date:__________ Period:________

Malaria & Income

HANDOUT

You are an epidemiologist examining the number of malaria cases in a variety of countries around the world. Malaria is a infectious disease caused by a parasite which is transmitted through the bite of an infected female Anopheles mosquito.

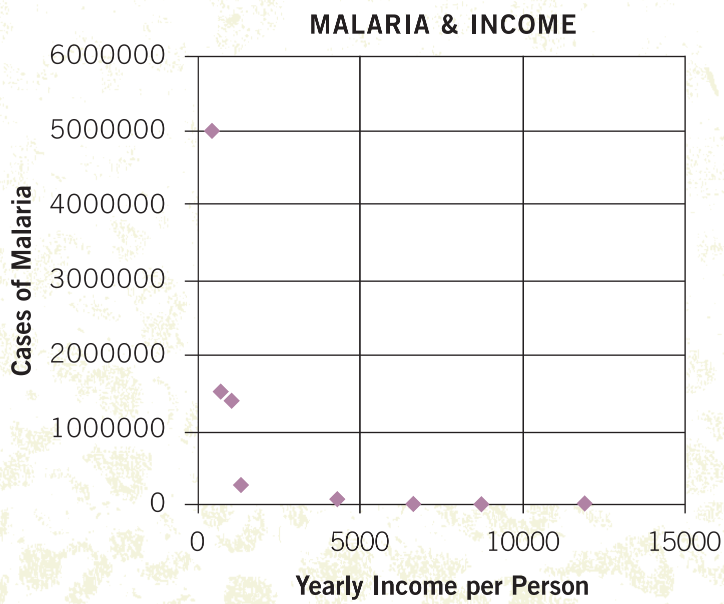
TABLE 1

Country	Yearly income per person (in dollars)	Log of income per person	Cases of malaria	Log of cases of malaria
D.R. Congo	269		5,008,956	
Zimbawe	505		1,535,877	
Rwanda	836		1,418,762	
Afghanistan	902		271,601	
China	4,498		116,260	
Ecuador	6,715		9,863	
South Africa	8,870		12,098	
Argentina	11,881		209	

You are interested in examining the income levels of people in each of the countries for which you have data to see if there is any relationship between incidents of malaria and people's income. Are there more cases of malaria in impoverished countries where people have lower yearly incomes? Or are there less cases of malaria in these countries?

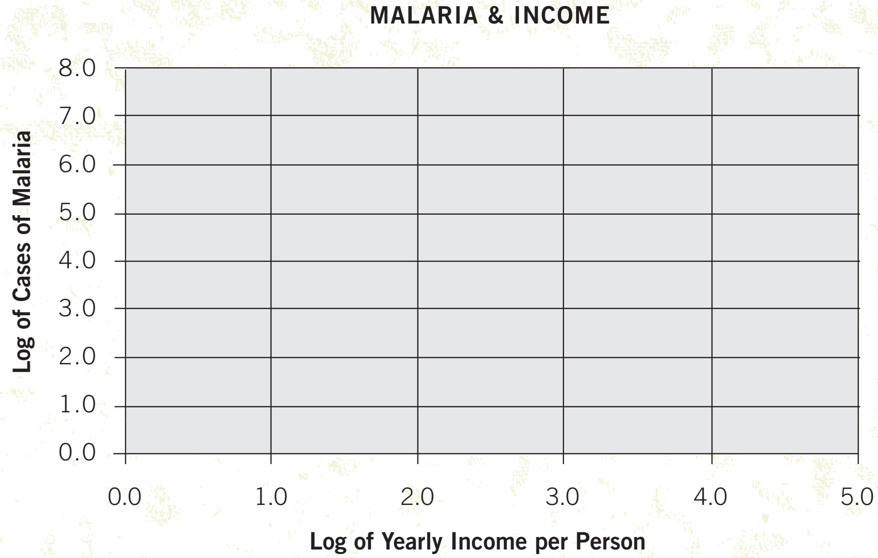
You have been able to obtain some data on yearly income and cases of malaria for eight countries. See Table 1.

If you were to simply plot the data as given, using "yearly income per person" and "cases of malaria," the graph would look like this:



1. In the Probability of Cholera Infection example (Part One) it was reasonable only to take the log of the x values because they were the large values. It is also possible to take the log of both the x and the y values. Go back and fill in the rest of Table 1 (on preious page) by taking the log of all values.

2. Plot the new data on the graph below:

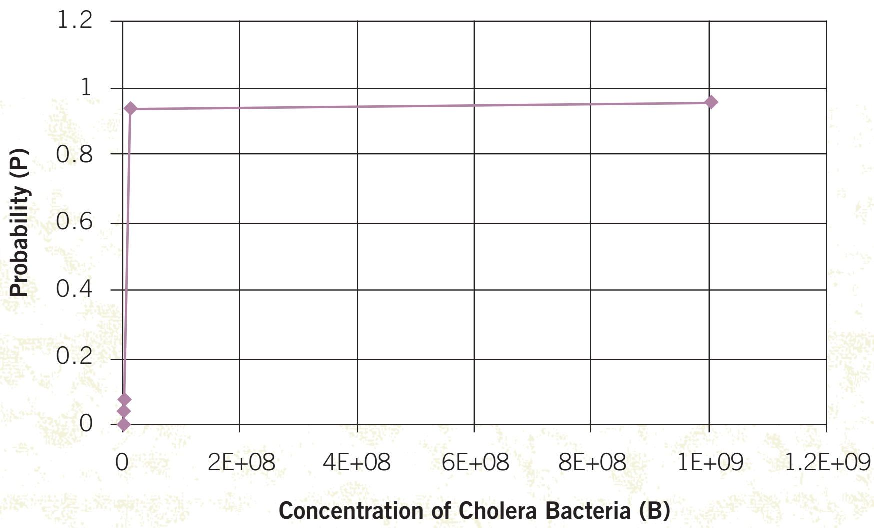


3. What conclusion can you now make about malaria cases and income? Is there a relationship? Explain.

Log Scales

PART ONE: PROBABILITY OF CHOLERA INFECTION

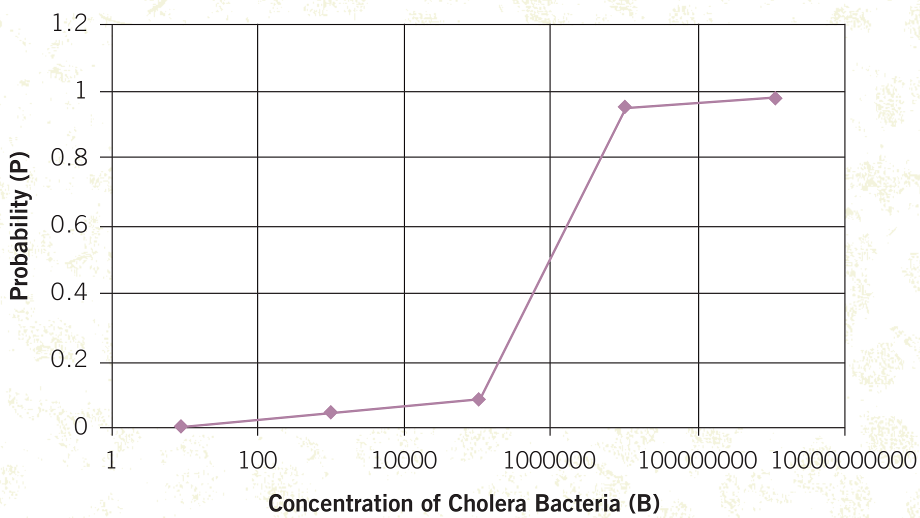
1.



2. Are you able to easily find the concentration at which there is a 0.5 probability of catching cholera by looking at your graph?

No, most of the points are on the left side of the graph

3.



KEY

4. Are you able to easily find the concentration at which there is a 0.5 probability of catching cholera by looking at your graph? What is the concentration?

Yes, follow horizontally from 0.5 on the y-axis and it is fairly easy to see that around 1,000,000 cells/ml is the concentration at which there is a 50% chance of catching cholera.

5. What does this "6" really mean?

It really means $10^6 = 1{,}000{,}000$

6. What scaling strategy would you use to present your data? Why?

It would be best to scale the x-axis using a logarithmic scale to best communicate at what concentration there is a 50% chance of catching cholera.

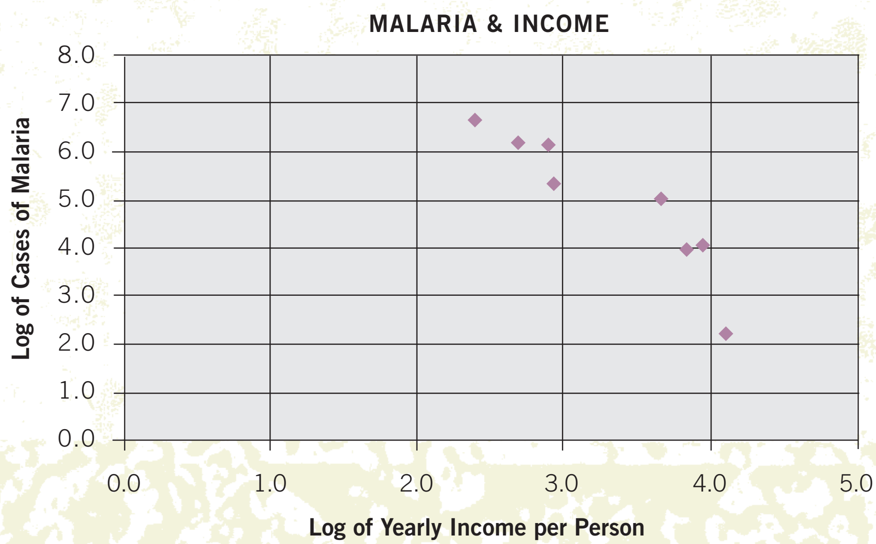
PART TWO: MALARIA & INCOME

1.

TABLE 1

Country	Yearly income per person (in dollars)	Log of income per person	Cases of malaria	Log of cases of malaria
D.R. Congo	269	2.4298	5,008,956	6.6997
Zimbawe	505	2.7033	1,535,877	6.1864
Rwanda	836	2.9222	1,418,762	6.1519
Afghanistan	902	2.9552	271,601	5.4339
China	4,498	3.6530	116,260	5.0654
Ecuador	6,715	3.8270	9863	3.9940
South Africa	8,870	3.9479	12,098	4.0827
Argentina	11,881	4.0749	209	2.3201

2.



3. What conclusion can you now make about malaria cases and income? Is there a relationship? Explain.

There is now a visual graph that shows that countries with less yearly income have more cases of malaria, which means that they have a greater burden of malaria.

LESSON

LESSON 2: Outbreak?

Activity Time: 100 – 150 minutes

In this lesson, students will take on the role of a consultant for the World Health Organization and will be challenged to recommend how Zimbabwe's Minister of Health should spend his money in order to protect a community from a cholera outbreak. Students will explore direct and indirect functions and their applications to a possible cholera outbreak.

This lesson should be delivered following the *Log Scales, Chera & Malaria* lesson plan.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Direct and Indirect Functions:** Direct and inverse variation functions are useful in modeling whether a disease will have an outbreak or not.

Essential Question:

- How can math be used to model a disease?

Learning Objectives:

Students will know…

- Mathematical data can be used to facilitate decision-making.
- Direct and inverse variation functions can be used to model disease outbreaks.

Students will be able to…

- Graph an inverse variation function.
- Compare a data point on a graph to a critical threshold.
- Interpret an inverse variation function and determine whether a community is likely to experience an outbreak of cholera.

Vocabulary:

- Cholera
- Concentration
- Excretion
- Infected
- Inverse variation function
- Outbreak
- Susceptible

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.
- **A2.8.H** Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.

Common Student Preconceptions:

- Large numbers and scientific notation are difficult to understand and use.

TEACHER PREPARATION

Materials:

- Computer with internet access, speakers, and a projectr
- *Outbreak? – Part 1* Handout (1 per student)
- *Outbreak? – Part 2* Handout (1 per student)
- *Outbreak? – Part 3* Handout (1 per student)
- *"Zimbabwe Begs for Cholera Aid"* Handout (1 per student)
- Rural Sanitation Photographs
- Scenario Cards (2 sets)
- Teacher Answer Key for Student Handouts

Preparation:

- Download the mp3 audio file "A Cholera Epidemic Stalks Zimbabwe" at http://www.pri.org/health/global-health/cholera-epidemic-zimbabwe.html. Alternatively, you can use the transcript of the podcast.
- Photocopy Student Handouts and Reading.
- Make two sets of the Scenario Cards by making two photocopies and cutting on the dotted lines.

PROCEDURE

Part One Hook

1. Play the 6 minute podcast **A Cholera Epidemic Stalks Zimbabwe**. As an alternative, you can access the transcript of the audio file. Either read the transcript aloud, or distribute to students for them to read.

Activity

2. Divide students into groups of 3-4.
3. Explain that the groups are consultants for the World Health Organization (WHO). Each team must make a recommendation to David Parirenyatwa, Zimbabwe's Minister of Health, on how to spend aid money in order to protect a small community from a cholera outbreak.
4. Pass out *Outbreak? – Part 1* Handout to each student. Do not pass out Part B yet.
5. Explain the Cholera Model Diagram on the handout. Be sure to go over the meaning of day^{-1} (per day).
6. Within each group, have each group member take turns explaining to the other group members each part of the diagram. The first group member will begin by explaining the (S) box. Moving clockwise, the second group member will explain the *a* parameter, and so on until the entire diagram has been reviewed.
7. As the student groups work on the problems on the handout, monitor student progress. After each group completes Question #2, the students will come to you so that you can check their equation. Upon showing you a correct equation, give each student a copy of the *Outbreak? – Part 2* Handout. Ask students to work in their groups to complete the handout.

Part Two Hook

8. Distribute copies of the article "Zimbabwe Begs for Cholera Aid," one per student. Ask students to read the article. Discuss the situation in Zimbabwe. How does David Parirenyatwa, Zimbabwe's Minister of Health, plan to use the aid money from the World Health Organization?
9. Using a computer with internet access and a projector, show students some of the maps of the Zimbabwe cholera outbreak on the WHO Crises and Emergencies website http://www.who.int/hac/crises/zwe/en/. Where is Zimbabwe? Where is Mutoko located? (Hint: it is in the northeast section of the map, a little north and east of Harare). What do these maps tell us about the severity of the outbreak? How high is the fatality rate from cholera infection in Mutoko?

Preconceptions

10. Ask students to think about the toilet facilities at their house, at their school, and at public facilities such as parks. Now, ask students to think about what toilet facilities might be like in other parts of the world. Why is it important for a community to have good sanitation?
11. Show students the Rural Sanitation Photographs, which show different ways that rural communities deal with human waste. The photographs show an open pit where waste is dumped, a privy pit, and an outhouse. In some communities, people don't have any toilet facilities at all, and poop out in the open. This is called open defecation. What happens when it rains? What if you have to get your drinking water from a nearby stream or river?

Activity

12. Redirect students' attention back to the *Outbreak? – Part 1 & 2* Handouts that they completed earlier. Ask students what does the variable *e* represent? The variable represents how much contaminated poop each person contributes to the aquatic environment. Also, help students to understand what "cells per ml per person per day" means. This is the concentration of cholera bacterium in a water sample (cells per ml) that one person contributes each day by defecating.
13. If needed to jog students' memories, review the students' work on the *Outbreak? – Part 1* Handout, specifically focusing on the meaning of the diagram and equation.
14. Distribute copies of *Outbreak? – Part 3* Handout, one per student, and monitor students' progress as they work in their groups. Have groups decide which parameter (*a, r, e, d*) they wish to manipulate in order to intervene in Mutoko (for comparison purposes, try to have all parameters represented among the groups).
15. When students reach Question #8 on their handouts, they will come to you for a Scenario Card. Pass out one Scenario Card to each group, making sure to choose a card that is matched with the parameter/intervention the group chose to manipulate. Students will use their Scenario Cards to complete the handout.

Wrap-Up

16. Have groups share their findings with the class. Discuss the following questions:
    > How did the Scenario Card affect your plan?
    > What changes did you need to make?
    > Now that we have heard from each group, what is your recommendation for how Zimbabwe's Minister of Health should spend the aid money from the World Health Organization in order to best control the cholera outbreak in Mutoko?
    > What other interventions could be done to help the community of Mutoko that weren't presented on the handout?

STUDENT ASSESSMENT

Assessment Opportunities:

- Students' understanding of the podcast and article can be assessed by asking comprehension questions.
- As students work in their groups, listen in on the groups' discussions. Provide just-in-time instruction to help clarify any misunderstandings.
- The Student Handouts can be scored using the Teacher Answer Key.

Scoring:

- Points can be assigned for the questions on the Student Handouts. Participation points can also be assigned for working in groups and contributing to class discussions.

EXTENSION ACTIVITIES

Extension Activities:

- Students could develop additional Scenario Cards for other interventions, such as building outhouses or distributing cholera vaccines.
- The 10 minute **Water for Life** video can be used to introduce the importance of clean water.

  http://webcast.un.org/ramgen/specialevents/waterforlife-eng.rm

- Share some of the photographs and statistics in the following two documents. Discuss why water is an UN priority for the 2005-2015 decade.

  UN International Water for Life Decade Report
  http://www.un.org/waterforlifedecade/pdf/waterforlifebklt-e.pdf

  UNICEF Soap, Toilets and Taps Report
  http://www.unicef.org/wash/files/FINAL_Showcase_doc_for_web.pdf

- If students enjoyed this learning activity, then they may also enjoy the "Outbreak in Infectburg" lesson plan from the Advanced Algebr Influenza section of this curriculum. This lesson engages students in planning for an influenza vaccination response in a rural town called Infectburg.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

The mathematical model and data featured in this lesson are from a 2001 article published in the journal *BMC Infectious Diseases*. It may be helpful to review this article for a more full understanding of cholera and water quality.

Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases*. 1:1doi:10.1186/1471-2334-1-1.
Available at http://www.biomedcentral.com/1471-2334/1/1.

Resources:

A Cholera Epidemic Stalks Zimbabwe podcast (6 minutes)
Public Radio International, 12/21/08
http://www.pri.org/health/global-health/cholera-epidemic-zimbabwe.html

Zimbabwe Cholera Outbreak
WHO Crises and Emergencies
http://www.who.int/hac/crises/zwe/en/

WHO Cholera Fact Sheet
http://www.who.int/mediacentre/factsheets/fs107/en/index.html

WHO Sanitation Information Site
http://www.who.int/topics/sanitation/en/

WHO Water, Sanitation, and Health Information Site
http://www.who.int/water_sanitation_health/en/

UNICEF Water, Environment and Sanitation
www.unicef.org/wes/index_3951.html

Global Handwashing Day
http://www.globalhandwashingday.org/

Credit:

Kirby, T. Zimbabwe begs for cholera aid.
London Evening Standard, April 12, 2008, Available from: http://www.thisislondon.co.uk/standard/article-23597023-details/Zimbabwe+begs+for+cholera+aid/article.do.

Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: the role of the aquatic reservoir. *BMC Infectious Diseases*. 1:1doi:10.1186/1471-2334-1-1.
Available from http://www.biomedcentral.com/1471-2334/1/1.

Name:____________________________ Date:___________ Period:________

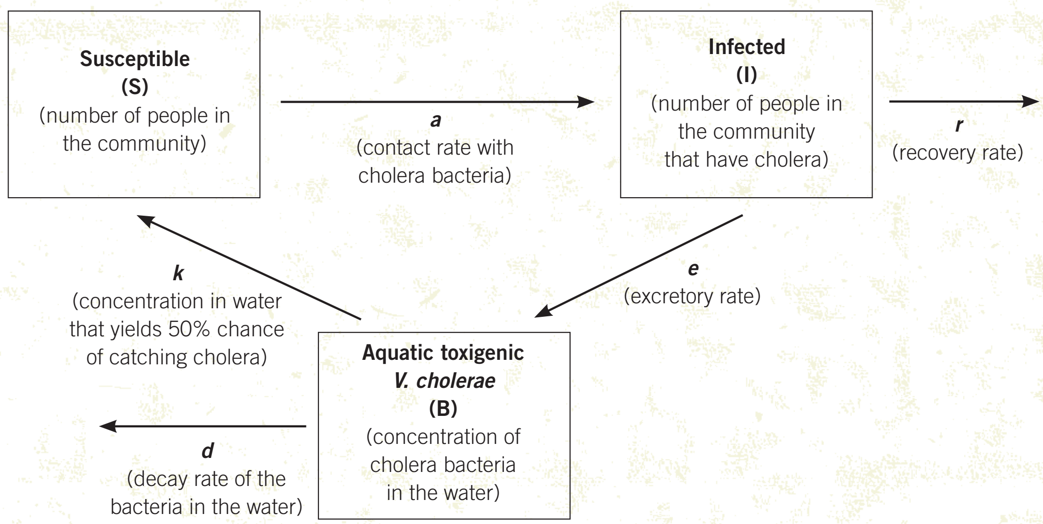
Outbreak? – Part 1

HANDOUT

You are a consultant working for the World Health Organization (WHO). You and your team are challenged with overseeing the distribution of aid money to Zimbabwe to help control cholera outbreaks in various communities around the country.

You and your team must make a recommendation to David Parirenyatwa, Zimbabwe's Minister of Health, on how to spend the aid money. Your recommendation needs to consider how to best protect the people of a community called Mutoko from a cholera outbreak.

Often diseases are modeled with a SIR model (Susceptible – Infected – Recovery). Below is a proposed Cholera Model Diagram for a cholera outbreak.



Parameter	Description
r	Rate at which people recover from cholera (day^{-1})
k	Concentration of *V. cholerae* in water that yields 50% chance of catching cholera (cells/ml)
d	Decay rate of *V. cholerae* in the aquatic environment (day^{-1})
a	Rate of exposure to contaminated water (day^{-1})
Variable	**Description**
S_c	Critical Number of Susceptibles (if this number is bigger than the number of susceptibles in your community, an outbreak will occur)
e	Contribution of each infected person to the population of *V. cholerae* in the aquatic environment (cell/ml day^{-1} person^{-1})

Credit: Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases.* 1:1doi:10.1186/1471-2334-1-1. Available at http://www.biomedcentral.com/1471-2334/1/1.

1. Your goal is to prevent or control a cholera outbreak. Circle the lower-case parameters in the diagram which you would like to go down in value. Place these parameters in the denominator of the equation o the right.

2. Put a box around the lower-case variables and parameters in the diagram which you would like to go up in value. Place these parameters in the numerator of the equation to the right.

$$S_c = \frac{\square\,\square\,\square}{\square\,\square}$$

Check your equation with your teacher.

Name:______________________________ Date:___________ Period:________

Outbreak? – Part 2

An important piece of information has just appeared in your email inbox. It is an email from a WHO field officer who has spent the last few months in Mutoko. She's been collecting and testing water samples to learn more about the cholera bacterium in the local river, which is a primary source of drinking water for Mutoko residents.

Attached to the email is a field report updating you on the situation in Mutoko. This data will be helpful as you begin to consider your recommendations for the Minister of Health.

Mutoko, Zimbabwe
Population: 9,932

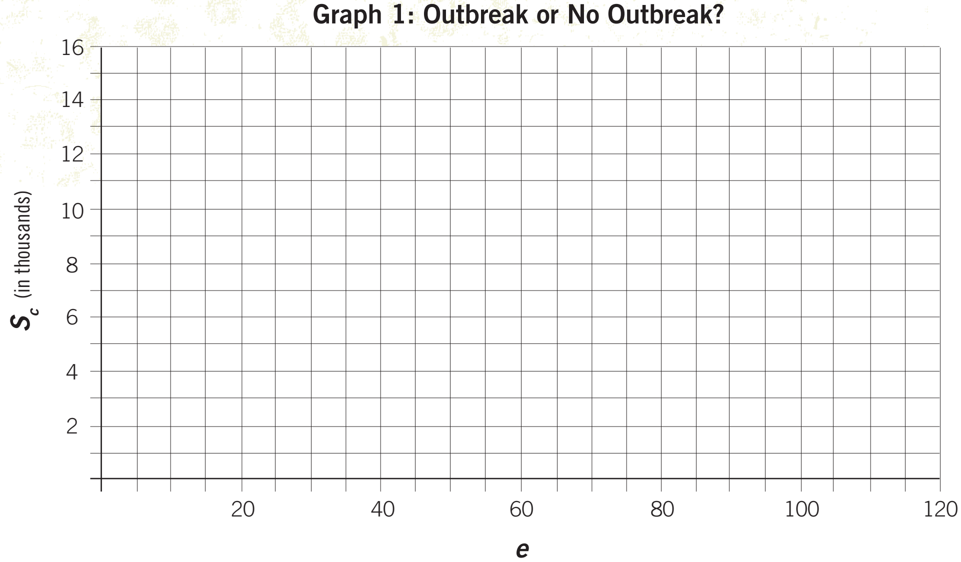
TABLE 1: Mutoko Data

Parameter	Value	Explanation
r	0.20	20% of the population recovers each day.
k	10^6	This concentration of the bacteria in the water provides a 50% chance that a person will catch cholera.
d	0.33	33% of the bacteria die off each day.
a	0.97	97% of the population (S) contact the contaminated water each day.

1. Write a new equation substituting your known parameters into the model, keeping ***e*** as the variable.

2. Graph your equation on the provided axes. First, fill out the table and then graph your equation.

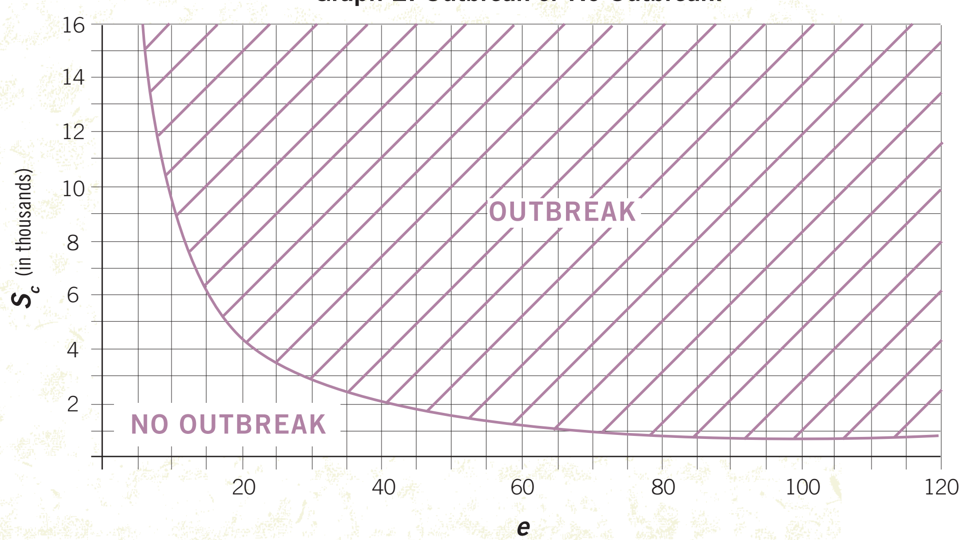
Graph 1: Outbreak or No Outbreak?



e	S_c
5	
10	
21	
30	
40	
50	
60	
70	
80	
90	
100	

Your graph should look similar to the one below. The curve on the graph is called the "critical population threshold" (S_c). If a community lies above the curve, than a cholera outbreak will likely occur. Those communities with small enough populations or small rates of contaminated excretion will not have an outbreak of cholera.

Graph 2: Outbreak or No Outbreak?



3. Mutoka has a population of about 10,000. Your team of experts has determined that the excretion rate is 10 cells of cholera bacterium per person per day per milliliter. Plot the point (10, 10000) on your graph (on the previous page). Should an outbreak of cholera be expected?

4. Which parameters and variables directly affect the critical population threshold (S_c)?

5. Which parameters and variables inversely affect the critical population threshold (S_c)?

6. What interventions does your group think might help to prevent an outbreak from occurring?

Homework suggestion: Practice problems on graphing and solving indirect functions so that you are prepared for tomorrow's challenge.

Name:_________________________ Date:__________ Period:________

Outbreak? – Part 3

HANDOUT

Good news! Your supervisor at WHO just informed you that $10,000 in aid is being earmarked to help prevent a cholera outbreak in Mutoko. You and your teammates need to start thinking about the recommendation that you are going to make to Zimbabwe's Minister of Health. He's waiting for your recommendation to help him decide how to best use the $10,000.

---

1. *Table 2: Cholera* Interventions provides a list of possible interventions that could be implemented in Mutoko. First, review the parameters in the Cholera Model Diagram. Then, fill in the empty column in Table 2 with the parameter you think will be affected by each intervention.

TABLE 2: Cholera Interventions

Intervention	Parameter affected	Impact to community	Cost
Distribute Oral Rehydration Therapy (ORT) to community		For each pallet of ORT distributed, parameter increases by 0.005	$200 pallet^{-1}
Chemically treat the water source		For each treatment of the water, parameter increases by 0.01	$150 treatment^{-1}
Build a well away from the contaminated water		For each well built, parameter decreases by 0.14	$2500 well^{-1}
Educate the community on hand washing and proper waste disposal		For each education program, parameter decreases by 0.03	$500 program^{-1}

2. As a team, decide which parameter (*a* ,*r, e, d*) you wish to manipulate in order to intervene in Mutoko. Table 2 will help you consider each parameter, the related intervention, and the cost. Keep in mind your $10,000 budget. Which parameter do you think will most successfully prevent the cholera outbreak?

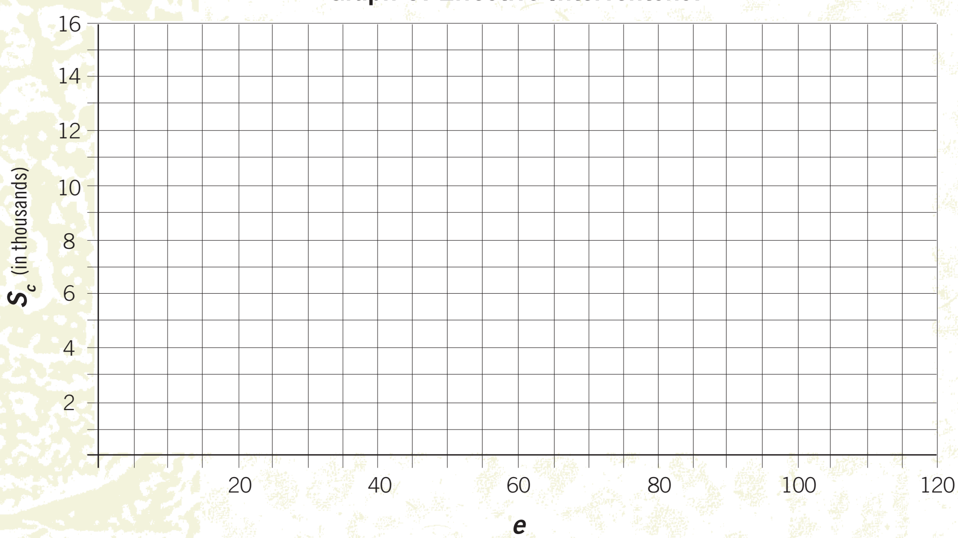
3. Now, treat your parameter like it is a variable, letting the other lowercase letters be their constant amounts from *Table 1: Mutoko Data*. Let $\boldsymbol{e} = 10$ and $\boldsymbol{S_c} = 10000$. Solve for your parameter.

4. Determine how much of your intervention is needed to just place your community in the “no outbreak” part of *Graph 2: Outbreak or No Outbreak?*

5. Write a new equation with your new parameter (keeping *e* the variable).

6. Graph your new equation using your new parameter (keeping *e* the variable). Decide as a group whether your parameter is big (or small) enough for you to be confident that an outbreak will not occur. Make adjustments to your parameter if needed. Recalculate how much you will need to spend in order to achieve this parameter value

Graph 3: Effective Interventons?



e	S_c
5	
10	
21	
30	
40	
50	
60	
70	
80	
90	
100	

7. How much money does the Minister of Health need to spend for your recommended intervention to be effective at preventing an outbreak?

You sit back in your chair and let out a long sigh. Things didn't quite go as perfectly as you planned. You just got off the phone with David Parirenyatwa, Zimbabwe's Minister of Health. Mr. Parirenyatwa called to tell you that he followed your recommendations on using the WHO aid money, but he expressed concern that the community was still on the verge of a cholera outbreak. He asked you to call him back tomorrow with a revised plan for Mutoko.

So what happened? You used the mathematical model for a cholera outbreak. You used data provided by the field officer in Mutoko. Was your recommendation carried out correctly? You grab your phone and dial the number for the field officer in Mutoko. Perhaps she can help you understand what may have happened.

---

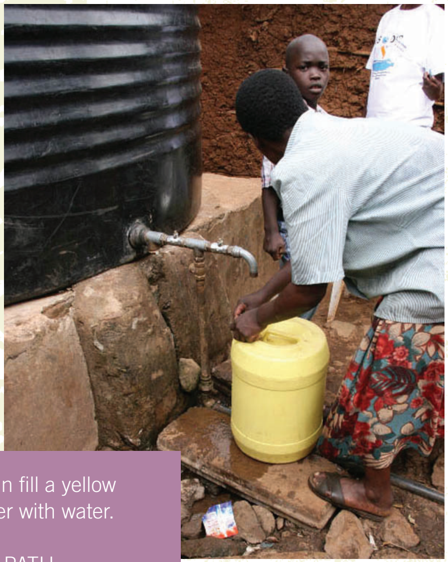
8. Present your findings to your teacher. Your teacher will then give you a Scenario Card describing something that happened in Mutoko which was completely out of your control. Write down the scenario from your card:

9. Using the information from the Scenario Card, calculate if a cholera outbreak will now occur. Do you have enough money leftover to remedy the situation? What is your plan? Be prepared to share your findings with the class.

Name:____________________________ Date:___________ Period:________

HANDOUT

Zimbabwe Begs for Cholera Aid



A woman fill a yellow container with water.

Source: PATH

Terry Kirby, 4/12/08, *London Evening Standard*

Zimbabwe declared a state of emergency today after finally admitting that the cholera outbreak which has claimed hundreds of lives in the impoverished country is out of control.

Zimbabwe's health minister David Parirenyatwa has asked World Health Organisation aid agencies for medicine, equipment and funds to pay medical staff.

Zimbabwe's state-controlled media quoted him as telling the agencies: "Our central hospitals are literally not functioning. Our staff is demotivated and we need your support to ensure that they start coming to work and our health system is revived."

Zimbabwe's deputy minister for water and infrastructural development Walter Mzembi was also reported as saying that his ministry only had water treatment chemicals to last about 12 weeks. "I am appealing for at least 40 million rand ($3.89 million) to purchase chemicals for the next two months and the money is needed between now and next Monday." The government has also appealed for $450 million in aid to deal with food shortages.

The United Nations has estimated that the death toll stands officially at 565, although some reports have estimated that the number now runs into thousands. A total of 12,500 cases have been recorded. The Zimbabwean government has previously claimed the outbreak was under control and blamed it on Western sanctions against President Robert Mugabe.

Mr. Parirenyatwa admitted his government needed water as well as sanitation equipment, the World Health Organisation office in Harare said. A spokesman added: "It was the first time where the minister has called all the parties together to detail all the needs of the government."

Yesterday the WHO flew enough anti-cholera supplies and medicines to Harare, which is the worst hit area, to treat up to 2,000 moderate cases.

Most of the capital has been without water since Sunday. Supply to the city has been erratic for two years amid the general collapse of the country's health and sanitation systems.

Many people rely upon boreholes and primitive hand pumps. Raw sewage runs down some streets in Harare.

Reprinted with permission of the *London Evening Standard*. Original article available at: http://www.thisislondon.co.uk/standard/article-23597023-details/Zimbabwe+begs+for+cholera+aid/article.do.

Name:______________________ Date:__________ Period:________

Rural Sanitation

HANDOUT

Name:______________________________ Date:____________ Period:_________

Scenario Cards

HANDOUT

Education Program	Education Program
You sent in teams of Western educators, some of whom were insensitive to the needs of Mutoko's culture. As a result, many people disregarded the hand washing education. Increase ***a*** by 0.2	The education program you implemented was mostly in print form. 75% of the population is illiterate and were unable to access the hand washing education. Increase ***a*** by 0.15
Chemical Treatment	**Chemical Treatment**
The chemicals you used had the unfortunate consequence of killing many fish in the local river. Cost to clean the water = $8,000	The chemicals were not as effective as the manufacturer had claimed. Decrease ***d*** by 0.4
Build Well	**Build Well**
The well was built too close to the contaminated water source. Now the well water is contaminated with *V. cholerae*. Increase ***a*** by 0.1	Your well was built improperly and collapsed. Increase ***a*** by 0.07
Distribute ORT	**Distribute ORT**
The ORT packets were distributed with insufficient training. The community members did not understand how to properly use the treatment. Decrease ***r*** by 0.05	War in a neighboring district creates instability in the region. It becomes much more expensive to import and distribute the ORT packets. Cost to distribute the ORT = $5,000.

Outbreak?

PART ONE:

1. Your goal is to prevent or control a cholera outbreak. Circle the lower-case parameters in the diagram which you would like to go down in value. Place these parameters in the denominator of the equation to the right.

$$S_c = \frac{\boxed{}\,\boxed{}\,\boxed{}}{\boxed{a}\,\boxed{e}}$$

2. Put a box around the lower-case variables and parameters in the diagram which you would like to go up in value. Place these parameters in the numerator of the equation to the right.

$$S_c = \frac{\boxed{k}\,\boxed{d}\,\boxed{r}}{\boxed{a}\,\boxed{e}}$$

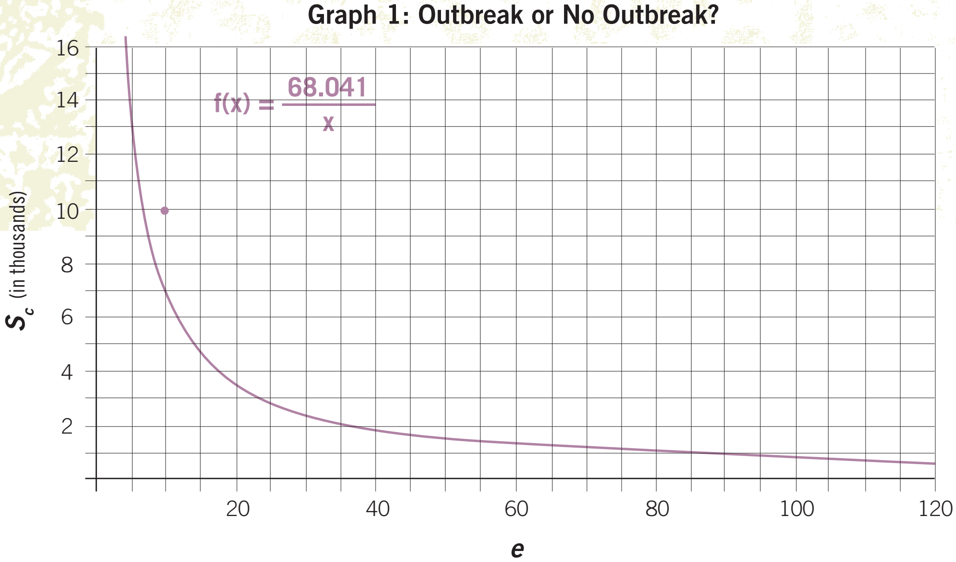
PART TWO:

1. Write a new equation substituting your known parameters into the model, keeping ***e*** as the variable.

$$S_c = \frac{10^6 \cdot 0.33 \cdot 0.20}{0.97 \cdot e} = \frac{68041}{e}$$

2. Graph your equation on the provided axes. First, fill out the table and then graph your equation.

Graph 1: Outbreak or No Outbreak?



e	S_c
5	13608
10	6804
21	3402
30	2268
40	1701
50	1361
60	1134
70	972
80	851
90	756
100	680

KEY

3. Mutoka has a population of about 10,000. Your team of experts has determined that the excretion rate is 10 cells of cholera bacterium per person per day per milliliter. Plot the point (10, 10000) on your graph (on the previous page). Should an outbreak of cholera be expected?

Yes, an outbreak should be expected.

4. Which parameters and variables directly affect the critical population threshold (S_c)?

k, d, r

5. Which parameters and variables inversely affect the critical population threshold (S_c)?

a, e

6. What interventions does your group think might help to prevent an outbreak from occurring?

Possible answers: Oral Rehydration Therapy; treat water; build a well; educate people about handwashing; build toilets, etc.

PART THREE:

1.

TABLE 2: Cholera Interventions

Intervention	Parameter affected	Impact to community	Cost
Distribute Oral Rehydration Therapy (ORT) to community	*r*	For each pallet of ORT distributed, parameter increases by 0.005	\$200 pallet^{-1}
Chemically treat the water source	*d*	For each treatment of the water, parameter increases by 0.01	\$150 treatment^{-1}
Build a well away from the contaminated water	*a*	For each well built, parameter decreases by 0.14	\$2500 well^{-1}
Educate the community on hand washing and proper waste disposal	*a*	For each education program, parameter decreases by 0.03	\$500 program^{-1}

2. ***Answers will vary.***

3. Now, treat your parameter like it is a variable, letting the other lowercase letters be their constant amounts from *Table 1: Mutoko Data*. Let $e = 10$ and $S_c = 10000$. Solve for your parameter.

An example: $$10000 = \frac{kdr}{ae} = \frac{10^6 \cdot 0.33 \cdot r}{0.97 \cdot 10} \qquad r = 0.29$$

4. Determine how much of your intervention is needed to just place your community in the "no outbreak" part of *Graph 2: Outbreak or No Outbreak?*

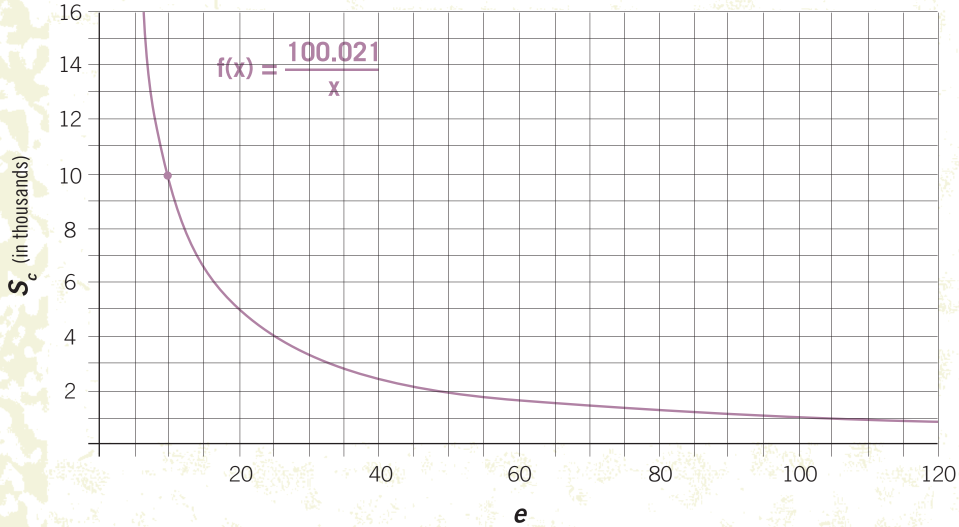
Example: r needs to be 0.294. r currently is 0.20. r needs to be increased by 0.094.
Each pallet of ORT increases r by 0.005. 0.094/0.005 = 18.8
Therefore 19 pallets must be purchased.
19 pallets at \$200 = \$3800

5. Write a new equation with your new parameter (keeping *e* the variable).

$$S_c = \frac{10^6 \cdot 0.33 \cdot 0.294}{0.97 \cdot e} = \frac{100021}{e}$$

6. Graph your new equation using your new parameter (keeping *e* the variable). Decide as a group whether your parameter is big (or small) enough for you to be confident that an outbreak will not occur. Make adjustments to your parameter if needed. Recalculate how much you will need to spend in order to achieve this parameter value

Graph 3: Effective Interventions?



e	S_c
5	
10	
21	
30	
40	
50	
60	
70	
80	
90	
100	

Note: Some groups may want to spend more than the minimum in order to place the point clearly on the "no outbreak" side of the curve.

7. How much money does the Minister of Health need to spend for your recommended intervention to be effective at preventing an outbreak?

Example: $3800 +

8. Present your findings to your teacher. Your teacher will then give you a Scenario Card describing something that happened in Mutoko which was completely out of your control. Write down the scenario from your card:

Example: Scenario Card decreases r by 0.05.
Now r is 0.294 – 0.05 = 0.244.

9. Using the information from the Scenario Card, calculate if a cholera outbreak will now occur. Do you have enough money leftover to remedy the situation? What is your plan?

Example: Since r is now 0.244, an outbreak may occur unless another intervention occurs. 10 more pallets of ORT will need to be purchased in order to prevent the outbreak. 10 pallets at $200 = $2000. There is still enough money.

LESSON 3: Circle of Contamination

LESSON

Activity Time: 50 minutes

In this lesson, students will create and interpret a graph of an inverse square variation function. Using the scenario of a water source contaminated with *V. cholerae*, students will calculate the spread of the bacteria in a circular pattern over time and calculate a person's probability of cholera infection.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Inverse Square Variation Function**: The concentration of bacteria can be modeled with an inverse square variation function.

Essential Question:

- How can the concentration of bacteria be modeled with an inverse square variation function?

Learning Objectives:

Students will know…

- Inverse square variation functions can model the concentration of bacteria over time as it spreads in water.
- Mathematical models are often driven by underlying assumptions.

Students will be able to…

- Create and interpret a graph of an inverse square variation function.

Vocabulary:

- Bacterium
- Cholera
- Concentration
- Inverse square variation

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.

Common Student Preconceptions:

- Large numbers and scientific notation are difficult to understand and use.

TEACHER PREPARATION

Materials:

- Computer with internet access, speakers, and projector
- *Circle of Contamination* Handout (1 per student)
- Teacher Answer Key for Student Handout
- *Slumdog Millionaire* DVD (optional)

Preparation:

- Preview the **Inverse Square Law** video. Make sure that you have the required QuickTime software to view the video. http://www.teachersdomain.org/assets/ket/ket08/ket08_int_ketinverse/ket08_int_ket-inverse.html.
- If using the *Slumdog Millionaire* film as a hook to engage student interest, queue the film to the scene where the young character dives into the outhouse in order to rescue an important photograph.
- Photocopy the Student Handout.

PROCEDURE

Hook

1. Show students the 6 minute **Inverse Square Law** video to introduce students to the inverse square law. Begin with the "One Dimension" tab, view the video and discuss with students. Then choose the "Two Dimension" and "Three Dimension" tabs, pausing to discuss after each video segment.
2. Optional: Show students the outhouse scene in *Slumdog Millionaire*.

Preconceptions

3. If large numbers and scientific notation are difficult for your students, review these concepts at the board by having students place some large numbers (in scientific notation) on the number-line, from 0 to 1 billion. For example:

Activity

4. Pass out copies of the *Circle of Contamination* Handout, one per student.
5. Depending on your students' abilities, you may choose to guide the class through the first four problems, working through problems together and sharing the answers.
6. As students work on completing the handout, monitor student progress.

Wrap-Up

7. Ask students to share their responses for the last three questions on the handout.
8. Discuss why it is important to keep in mind the underlying assumptions that drive a mathematical model.

STUDENT ASSESSMENT

Assessment Opportunities:

- Students' understanding of the **Inverse Square Law** video can be assessed by asking comprehension questions.
- As students work in their groups, listen in on the groups' discussions. Provide just-in-time instruction to help clarify any misunderstandings.
- The Student Handout can be scored using the Teacher Answer Key.

Scoring Rubric:

- Points can be assigned for the questions on the Student Handout. Participation points can also be assigned for working in groups and contributing to class discussions.

EXTENSION ACTIVITIES

Extension Activities:

The lesson could be extended by having students consider the water contamination scenario in three dimensions, rather than being limited to two dimensions.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Inverse Square Law Video (6 minutes)
Kentucky Educational Television, 2008
http://www.teachersdomain.org/assets/ket/ket08/ket08_int_ketinverse/ket08_int_ketinverse.html

WHO Cholera Fact Sheet:
http://www.who.int/mediacentre/factsheets/fs107/en/index.html

WHO Sanitation Information Site
http://www.who.int/topics/sanitation/en/

WHO Water, Sanitation, and Health Information Site
http://www.who.int/water_sanitation_health/en/

UNICEF Water, Environment and Sanitation
www.unicef.org/wes/index_3951.html

Credit:

Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases*. 1:1doi:10.1186/1471-2334-1-1.
Available from http://www.biomedcentral.com/1471-2334/1/1.

Name:____________________________ Date:___________ Period:________

Circle of Contamination

HANDOUT

1. After watching the Inverse Square Law video, describe how bacteria or liquid placed into water might expand outward in a radial pattern. Assume that the bacteria remains on the surface and only expands in two dimensions. Draw a diagram showing what the first three minutes might look like. Label minute 0, minute 1, minute 2, and minute 3 on your diagram.

2. Describe how the concentration of the bacteria changes with time.

3. How are the concentration of the bacteria and the area of the circle related?

A woman fills containers at a community water spigot

Source: T. Britschgi

Cholera is an infectious disease that can cause severe diarrhea which, if untreated, can quickly become fatal. People can become infected when they drink water that is contaminated with the cholera bacterium, *V. cholerae*. This bacterium is measured by taking a sample of water and measuring the concentration of *V. cholerae* cells per milliliter (ml) of water. The higher the concentration, the greater probability that a person will become infected with the bacteria from drinking that water.

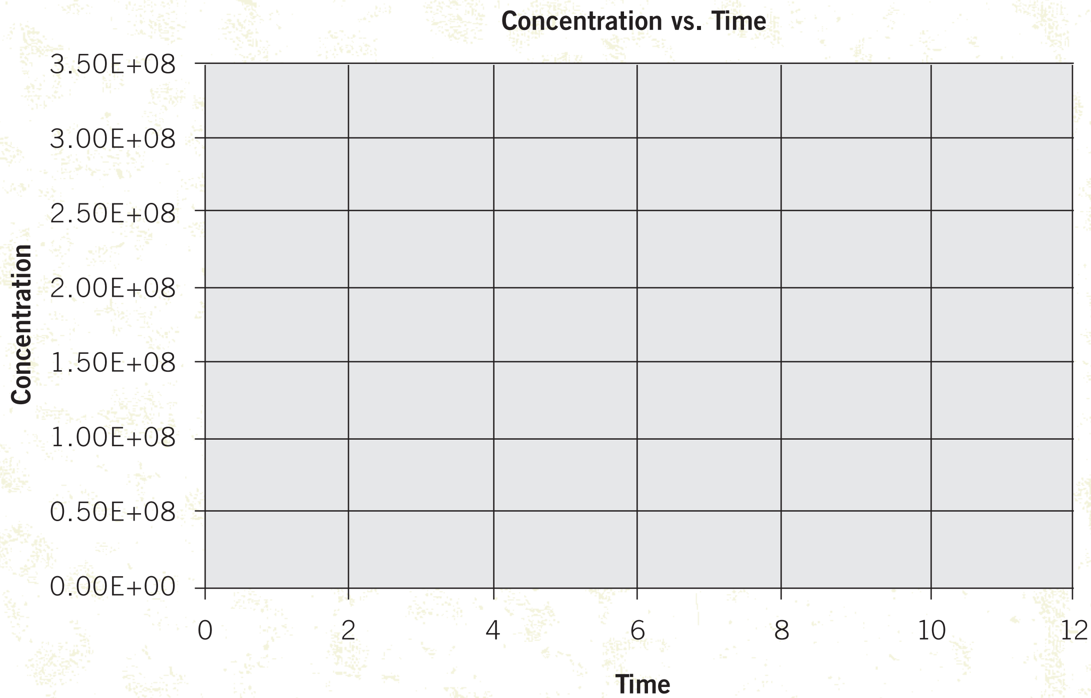
Imagine that a water source is contaminated with *V. cholerae* when a person who is infected with the bacteria poops in the water. The bacteria spreads out in a circular pattern through time. The original concentration of the bacteria was 1 billion (1×10^9) cells per milliliter in 1 square foot. Each minute thereafter the radius expands by 1 foot. Remember that for this scenario we are only working in two dimensions.

4. Find the concentration after 1 minute.
(Hint: First find the area of the region now contaminated at 0 minutes).

5. Fill in the chart below:

Time (minutes)	Area of Contaminated Region (ft^2)	Concentration (cells/ml)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
t		

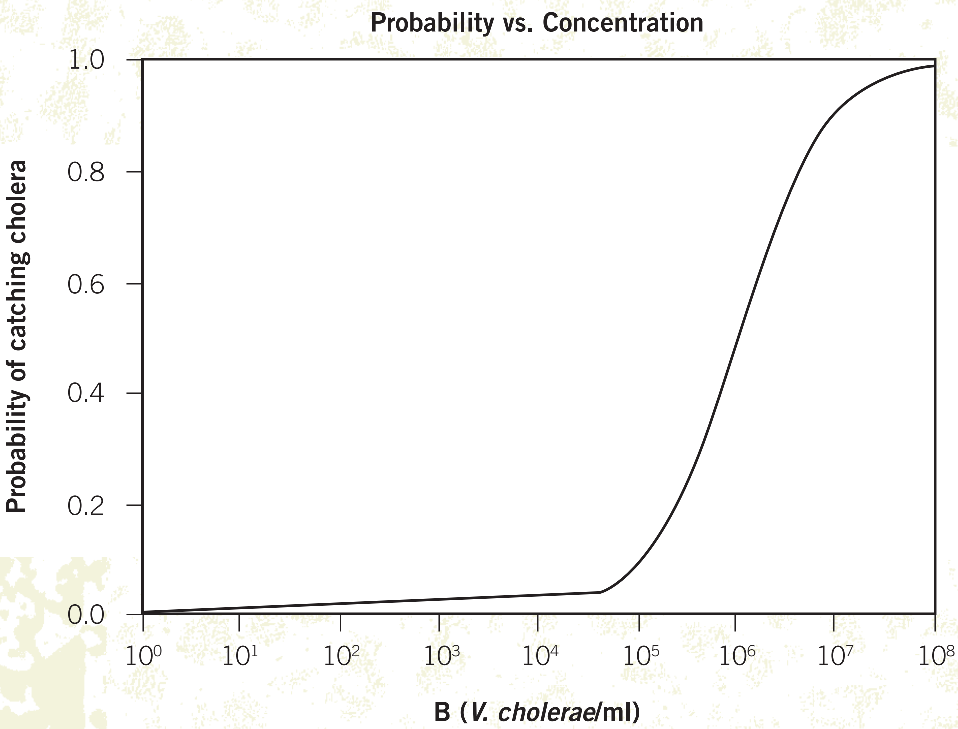
6. Plot the concentrations (from the table) on the graph below:



7. What is the equation for your graph?

8. Use your equation to determine what the concentration of *V. cholerae* would be after 30 minutes.

9. Study the following graph of the concentration of cholera bacteria (B) and the probability of catching cholera. Approximately what concentration of bacteria is required to give someone a 50% chance of catching cholera if they drink the water?



Credit: Codeco, C.A. (2001). Endemic and epidemic dynamics of cholera: The role of the aquatic reservoir. *BMC Infectious Diseases.* 1:1doi:10.1186/1471-2334-1-1.
Available from http://www.biomedcentral.com/1471-2334/1/1.

10. Using your equation, find the amount of time required for the cholera bacteria to have spread out enough to give someone a 50% chance of catching cholera.

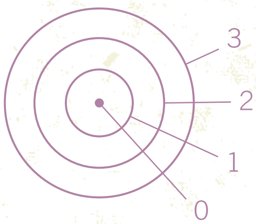
11. How much time will elapse before the concentration drops to 1000 cells/ml (the concentration where your probability of catching cholera is about 5%)?

12. There are some assumptions that we have to make when we use this model to describe the dissipation of the bacteria through the water. Describe at least two of these assumptions.

Circle of Contamination

KEY

1. Draw a diagram showing what the first three minutes might look like. Label minute 0, minute 1, minute 2, and minute 3 on your diagram.



2. Describe how the concentration of the bacteria changes with time.

The concetration is going down.

3. How are the concentration of the bacteria and the area of the circle related?

As the area increases, the concentration decreases.

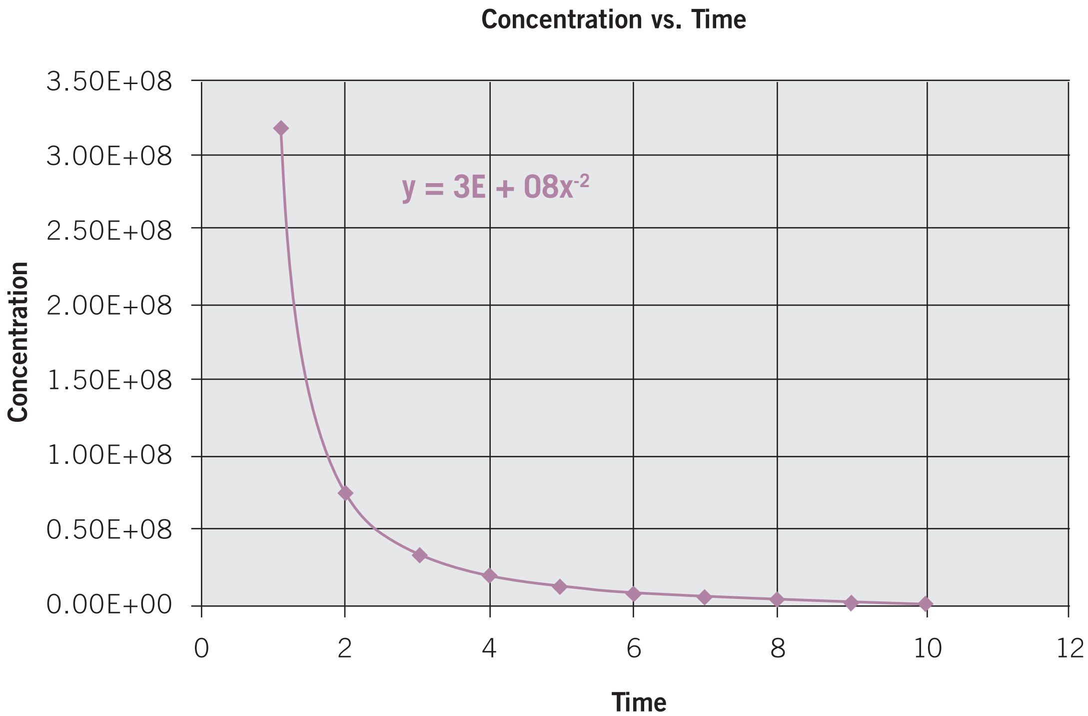
4. Find the concentration after 1 minute.

$$\frac{1 \times 10^9}{\pi \cdot 1^2} = 3.18 \times 10^8 \textit{ cells/ml}$$

5.

Time (minutes)	Area of Contaminated Region (ft^2)	Concentration (cells/ml)
1	3.14159	3.18E+08
2	12.56636	7.96E+07
3	28.27431	3.54E+07
4	50.26544	1.99E+07
5	78.53975	1.27E+07
6	113.09724	8.84E+06
7	153.93791	6.50E+06
8	201.06176	4.97E+06
9	254.46879	3.93E+06
10	314.159	3.18E+06
t	$\pi \cdot t^2$	$\frac{1 \times 10^9}{\pi \cdot t^2}$

6. Plot the concentrations (from the table) on the graph below:



7. What is the equation for your graph?

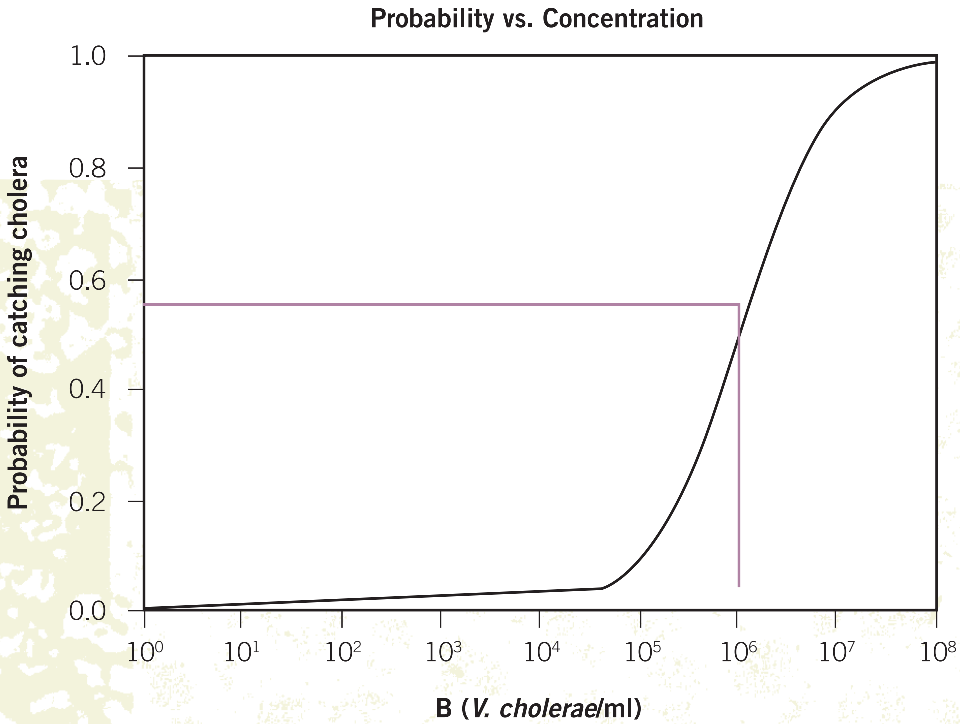
$$C = \frac{1 \times 10^9}{\pi \cdot t^2}$$

8. Use your equation to determine what the concentration of *V. cholerae* would be after 30 minutes.

$C = 3.45 \times 10^5$ ***cells/ml***

9. Study the following graph of the concentration of cholera bacteria (B) and the probability of catching cholera. Approximately what concentration of bacteria is required to give someone a 50% chance of catching cholera if they drink the water?

10^6 ***cells/ml***



10. Using your equation, find the amount of time required for the cholera bacteria to have spread out enough to give someone a 50% chance of catching cholera.

$$10^6 = \frac{1 \times 10^9}{\pi \cdot t^2}$$

$t = 17.84$ min

11. How much time will elapse before the concentration drops to 1000 cells/ml (the concentration where your probability of catching cholera is about 5%)?

$$1000 = \frac{1 \times 10^9}{\pi \cdot t^2}$$

$t = 2.66 \times 10^9$ min = 5060 years

12. There are some assumptions that we have to make when we use this model to describe the dissipation of the bacteria through the water. Describe at least two of these assumptions.

Possible answers include:

1. ***The spread of the bacteria occurs at 1 foot every minute.***
2. ***Dissipation occurs only in two dimensions.***
3. ***Dissipation occurs as a circle.***
4. ***We assume that the bacteria do not die off naturally over time (which they do).***
5. ***There are no more additions of bacteria into the water.***
6. ***The water source is infinitely large (there are no shorelines to worry about).***

LESSON 1: Oral Rehydration Therapy Challenge

Activity Time: 100 minutes

In this problem-based activity, students will be challenged to offer solutions for a cholera outbreak in central Africa that requires the implementation of an oral rehydration program.

This lesson can complement students' study of unit conversions and molar calculations.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Unit Conversion and Mole Calculations**: The solution to a diarrheal outbreak is the implementation of a quick-response oral rehydration therapy program. Conversions of units and mole calculations are an essential component of developing the proper balance of compounds in a rehydration program.

Essential Question:

- Why is severe diarrhea a health risk for children and adults?
- How are molar and unit conversions applicable in real-world situations?
- What are the cultural factors that should be considered when an outside group is working to address a global health issue in a local community?

Learning Objectives:

Students will know…

- The cholera toxin causes severe diarrhea because the toxin cause a loss of ions in small intestine cells, which through osmotic pressure causes loss of water and dehydration.
- In order to replenish the loss of salts in cell tissue, a combination of sugar and salt is needed so as to cause the cells to draw the salt in with the sugar and therefore enable rehydration.
- Global health workers must be sensitive to the customs and traditions of local communities in order to provide viable solutions to infectious disease problems.

Students will be able to…

- Do molar calculations to determine the proper amount of salts, sugars, and water needed for a proper oral rehydration therapy.
- Do unit conversions.

Vocabulary:

- Cholera
- Molar conversion
- Oral rehydration therapy (ORT)
- Unit conversion

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 APPA** Science affects society and cultures by influencing the way many people think about themselves, others, and the environment. Society also affects science by its prevailing views about what is important to study and by deciding what research will be funded.
- **9-12 APPB** The technological design process begins by defining a problem in terms of criteria and constraints, conducting research, and generating several different solutions.

Common Student Preconceptions:

- Diarrhea is a minor nuisance and not life-threatening.
- Rehydration drinks, similar to Pedialyte and Gatorade, can help treat diarrhea.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *Oral Rehydration Therapy Challenge* Handout (1 per student)
- *Map of Cholera Treatment Centers* Handout (1 per student)
- *A Simple Solution* Handout (1 per student)
- *WHO Daily Cholera Update* Handout (1 per student)
- *Oral Presentation Rubric* Handout (1 per student)
- *Article Review Rubric* (1 per student) from TB Chemistry lesson "Article Review"
- Science journals, lab notebooks, or blank paper

Preparation:

- Print out the article, A Simple Solution, from the following website:

  A Simple Solution
  Time Magazine
  http://www.time.com/time/magazine/article/0,9171,1543876,00.html
- Makes copies of Student Handouts.
- Students will need to read the Student Background Reading on cholera from the Introduction to Global Health section of the curriculum prior to participating in this chemistry activity.

PROCEDURE

Hook

1. Provide students with the following information on the current cholera outbreak in Zimbabwe, then show the video listed below.

   A Cholera outbreak began in Zimbabwe in August 2008 that quickly swept across the country and spread to Botswana, Mozambique, South Africa, and Zambia. By May 2009 there had been 98,309 reported cases and 4,283 deaths, making it the deadliest African cholera outbreak in the last 15 years. The Zimbabwean government declared the outbreak a national emergency and requested international aid.

   Zimbabwean Cholera Outbreak Video
   The Guardian, 2/26/09, 6:44 minutes
   http://www.guardian.co.uk/world/video/2009/feb/26/zimbabwe-cholera

Preconceptions

2. Ask students to record in their journals their initial thoughts and concerns related to the cholera problem and their ideas for approaches to solve the problem. After providing time for journaling, have students share their thoughts in a large group discussion format.

Article Review

3. Pass out copies of the *A Simple Solution* Handout, one per student. Ask students to read the article and complete an Article Review.
4. Pass out copies of the *Article Review Rubric* from the Article Review activity from the tuberculosis chemistry lesson plans. Students should preview the rubric so that they understand the expectations for this learning task.
5. Lead a brief discussion on the article. The following questions may be helpful to launch the discussion:
   - What is cholera? What are its symptoms?
   - How does oral rehydration work? What's going on chemically inside the body?
   - Why is oral rehydration underused, even though it is inexpensive and effective?
   - How do cultural beliefs come into play when teaching people about sanitation, hygiene, and oral rehydration therapy?
   - Besides ORT, what are some other treatments and preventative measures to control cholera?

ORT Challenge

6. Break students into groups of 3–4 students. Pass out copies of the *Oral Rehydration Therapy Challenge* Handout, the WHO Daily Cholera Update Handout, and the *Map of Cholera Treatment Centers* Handout, one of each per student.
7. Have students work in small groups to develop the correct oral rehydration therapy ratio from the mole quantities that are found on the Student Handout. Students should initially work in their groups to determine an appropriate amount of ingredients for a safe rehydration packet using locally-available ingredients.
8. While working in their groups, encourage students to use their journals to document their progress as they work through their calculations and problem solving.
9. Groups should develop a recommendation for how this ORT will be administered in the country, taking into consideration the cultural context of the region and keeping in mind the locations of the cholera treatment centers.
10. After the groups have had time to develop their recommendations, give each group several minutes to present their recommendation to the class. Provide time for questions and answers with each group.
11. Then, challenge the class to come together to develop a large group consensus on addressing the cholera outbreak. As a class, what can they all agree on as the best recommendation for controlling the outbreak?
12. Ask the class to present their final recommendation to a representative from the World Health Organization (WHO). The teacher, or a guest, can play this role. The students can present their recommendation verbally or in written format.

Warm-Up

13. Lead a whole class discussion about their experience of planning out an ORT intervention.
14. Ask students to explain the connections between unit conversions and molar conversions in a real-world context.
15. Ask students to use their journals to record their final reflections on the activity.
16. Show students the video clip, **Oral Rehydration Therapy**, to show how a simple ORT recipe worked to save young lives in Bangladesh.

    Oral Rehydration Therapy Video
    Rx for Survival, 1:40 minutes
    http://www.pbs.org/wgbh/rxforsurvival/series/diseases/diarrheal_diseases.html

STUDENT ASSESSMENT

Assessment Opportunities:

- The journal responses and the discussions about the video and reading offer an opportunity to gauge students' thinking about cholera and real-world chemistry applications.
- The completed *Oral Rehydration Therapy Challenge* Handout provides an opportunity to assess students' unit and molar conversion skills.
- Each group's oral presentation can be graded using the provided soring rubric.
- The class' ability to come to consensus offers an opportunity to assess their ability to agree and disagree respectfully, and to come to consensus.

Student Metacognition

- Students will utilize their journals to write their initial thoughts and ideas at the beginning of the activity, document their progress through their calculations and problem solving, and then do some final reflection on the entire activity.

Scoring:

- The *Oral Rehydration Therapy Challenge* Handout can be graded.
- The students' Article Reviews can be scored using the provided scoring rubric.
- The groups' oral presentations can be scored using the provided scoring rubric.
- Students can be assigned participation points for contributing to discussions and group work.

EXTENSION ACTIVITIES

Extension Activities:

- To extend the ORT activity you can provide sugar, salt, sealable plastic baggies, measuring devices, and balances for students to create their own ORT packets. Students can then determine how they will communicate proper use of the therapy, keeping in mind that; literacy and language barriers are often the largest obstacle to proper implementation of an ORT program (ie. use pictures/ cartoons to assist in explanation).
- Show students some of the other cholera videos located at the following website: http://www.guardian.co.uk/world/video/2009/feb/26/zimbabwe-cholera
- Show students the entire "The Power of Clean Water" episode from the *Rx for Survival* DVD series.
- Challenge students to read and discuss the case study "Preventing Diarrheal Deaths in Egypt" from the book *Case Studies in Global Health* (see Resources section).

Adaptations:

- Part One of the Student Handout focuses on more traditional chemistry content, while Part Two challenges students to apply their chemistry knowledge in a real world challenge. Some teachers may choose to focus on Part One of the handout.
- More advanced students may be interested in learning more about the cholera by exploring the following websites: **Microbial World: Cholera**, and **The Cholera Toxin Family**. See the Resources section.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, the Resources section provides some websites that can help you to understand this topic.

Resources:

Oral Rehydration Therapy Video
Rx for Survival, 1:40 minutes
http://www.pbs.org/wgbh/rxforsurvival/series/diseases/diarrheal_diseases.html

A Simple Solution
Time Magazine, 10/8/06
http://www.time.com/time/magazine/article/0,9171,1543876,00.html

Zimbabwean Cholera Outbreak Video
The Guardian, 2/26/09, 6:44 minutes
http://www.guardian.co.uk/world/video/2009/feb/26/zimbabwe-cholera

Preventing Diarrheal Deaths in Egypt
Case Studies in Global Health: Millions Saved
Ruth Levine, Jones and Bartlett Publishers, 2007

WHO Cholera Outbreaks
http://www.who.int/topics/cholera/en/

The Life and Death of the Cholera Pathogen
http://dujs.dartmouth.edu/fall-2007/the-life-and-death-of-the-cholera-pathogen

Microbial World: Cholera
http://www.eid.ac.cn/MirrorResources/2008/Cholera.html

The Cholera Toxin Family
http://www.bmsc.washington.edu/WimHol/figures/figs2/WimFigs2.html

WHO: Oral Rehydration Salts as a Cholera Treatment
http://www.who.int/cholera/technical/en/index.html

PATH: Oral Rehydration Therapy Fact Sheet
http://www.path.org/publications/details.php?i=1552

Recipe for Homemade Oral Rehydration Therapy
http://rehydrate.org/solutions/homemade.htm

Credit:

Gerlin, A. (2006). A simple solution. *Time Magazine*, 8 Oct 2006.
Available from: http://www.time.com/time/magazine/article/0,9171,1543876,00.html.

WHO. (2009). *Daily Cholera Update, 31 Dec 2008*. Date of issue: 1 Jan 2009.
Available from: http://www.who.int/hac/crises/zwe/zimbabwe_daily_cholera_update_31dec2008.pdf.

WHO. *Zimbabwe Cholera Treatment Centers Map*.
Available from: http://www.who.int/hac/crises/zwe/maps/zimbabwe_cholera_map_8dec2008.pdf

Name:________________________ Date:__________ Period:________

Oral Rehydration Therapy Challenge

HANDOUT

PART 1

Background:

Two decades ago diarrhea was responsible for around 5 million deaths annually. Through major public health efforts primarily aimed at preventing and treating dehydration this figure has decreased to around 2 million deaths. Prevention of dehydration is primarily achieved by ensuring that children with diarrhea are provided with more fluids than usual, and/or increased frequency of breastfeeding, during the acute episode. The combination of increased home fluids and the use of Oral Rehydration Salts (ORS) for the treatment of dehydration have proven to be a very powerful intervention for the prevention of childhood deaths from diarrhea. This treatment is known as Oral Rehydration Therapy (ORT).

The following oral rehydration salts recipe is the current UNICEF recommendation to counteract the dehydration that occurs when a individual suffers from a severe diarrheal episode.

ORAL REHYDRATION SALTS (ORS) RECIPE

ORS	grams /liter	Chemical Formula	moles /liter
Sodium chloride	2.6		
Glucose, anhydrous (6-(hydroxymethyl)oxane-2,3,4,5-tetrol)	13.5		
Potassium chloride	1.5		
Trisodium citrate, dihydrate	2.9		

1. Determine the chemical formula of the above compounds and fill in the table (above).

2. Determine how many moles of that compound is required to make a single ORS packet. Please show your calculations.

PART 2

Use the information in Part 1 to direct your planning for the following cholera outbreak:

A cholera outbreak began in Zimbabwe in August 2008 that quickly swept across the country and spread to Botswana, Mozambique, South Africa, and Zambia. By May 2009 there had been 98,309 reported cases and 4,283 deaths — making it the deadliest African cholera outbreak in the last 15 years. The Zimbabwean government declared the outbreak a national emergency on December 4, 2008 after more than 500 people died from the disease. It was at this time that the government requested international aid.

Using the known cases from the World Health Organization (WHO) daily update for December 31, 2008 and the map showing where the cholera treatment centers (CTC) are located throughout the country, your group will need to develop a plan to administer oral rehydration salts to the people of Zimbabwe through the cholera treatment centers.

The UNICEF rehydration recipe is a very effective solution, but access to glucose, potassium chloride, and trisodium citrate in all regions of the world is not always possible. From the excerpt from *Rx for Survival* video we learned that simple oral rehydration therapy can be administered at home using a simple recipe of sugar, salt, and clean water. To create your own recipe for ORS, you will need to revise the provided recipe for ORS. For your calculations, combine the masses of the salts and replace glucose with sucrose.

1. Your group will need to calculate the cost per patient treated, assuming a 1-week treatment regimen with each patient needing to receive 3 liters of ORS solution daily. In addition, determine the overall cost for providing emergency ORS to all cholera patients. Assume that the price of 5 lbs. of sugar (sucrose) is $4.04 and 4lbs. of table salt (sodium chloride) is $1.99.

2. Once your group has come up with your approach to this cholera outbreak, you will present your recommendation to the class. You will deliver a 5-6 minute oral presentation on your oral rehydration therapy plan. A rubric will be used to score your presentation. You will be expected to answer follow-up questions following your presentation.

Name:___________________________ Date:__________ Period:________

Map of Cholera Treatment Centers

Source: WHO. Zimbabwe Cholera Treatment Sites
Available from http://ochaonline.un.org/CholeraSituation/InteractiveCholeraTreatmentCentresMap/tabid/5151/language/en-US/Default.aspx

Name:____________________________ Date:___________ Period:________

WHO Daily Cholera Update

ZIMBABWE

Mobile number for alerts is
0912 104 257

Toll free number for alert by district and
province is 08089000

Office of the WHO Representative in Zimbabwe

31st December, 2008

Please note that this is provisional data, numbers may change as data cleaning continues.

Highlights of the day:

- 741 cases and 38 deaths added today (in comparison 630 cases yesterday)
- 52.8% of the districts affected have reported today (28 out of 53 affected districts)
- 85 % of districts reported to be affected (53 districts/62)
- All 10 of the country's provinces are affected

Districts reporting high number of cases today (cases added today> 30)	Districts with a daily CFR > 1% :	Districts with high of deaths outside health facility/CTC > 3	Districts which have not reported for more than 3 days:
1. Harare 2. Goromomzi 3. Makonde 4. Hurungwe 5. Chegutu 6. Mutare 7. Gwanda	1. Harare 2. Centenary 3. Bindura 4. Seke 5. Chegutu 6. Mutare 7. Gwanda 8. Plumtree 9. Masvingo 10. Gweru city (Mkoba) 11. Gokwe North	Nil	1. Kadoma city 2. Norton (7 days)

Conclusion of the day:

High priority districts to investigate today		Priority districts to call back on the phone (as delay of more than 3 days to report) and in bold High priority districts which needs field visit (no report for more than 7 days)	
• Harare • Goromomzi • Makonde • Hurungwe • Chegutu • Mutare • Gwanda	• Centenary • Bindura • Seke • Plumtree • Masvingo • Gweru city (Mkoba) • Gokwe North	1. Kadoma city 2. **Norton** (7 days)	

HANDOUT

Province	District/area affected	TODAY"S UPDATE Cases added today	Deaths added today	Community Deaths added today (included in the total	CFR of cases added today (included in the total)	Cumulative Cases	Cumulative Death	Cumulative CFR (%)	Community Deaths (included in the total)	Proportion Community Deaths (%)	Date last updated	Number of days since previous report
Harare	Chitungwiza	11	0	0	0.0	853	144	16.9			31/12/2008	1
	Harare	189	3	0	1.6	10201	234	2.3	16	6.8	31/12/2008	1
Bulawayo	Bulawayo urban	3	0	0	0.0	371	12	3.2	8	66.7	31/12/2008	1
Mashonaland Central	Shamva	0	0	0		39	8	20.5	8	100.0	29/12/2008	3
	Centenary	9	2	0	22.2	107	11	10.3	7	63.6	31/12/2008	1
	Mazowe	8	0	0	0.0	118	4	3.4	3	75.0	31/12/2008	1
	Guruve	0	0	0		44	7	15.9	7	100.0	29/12/2008	3
	Mbire	0	0	0		7	0	0.0	0		29/12/2008	3
	Mt Darwin	0	0	0		36	2	5.6	1	50.0	29/12/2008	3
	Bindura	7	2	0	28.6	100	5	5.0	5	100.0	31/12/2008	1
	Rushinga	0	0	0		78	4	5.1	4	100.0	29/12/2008	3
Mashonaland East	Mudzi	0	0	0		1843	121	6.6	67	55.4	30/12/2008	2
	Murehwa	0	8	0		98	14	14.3	10	71.4	31/12/2008	1
	Goromonzi	88	0	0	0.0	389	26	6.7	19	73.1	30/12/2008	2
	Mutoko	0	0	0		154	32	20.8	25	78.1	31/12/2008	1
	Marondera	13	0	0	0.0	67	6	9.0	4	66.7	31/12/2008	1
	Chikomba	0	0	0		67	5	7.5	5	100.0	31/12/2008	1
	Hwedza	0	0	0		15	1	6.7	1	100.0	31/12/2008	1
	UMP	0	0	0		47	19	40.4	5	26.3	31/12/2008	1
Mashonaland West	Seke	17	2	0	11.8	348	20	5.7	16	80.0	30/12/2008	2
	Makonde	165	0	0	0.0	2525	74	2.9	36	48.6	31/12/2008	1
	Kariba Mahombekombe	0	0	0		219	12	5.5	2	16.7	30/12/2008	2
	Kariba Rural	0	0	0		283	16	5.7	8	50.0	31/12/2008	1
	Zvimba	10	0	0	0.0	144	10	6.9	5	50.0	31/12/2008	1
	Kadoma city	0	0	0		1015	38	3.7	15	39.5	26/12/2008	6
	Hurungwe	32	0	0	0.0	442	29	6.6	16	55.2	31/12/2008	1
	Norton	0	0	0		618	25	4.0	11	44.0	25/12/2008	7

	Chegutu	56	2	0	3.6	1914	141	7.4	29	0.0	29/12/2008	3
Manicaland	Mutasa	0	0	0		7	5	71.4	5	100.0	29/12/2008	3
	Mutare City	0	0	0		16	1	6.3	0	0.0	29/12/2008	3
	Buhera	0	0	0		756	31	4.1	27	87.1	29/12/2008	3
	Chipinge	0	0	0		529	41	7.8	31	75.6	30/12/2008	2
	Makoni	0	0	0		340	45	13.2	40	88.9	30/12/2008	2
	Mutare	65	4	0	6.2	1239	64	5.2	58	90.6	31/12/2008	1
	Chimanimani	0	0	0		588	25	4.3	23	92.0	30/12/2008	2
Matebeleland North	Lupane	0	0	0		2	0	0.0	0		29/12/2008	3
Matebeleland South	Gwanda	49	8	0	16.3	68	8	11.8	3	37.5	31/12/2008	1
	Plumtree	3	1	0	33.3	3	0	0.0	0		31/12/2008	1
	Beitbridge	5	0	0	0.0	3717	115	3.1	38	33.0	31/12/2008	1
Masvingo	Masvingo	4	1	0	25.0	416	45	10.8	17	37.8	31/12/2008	1
	Gutu	0	0	0		17	1	5.9	0	0.0	30/12/2008	2
	Chivi	0	0	0		441	54	12.2	42	77.8	30/12/2008	2
	Bikita	0	0	0		190	31	16.3	21	67.7	30/12/2008	2
	Chiredzi	0	0	0		569	26	4.6	18	69.2	30/12/2008	2
	Mwenezi	0	0	0		94	11	11.7	8	72.7	29/12/2008	3
	Zaka	0	0	0		87	21	24.1	21	100.0	29/12/2008	3
Midlands	Gweru City (Mkoba)	5	1	0	20.0	182	4	2.2	2	50.0	31/12/2008	1
	Zvishavane	0	0	0		98	9	9.2	8	88.9	31/12/2008	1
	Mberengwa	0	0	0		85	16	18.8	14	87.5	31/12/2008	1
	Gokwe North	2	4	0	200.0	12	5	41.7	5	100.0	31/12/2008	1
	Gokwe South	0	0	0		9	0	0.0	0		31/12/2008	1
	Kwekwe	0	0	0		24	1	4.2	0	0.0	31/12/2008	1
	Shurugwi	0	0	0		23	6	26.1	6	100.0	31/12/2008	1
	Chirumhanzu	0	0	0		2	1	50.0			29/12/2008	3
TOTAL		**741**	**38**	**0**	**5.1**	**31656**	**1586**	**5.0**	**720**	**45.4**		

CTC: A cholera treatment center (CTC); also called a cholera treatment unit (CTU). These are health care centers providing ORT, antibiotics, and health care to people suffering from cholera. CTCs are most often run by the Zimbabwe Ministry of Health, with support from international non-governmental organizations.

CFR: Case fatality rate (CFR) is an equation that takes the number of deaths from cholera in a specific time period divided by the number of diagnosed cases of cholera in the same time period, multiplied by 100.

CFR= 100(deaths / diagnosed cases)

Community deaths: People who died at home from symptoms that fit the cholera definition. Community deaths do not include people who died in a clinic, hospital or CTC/CTU. These deaths are difficult to verify and often require outreach staff from clinics to visit the community and talk to family members about the person's symptoms prior to death.

Name:___________________________ Date:___________ Period:________

Oral Rehydration Plan
Oral Presentation Rubric

HANDOUT

	4	3	2	1
Collaboration with Peers	Always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Almost always listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of the topic.	Does not seem to understand the topic very well.
Time-Limit	Presentation is 5-6 minutes long.	Presentation is 4 minutes long or more than 6 minutes long.	Presentation is 3 minutes long.	Presentation is less than 3 minutes long.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	Student seems somewhat prepared but might have needed a couple more rehearsals.	Student does not seem at all prepared to present.
Attire	Business attire, very professional look.	Casual business attire, clean and pressed.	Casual business attire, messy.	General attire not appropriate for audience (jeans, t-shirt, shorts).
Comprehension	Student is able to accurately answer all questions about the topic.	Student is able to accurately answer almost all questions about the topic.	Student is able to accurately answer most questions about the topic.	Student is unable to accurately answer questions about the topic.
Props	Students use several props (could include costume) that show considerable work/creativity and which make the presentation better.	Students use 1 prop that shows considerable work/creativity and which make the presentation better.	Students use 1 prop.	The students use no props OR the props chosen detract from the presentation.

LESSON 2:
Soap Lab

Activity Time: 100 minutes

In this hands-on lesson, students will learn about saponification, the chemistry involved in creating soap. Students will understand how soap is a simple, low-cost method of decreasing exposure to many communicable diseases, including diarrheal illnesses such as cholera. This lesson fits well within the study of organic chemistry and saponification.

This lesson can complement students' study of chemical bonding. Prior to delivering this lesson, students should have some familiarity with saponification, micelles, hydrophobic/hydrophilic, and polar/non-polar covalent bonds.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Saponification:** Soap is formed from both hydrophilic and hydrophobic compounds that make hydrophobic compounds soluble in water.
- **Micelles:** Sodium stearate's polar/non-polar structure causes it to form a micelle, where the hydrophilic heads point outwards into the aqueous solution, and the hydrophobic tails point inwards toward each other. The micelle may form around oil globules, allowing for the oil to be rinsed away in the water.

Essential Question:

- Why is sodium stearate such a useful molecule?
- How do hydrophilic and hydrophobic compounds and parts of compound interact with one another and with water?
- How can soap be a preventative measure for cholera, influenza, and many other infectious diseases?

Learning Objectives:

Students will know…

- Soap is created when fats are combined with a strong base.
- The solubility of compounds is dependent on the polarity of a compound and its solvent ("Like dissolves like").
- Basic hygiene measures, like hand washing, can lead to significant gains in public health.

Students will be able to…

- Make soap.

Vocabulary:

- Base
- Cholera
- Fat
- Hydrophilic
- Hydrophobic
- Micelle
- Non-polar molecule
- Oil
- Polar molecule
- Saponification

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 APPF** It is important for all citizens to apply science and technology to critical issues that influence society.
- **9-11 PS2E** Molecular compounds are composed of two or more elements bonded together in a fixed proportion by sharing electrons between atoms, forming covalent bonds. Such compounds consist of well-defined molecules. Formulas of covalent compounds represent the types and number of atoms of each element in each molecule.
- **9-11 PS2G** Chemical reactions change the arrangement of atoms in the molecules of substances. Chemical reactions release or acquire energy from their surroundings and result in the formation of new substances.

Common Student Preconceptions:

- Hand washing without an antimicrobial agent is not effective.
- You only need to wash your hands after going to the bathroom or after handling raw meat.
- Hand washing is only really important if you are sick.

TEACHER PREPARATION

Materials:

- 350 g Fat (Best choices include palm oil, coconut oil, and olive oil. Many other fats can be suitable, but may yield softer soap products. Basic recipe calls for vegetable shortening)
- 50 g Sodium hydroxide
- 15 100 mL Beakers
- 15 50 mL Beakers
- 15 Stir Rods
- Water (Distilled is preferred)
- 3-4 Hot Plates
- Goggles (1 per student)
- Disposable weighing dish or some other small disposable container (ie. Dixie cups)
- Fluorescent compound, such as Glo-Germ powder (www.glogerm.com)
- Black light
- Science journals, lab notebooks, or blank paper
- *Hand-Washing Could Save the Lives of Millions of Children* Handout (1 per student)
- *Soap Lab* Handout (1 per student)
- Teacher Answer Key

Preparation:

- Set-up lab stations with the chemicals and equipment needed for making soap.
- Place a fluorescing compound, such as Glo-Germ powder, on the door handle to the classroom before the start of the period. Have students enter the classroom with the door closed so as to require as many students as possible to be exposed to the fluorescent compound.
- Make copies of Student Handout.
- Prior to delivering this lesson, students should have some familiarity with saponification, micelles, hydrophobic/hydrophilic, and polar/non-polar covalent bonds.

PROCEDURE

Hook

1. When class starts, walk through the classroom with a black light revealing students' exposure to the contaminant. (A handheld black light would be sufficient, but a larger light would make the experience that much more dramatic).

Preconceptons

2. Have students Think-Pair-Share with the following questions. First have students "think" by writing in their journals. Then have students "pair" up and discuss their thinking. Then bring the class together as a whole group to discuss the questions. (This discussion should lead students to consider the importance of personal hygiene)
   - How does an infectious disease spread?
   - How could I protect myself from possible infection?

Activity

3. Ask students to get into their lab groups/ partners.
4. Pass out copies of the *Hand-Washing Could Save the Lives of Millions of Children* Handout, one per student. After students have read the article, discuss the main points of the article and make connections to how hand-washing is one strategy to help prevent the spread of cholera.
5. Pass out copies of the *Soap Lab* Handout, one per student. Review your laboratory safety guidelines with students before they begin working on the lab, making sure to note the caustic nature of sodium hydroxide. Goggles are an absolute requirement, but aprons and gloves are also recommended. If gloves are not provided, encourage students to be aware of their exposure and to wash their hands regularly if they are exposed to the sodium hydroxide.
6. Provide time for students to work on making soap. Students will examine the structure of sodium stearate, determine the hydrophilic and hydrophobic portions of the compound, and then describe how soap might remove bacteria and viruses from the skin's surface.
7. Set up a soap gallery so that students can view each other's soap products.

Wrap-Up

8. Lead a whole class discussion using the following questions:
   - What are the necessary components for good personal hygiene?
   - What are some of the challenges of having these components in developed versus developing regions of the world?

STUDENT ASSESSMENT

Assessment Opportunities:

- The class discussions provide an opportunity to hear students' thinking, preconceptions, and misunderstandings.
- Students' journal responses can be used to assess student learning.
- The Student Handout can be used to assess student learning.

Student Metacognition:

- The journaling prompts and the Think-Pair-Share time provides an opportunity for students to reflect and discuss their thinking.

Scoring:

- Participation points can be awarded for participating in class discussions and lab work.
- The Student Handout can be graded, as can students' soap products.

EXTENSION ACTIVITIES

Extension Activities:

- Have students use some type of fluorescent powder to simulate possible exposure to common disease causing microorganisms and have students then use their soap to remove the contaminant. Include samples of commercially made soap to compare the cleaning ability of these products versus student-made soap products. See the Which Wash Wins website in the Resources section for more ideas.
- To provide students with a more in-depth understanding of saponification, see the activities and materials provided in the lesson *Structure of DDT—Part II* in the malaria section of the curriculum.
- Typhoid is another infectious disease that can be spread due to a lack of personal hygiene and hand washing. See the *Most Dangerous Woman in the World* website in the Resources section for information and activities about Typhoid Mary.
- Students can evaluate their initial soap product and try to create a more desirable bar of soap. Providing students with several different types of fats, colorings, and scents could make students' soap making exploration really engaging. This could be an independent project for interested students or done as a larger project for the whole class. When using different fats to make soap it will be necessary to use a Lye Calculator online to determine the correct ratio of sodium hydroxide, water, and fats. Each oil/fat requires a different ratio. It is recommended that you use at least a 5% super fatted recipe.

Adaptations:

- For students with reading difficulties, providing a smaller excerpt for students to read or reading the passage out loud with the class may be necessary, making sure to stop often to emphasize particular points and elicit students' thinking.
- If access to Glo-Germ and a black lights is not available, the concepts can simply be addressed during a discussion of germs. You could also create a different way of contamination that uses strips of paper that get passed around when students interact at the beginning of the period.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, the Resources section provides some websites that can help you to understand this topic.

Resources:

WHO "Hand-Washing Could Save the Lives of Millions of Children" http://www.who.int/entity/bulletin/volumes/82/8/news.pdf

MMS Lye Soap Calculator http://www.thesage.com/calcs/lyecalc2.php

Bramble Berry Soap Calculator http://www.brambleberry.com/Soap-Making-Lye-Calculator-W12.aspx

NOVA Which Wash Wins? http://www.pbs.org/wgbh/nova/teachers/activities/3115_typhoid.html

NOVA The Most Dangerous Woman in the World http://www.pbs.org/wgbh/nova/typhoid/

Synthesis of Soap http://homepages.ius.edu/DSPURLOC/c122/soap.htm

UNICEF Soap, Toilets and Taps Report http://www.unicef.org/wash/files/FINAL_Showcase_doc_for_web.pdf

Global Handwashing Day http://www.globalhandwashingday.org/

Credit:

Fleck, F. (2004). "Hand-washing could save the lives of millions of children." *Bulletin of the World Health Organization.* August 2004, 82 (8). Available from: www.who.int/entity/bulletin/volumes/82/8/news.pdf.

Name:___________________________ Date:__________ Period:________

Hand-Washing Could Save the Lives of Millions of Children

HANDOUT

Bulletin of the World Health Organization
August 2004
By Fiona Fleck, Geneva

Parents and other household members who wash their own hands carefully and regularly with soap as well as the hands of infants who are too small to do it themselves could halve the rate of deadly diarrhea, according to a new study.

A team of researchers led by Dr. Stephen P. Luby from the Atlanta-based Centers for Disease Control and Prevention in the United States conducted an intensive program of hand-washing education and promotion among 906 families with 4700 children.

According to Luby, although washing hands with soap is a well-known disease prevention measure, his study is the first to focus on washing the hands of infants under 12 months who are too young to wash their own hands but are at highest risk from diarrhea related diseases.

"It is remarkable that hand-washing with soap led to a marked reduction in diarrhea without improving water quality, even among malnourished children who are at increased risk of death from diarrhea," said Luby who reported that the water used for drinking and washing available to the communities participating in the study was highly contaminated with sewage.

"The study re-emphasizes that behavioral changes can have an impact," said Dr. James Bartram, Coordinator of WHO's Water, Sanitation and Health Program. However, access to safe water remains a prerequisite for maintaining hygiene and to further reducing diarrheal diseases—88% of which is attributable to unsafe water supply, inadequate sanitation and hygiene, said Bartram.

Families participating in the study published in JAMA (2004;291;2547-54) lived in urban squatter settlements in Karachi, Pakistan, and had at least two children younger than 15, at least one of whom was younger than five.

The team visited these households weekly from April 2002 to April 2003 to show them how to wash hands properly with soap after defecation, and before preparing food, eating, and feeding a child. They used slide shows, videotapes and pamphlets to illustrate health problems resulting from contaminated hands.

The researchers found that children younger than 15 years living in households that received hand-washing education and plain soap had a 53% lower incidence of diarrhea compared with children in households not receiving this education and free soap. They found no significant difference in households using antibacterial soap.

According to WHO, 1.8 million children die every year from diarrheal diseases and 90% of those are aged less than five years, mainly in developing countries. The study's findings suggest that half of those lives could be saved. It also suggests that vigorous public promotion of hand-washing, particularly among those without reliable clean water supplies, could have a major impact on health.

Whilst recognizing the important role played by governments in the promotion of hand-washing as a cost-effective way of fighting diarrhea, Bartram also said that the key question for policy-makers is how to sustain that hygienic behavior: "People make an effort to wash their hands during a study like this, but how long is it before that behavior tails off?"

Fleck, F. (2004). "Hand-washing could save the lives of millions of children." *Bulletin of the World Health Organization*. August 2004, 82 (8). Available from: http://www.who.int/entity/bulletin/volumes/82/8/news.pdf. Note that some spellings have been changed to American English.

Name:____________________________ Date:___________ Period:________

Soap Lab

HANDOUT

Basic Soap Recipe

Soap is essentially a salt (sodium or potassium) of long-chain carboxylic acids. The long-chain carboxylic acids are made by the hydrolysis of the long-chain esters found in animal and vegetable fats. The hydrolysis is carried out by combining the esters with an alkali such as sodium hydroxide. The method works well for different types of oil/fat and it might be worth investigating the quality of the soap produced from the different types of vegetable and/or animal fats.

Word equation

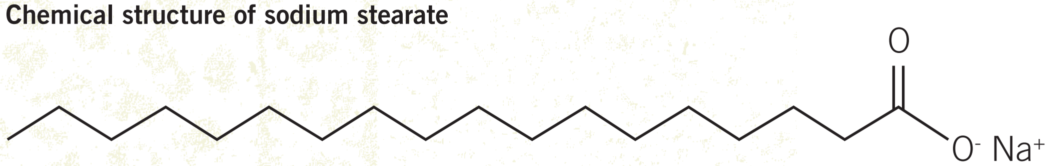
Fat/oil + sodium hydroxide ⟶ soap + glycerol

Chemical equations

Glyceryl stearate + sodium hydroxide ⟶ sodium stearate + glycerol

$$\left[\begin{array}{l} CH_2OOCC_{17}H_{35} \\ CHOOCC_{17}H_{35} \\ CH_2OOCC_{17}H_{35} \end{array}\right. + 3\ NaOH \rightarrow 3\ C_{17}H_{32}COONa + \left[\begin{array}{l} CH_2OH \\ CHOH \\ CH_2OH \end{array}\right.$$

Chemical structure of sodium stearate



Pre-Lab Questions

1. Indicate on the stick model of soap which region of the molecule would be hydrophilic and which would be hydrophobic.

2. What impact does hand washing have on keeping people healthier? Explain your answer using direct quotes from the reading.

Materials

22.60 g of vegetable shortening

2.90 g of Sodium Hydroxide (NaOH)

7.50 mL of DI water

100 mL beaker

50 mL beaker

1 stir rod

1 hot plate (shared among multiple groups)

1 disposable weighing dish or some other disposable container

goggles

Procedure

1. In a 100mL beaker melt 22.60 g of vegetable shortening over low heat and hold at a temperature of 55°C.
2. Pour 2.90 g of Sodium Hydroxide (NaOH) into 7.50 mL of DI water slowly while stirring. This solution should be kept at a temperature of 35°C.
3. Pour the sodium hydroxide solution into the molten vegetable shortening in a thin even stream. To avoid separation, the temperatures of both liquids should be close to the temperatures above.
4. Stir constantly until the solution becomes a thick syrup and begins to show trace. Trace looks like a thin pudding. When you let a drop of it fall back into the mixture it should hold a bit of its outline before coalescing back with the mixture. (Caution: too rapid addition of the sodium hydroxide solution, or too fast stirring can cause separation and failure).
5. Pour the mixed solution into a disposable weighing dish and allow it to set overnight.

Answer the following questions:

1. Explain how the sodium stearate molecule works to remove bacteria, viruses, and oils from your skin? (Use the following words to explain: hydrophilic, hydrophobic, micelles, non-polar, polar) Include a labeled drawing to show your understanding.

2. What other fats (long chain esters) can you suggest be used for the production of soap? Include the name of the fat and where it might locally be obtained (minimum of 4 different fats).

3. How might the access to soap and other personal hygiene products improve overall public health in a community?

4. When looking at your soap, does it meet your expectations of what you would want in a bar of soap? What qualities would you like to see improved in your soap bar?

5. (Optional) Research what ingredients work best at making the type of bar soap you described in the previous question and present your best recipe for the soap that you would prefer.

Credit: Soap molecule image: barrett-group.mcgill.ca/.../mesogen-soap.jpg

Soap Lab

KEY

Pre-Lab Questions

1. Indicate on the stick model of soap which region of the molecule would be hydrophilic and which would be hydrophobic.
2. What impact does hand washing have on keeping people healthier? Explain your answer using direct quotes from the reading.

Answers may vary, but students should emphasize the facts that the use of soap and hand washing after going to the bathroom and before food preparation can have a significant improvement on individuals' health. Students should also identify the special significance hand washing has on young children's health and survival.

Answer the following questions:

1. Explain how the sodium stearate molecule works to remove bacteria, viruses, and oils from your skin? (Use the following words to explain: hydrophilic, hydrophobic, micelles, non-polar, polar) Include a labeled drawing to show your understanding.

The sodium stearate molecule has a hydrophilic and hydrophobic end. The hydrophobic end being non-polar is attracted to the non-polar surfaces of bacteria, viruses, and oils that are on the surface of the skin and surround it. With the hydrophobic ends attached to the foreign object, the hydrophilic ends are then pointed outward to the water. The hydrophilic ends, being polar, are attracted to water and therefore are then picked up by running water and then removed from the surface of the skin. The shape of the hydrophobic ends on the inside and the hydrophilic on the outside is called a micelle.

2. What other fats (long chain esters) can you suggest be used for the production of soap? Include the name of the fat and where it might locally be obtained (minimum of 4 different fats).

Tallow (cow fat) – local butcher, slaughter house

Lard (pig fat) – local butcher, grocery store

Olive Oil – grocery store

Sesame Oil – grocery store

Coconut Oil – online distributor, local soap supplier

Palm Oil – online distributor, local soap supplier

To see an extensive list of types of fats available explore an online lye calculator.

3. How might the access to soap and other personal hygiene products improve overall public health in a community?

By lowering the illnesses related to poor hygiene, individuals will limit the continued contamination in the community. Better hygiene will improve the survival of young children to adulthood, as well as allow communities to be more productive in their local economy whether it is in agriculture or some other industry.

4. When looking at your soap, does it meet your expectations of what you would want in a bar of soap? What qualities would you like to see improved in your soap bar?

Answers will vary. Students should provide a critical view of how their soap product is lacking.

5. (Optional) Research what ingredients work best at making the type of bar soap you described in the previous question and present your best recipe for the soap that you would prefer.

Answers will vary.

LESSON 1: Blue Death in 5 Points NY

Activity Time: 200 minutes (four 50 minute periods)

Students will read an article about the 1832 cholera outbreak in NY. They will then generate questions based on the "big ideas" in the article. Students will then work in groups to research one of their own questions. Groups will write a brief regarding their question and present it to the class.

This lesson complements the study of U.S. history in the early 1800s.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Government Responsibility:** What responsibility does a government have in responding to a crisis?
- **Socio-Economic Status:** How is the response to a crisis related to a person's socio-economic status (SES)?

Essential Question:

- Is the government responsible for helping those in need as a result of a crisis and should that help depend on a person's SES?

Learning Objectives:

Students will know…

- Cities began looking at water quality as a result of the 1832 cholera pandemic.
- African Americans and poor Irish Catholics were discriminated against in the treatment of cholera.

Students will be able to…

- Create questions at each level (1–3).
- Conduct historical research.
- Use Cornell notes for recording research notes.
- Write briefs and defend a position with historical evidence.

Vocabulary:

- Cholera
- Levels of questions
- Pandemic
- Socio-economic status (SES)

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History 4.2.2** Analyzes how cultures and cultural groups have shaped the United States (1890—present). While this lesson focus on a time outside of the time frame of this GLE, the lesson focuses on the content of this GLE.
- **History 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.
- **Social Studies Skills 5.2.1** Evaluates and revises research questions to refine inquiry on an issue or event.
- **Social Studies Skills 5.3.1** Creates and articulates possible alternative resolutions to public issues and evaluates these resolutions using criteria that have been identified in the context of a discussion.

Common Student Preconceptions:

- Cholera is only a problem in developing countries and isn't in the U.S.
- People should be treated fairly when they are sick, whether or not they are poor.

TEACHER PREPARATION

Materials:

- Computer with internet and projector
- *1981 AIDS Outbreak Case Study* Handout (1 per student)
- *Levels of Questioning* Handout (1 per student)
- *Epidemics and the Modern Metropolis* Handout (1 per student)
- *Brief Template* Handout (1 per student)
- *Scoring Rubric* (1 per group)
- Chart paper

Preparation:

- If students aren't familiar with Art Costa's Levels of Questioning, discuss the different levels of questioning so that students understand the three levels.
- Make sure students understand how to use Cornell Notes format for note-taking. When using Cornell notes for this exercise, use the left side of the paper for generating questions from the reading. These questions can be level 1–3 or simply items that students do not understand about the reading.
- Make copies of Student Handouts. Also make copies of the Scoring Rubric.

PROCEDURE

Hook

1. Pass out copies of the *1981 AIDS Outbreak Case Study*, one per student. Provide about 20 minutes for students to read the case and answer the questions.
2. Discuss the case. Ask students: what was the governmental reaction and how were the victims viewed?

Preconceptions

3. Ask students the following question: is the government responsible for helping those in need as a result of a crisis and should that help depend on a person's SES?
4. Spend about 10 minutes recording students' preconceptions related to the question on chart paper. You'll revisit these preconceptions throughout the next few days.

Day One Activity

5. Present a slide show of images from the 1832 cholera outbreak in New York City. See the Resources section for the website address.
6. Pass out Exit Tickets with the following question:
   - Write down one question you have after viewing the images of the 1832 pandemic.

Day Two Activity

7. Choose several of the more significant questions collected from yesterday's Exit Tickets. Share these questions with the class as something to consider as the lesson progresses.
8. Pass out copies of the *Levels of Questioning* Handout, one per student. Talk through the handout to make sure students understand it.
9. Pass out copies of the *Epidemics and the Modern Metropolis* Handout, one per student. Let the students know that this article deals with the slide show they previously viewed. It will help them answer the questions they came up with for their Exit Tickets from day one.
10. Have students read the article, take notes using the Cornell Notes format, and create questions based on the article. Each student needs to develop 6 Level One questions, 4 Level Two questions, and 2 Level Three

questions. Students need to provide answers for their Level One and Level Two questions, but not for the Level Three questions. Allow about 45 minutes for students to read and develop their questions.

11. Collect students' questions. Read through the Level Three questions and select the ones that are most appropriate (questions should relate to the "big ideas," "enduring understandings," and "essential questions" for the lesson). The number of questions that you choose is determined by how many groups of three can be created in the class. Each group will need to be given one question. If there are not enough quality questions for each group, then double up the best questions.

Day Three Activity

12. Divide the students up into groups of 3. Give each group a different Level Three question and give each student a copy of the *Brief Template* Handout.
13. Explain that each group will discuss their question and come to a consensus on how to answer the question. They will then complete the *Brief Template* and prepare to give a presentation to the class. Allow about 45 minutes for students to discuss, work on their briefs, and prepare their presentation.
14. Pass out Exit Tickets with the following question:
    - Does the government have a responsibility to come to the aid of people in need? Why or why not?

Day Four Activity

15. Schedule each group to present their brief to the class. Allow five minutes for each group: four minutes to present and one minute to answer questions from the class.

Wrap-Up

16. If time permits on Day Four, return to the case study on the 1981 AIDS outbreak and discuss the similarities with the 1832 cholera outbreak.

STUDENT ASSESSMENT

Assessment Opportunities:

- Students preconceptions about the lesson's essential question are elicited and can be analyzed, looking for misconceptions.
- The Exit Tickets provide an opportunity to asses students' learning at the end of each class period.
- The three levels of questions can be analyzed to gauge students' comprehension of the article.
- Each group's brief, notes, and presentation provides opportunities to assess their growth in knowledge, as well as the students' ability to work as a group.

Student Metacognition:

- Students are asked to generate questions from a reading and then investigate to answer their questions.
- Students are asked to explain their conclusions.

Scoring:

- Students' presentations can be graded using the provided scoring rubric.

EXTENSION ACTIVITIES

Extension Activities:

- Students could be challenged to interview a city planner in their local community to see how the questions regarding water quality/sanitation impact city growth.

Adaptations:

- For students who struggle with the reading level, have them highlight the words or terms they do not understand in the article or case study and continue to read. If they are not able to come to an understanding through the context, they can come to the teacher for help.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, the Resources section provides some websites that can help you to understand the use of Cornell Notes and Levels of Questioning.

Resources:

Cholera Slideshow
http://www.nytimes.com/slideshow/2008/04/15/science/20080415_CHOLERA_SLIDESHOW_index.html

Cornell Notes
http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Costa's Levels of Questioning
http://mrkash.com/costa.html

Credit:

Wilford, J. N. (2008). How epidemics helped shape the modern metropolis. *New York Times*, 4/15/08. Available from: http://www.nytimes.com/2008/04/15/health/15iht-15chol.11988148.html.

Kanabus, A. & Fredriksson, J. *History of AIDS up to 1986.* Avert.org.
Available from: http://www.avert.org/aids-history-86.htm.

Name:_________________________ Date:__________ Period:_______

1981 AIDS Outbreak Case Study

HANDOUT

A SHORT HISTORY OF THE AIDS EPIDEMIC IN THE US

Read the excerpt taken from Avert.org and answer the questions that follow.

Kaposi's Sarcoma (KS) was a rare form of relatively benign cancer that tended to occur in older people. But by March 1981 at least eight cases of a more aggressive form of KS had occurred amongst young gay men in New York. At about the same time there was an increase, in both California and New York, in the number of cases of a rare lung infection Pneumocystis carinii pneumonia (PCP). In April this increase in PCP was noticed at the Centers for Disease Control (CDC) in Atlanta. A drug technician, Sandra Ford, noticed a high number of requests for the drug pentamine, used in the treatment of PCP:

> "A doctor was treating a gay man in his 20s who had pneumonia. Two weeks later, he called to ask for a refill of a rare drug that I handled. This was unusual – nobody ever asked for a refill. Patients usually were cured in one 10-day treatment or they died"
>
> ~Sandra Ford for Newsweek

In June, the CDC published a report about the occurrence, without identifiable cause, of PCP in five men in Los Angeles. This report is sometimes referred to as the "beginning" of AIDS, but it might be more accurate to describe it as the beginning of the general awareness of AIDS in the USA. A few days later, following these reports of PCP and other rare life-threatening opportunistic infections, the CDC formed a Task Force on Kaposi's Sarcoma and Opportunistic Infections (KSOI). Around this time a number of theories were developed about the possible cause of these opportunistic infections and cancers. Early theories included infection with cytomegalovirus, the use of amyl nitrite or butyl nitrate "poppers," and "immune overload".

Because there was so little known about the transmission of what seemed to be a new disease, there was concern about contagion, and whether people who had no apparent signs or symptoms could pass on the disease. Knowledge about the disease was changing so quickly that certain assumptions made at this time were shown to be unfounded just a few months later. For example, in July 1981 Dr. Curran of the CDC was reported as follows:

> "Dr. Curran said there was no apparent danger to non homosexuals from contagion. 'The best evidence against contagion', he said, 'is that no cases have been reported to date outside the homosexual community or in women.'"
>
> ~The New York Times

Scanning electron micrograph of HIV-1 budding from cultured lymphocyte. Multiple round bumps on cell surface represent sites of assembly and budding of virions.

Source: CDC

Just five months later, in December 1981, it was clear that the disease affected other population groups, when the first cases of PCP were reported in injecting drug users. At the same time the first case of AIDS was documented in the UK.

The disease still did not have a name, with different groups referring to it in different ways. The CDC generally referred to it by reference to the diseases that were occurring, for example lymphadenopathy (swollen glands), although on some occasions they referred to it as KSOI, the name already given to the CDC task force. In contrast some still linked the disease to its initial occurrence in gay men, with a letter in The Lancet calling it "gay compromise syndrome." Others called it GRID (gay-related immune deficiency), AID (acquired immunodeficiency disease), "gay cancer," or "community-acquired immune dysfunction."

In June of 1982, a report of a group of cases amongst gay men in Southern California suggested that an infectious agent that was sexually transmitted might cause the disease. By the beginning of July a total of 452 cases, from 23 states, had been reported to the CDC. Later that month the first reports appeared that the disease was occurring in Haitians, as well as hemophiliacs. This news soon led to speculation that the epidemic might have originated in Haiti, and caused some parents to withdraw their children from hemophiliac camps.

The occurrence of the disease in non-homosexuals meant that names such as GRID were redundant. The acronym AIDS was suggested at a meeting in Washington, D.C., in July. By August this name was being used in newspapers and scientific journals. AIDS (Acquired Immune Deficiency Syndrome) was first properly defined by the CDC in September.

By the beginning of July a total of 452 cases, from 23 states, had been reported to the CDC.

An anagram of AIDS, SIDA, was created for use in French and Spanish. Doctors thought AIDS was an appropriate name because people acquired the condition rather than inherited it; because it resulted in a deficiency within the immune system; and because it was a syndrome, with a number of manifestations, rather than a single disease. Still very little was known about transmission and public anxiety continued to grow.

> "'It is frightening because no one knows what's causing it,' said a 28-year old law student who went to the St. Mark's Clinic in Greenwich Village last week complaining of swollen glands, thought to be one early symptom of the disease. 'Every week a new theory comes out about how you're going to spread it.'"
>
> ~The New York Times

By 1982 a number of AIDS specific voluntary organizations had been set up in the USA. They included the San Francisco AIDS Foundation (SFAF), AIDS Project Los Angeles (APLA), and Gay Men's health Crisis (GMHC). In November 1982 the first AIDS organization, the "Terry Higgins Trust" (later known as the Terrence Higgins Trust), was formally established in the UK, and by this time a number of AIDS organizations were already producing safer sex advice for gay men.

In December a 20-month old child who had received multiple transfusions of blood and blood products died from infections related to AIDS. This case provided clearer evidence that AIDS was caused by an infectious agent, and it also caused additional concerns about the safety of the blood supply. Also in December, the CDC reported the first cases of possible mother to child transmission of AIDS.

By the end of 1982 many more people were taking notice of this new disease, as it was clearer that a much wider group of people was going to be affected.

> "When it began turning up in children and transfusion recipients, that was a turning point in terms of public perception. Up until then it was entirely a gay epidemic, and it was easy for the average person to say 'So what?' Now everyone could relate."
>
> ~Harold Jaffe of the CDC for Newsweek

It was also becoming clear that AIDS was not a disease that just occurred in the USA. Throughout 1982 there were separate reports of the disease occurring in a number of European countries. Meanwhile in Uganda, doctors were seeing the first cases of a new, fatal wasting disease. This illness soon became known locally as ‘slim.’

In January (1983), reports of AIDS among women with no other risk factors suggested the disease might be passed on through heterosexual sex. At about the same time the CDC convened a meeting to consider how the transmission of AIDS could be prevented, and in particular to consider the newly emerged evidence that AIDS might be spread through blood clotting factor and through blood transfusions. As James Curran, the head of the CDC task force, said:

> “The sense of urgency is greatest for hemophiliacs. The risk for others [who receive blood products] now appears small, but is unknown.”

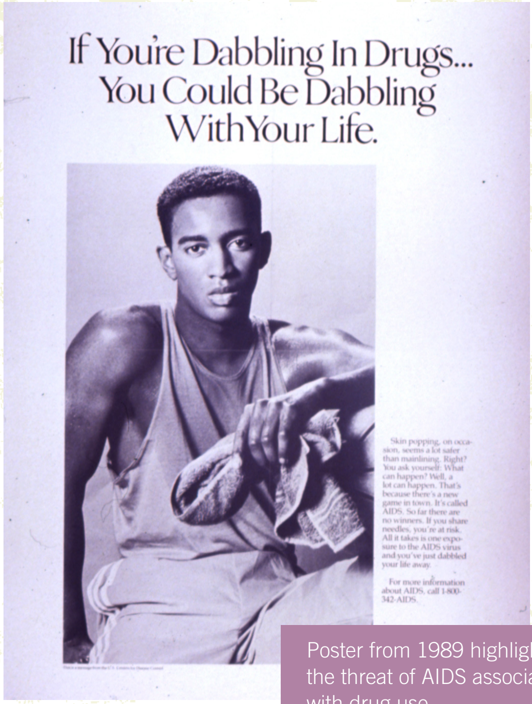
The risk for hemophiliacs was so great because the blood concentrate that some hemophiliacs used exposed them to the blood of up to 5,000 individual blood donors. In March, the CDC stated that,

> “Persons who may be considered at increased risk of AIDS include those with symptoms and signs suggestive of AIDS; sexual partners of AIDS patients; sexually active homosexual or bisexual men with multiple partners; Haitian entrants to the United States; present or past abusers of IV drugs; patients with hemophilia; and sexual partners of individuals at increased risk for AIDS.”

The same report also said,

> “Each group contains many persons who probably have little risk of acquiring AIDS… Very little is known about risk factors for Haitians with AIDS.”

Nevertheless, the inclusion of Haitians as a risk group caused much controversy. Haitian Americans complained of stigmatization, officials accused the CDC of racism, and



Poster from 1989 highlighting the threat of AIDS associated with drug use

Source: CDC

Haiti suffered a serious blow to its tourism industry. Before long people were talking colloquially of a “4-H Club” at risk of AIDS: homosexuals, hemophiliacs, heroin addicts and Haitians. Some people substituted hookers for hemophiliacs.

In May 1983, doctors at the Institute Pasteur in France reported that they had isolated a new virus, which they suggested might be the cause of AIDS. Little notice was taken of this announcement at the time, but a sample of the virus was sent to the CDC. A few months later the virus was named lymphadenopathy-associated virus or LAV, patents were applied for, and a sample of LAV was sent to the National Cancer Institute. But whilst progress was being made by scientists there was at the same time increasing concern about transmission, and not just in relation to the blood supply. A report of AIDS occurring in children suggested quite incorrectly the possibility of casual household transmission.

AIDS transmission became a major issue in San Francisco, where the Police Department equipped patrol officers with special masks and gloves for use when dealing with what the police called "a suspected AIDS patient".

> "The officers were concerned that they could bring the bug home and their whole family could get AIDS."
>
> ~The New York Times

And in New York:

> "Landlords have evicted individuals with AIDS" and "the Social Security Administration is interviewing patients by phone rather than face to face."
>
> ~Dr. David Spencer, Commissioner of Health, New York City

There was considerable fear about AIDS in many other countries as well:

> "In many parts of the world there is anxiety, bafflement, a sense that something has to be done—although no one knows what."
>
> ~The New York Times

As anxiety continued, the CDC tried to provide reassurance that children with AIDS had probably acquired it from their mothers and that casual transmission did not occur:

> "The cause of AIDS is unknown, but it seems most likely to be caused by an agent transmitted by intimate sexual contact, through contaminated needles, or, less commonly, by percutaneous inoculation of infectious blood or blood products. No evidence suggests transmission of AIDS by airborne spread. The failure to identify cases among friends relatives, and co-workers of AIDS patients provides further evidence that casual contact offers little or no risk [...] the occurrence in young infants suggests transmission from an affected mother to a susceptible infant before, during, or shortly after birth."
>
> ~CDC

Reports from Europe suggested that two rather separate AIDS epidemics were occurring. In the UK, West Germany and Denmark, the majority of people with AIDS were homosexual, and many had a history of sex with American nationals. However in France and Belgium AIDS was occurring mainly in people from Central Africa or those with links to the area. Examples of this second epidemic included a number of previously healthy African patients who were hospitalized in Belgium with opportunistic infections (such as PCP and ryptosporidiosis), Kaposi's sarcoma, or other AIDS-like illnesses. All of these Africans had immune deficiency similar to that of American AIDS patients. However they had no history of blood transfusion, homosexuality, or intravenous drug abuse. In light of such reports, European and American scientists set out to discover more about the occurrence of AIDS in Central Africa.

By this time, doctors working in parts of Zambia and Zaire had already noticed the emergence of a very aggressive form of Kaposi's sarcoma. This cancer was endemic in Central Africa, but previously it had progressed very slowly and responded well to treatment, whereas the new cases looked very different and were often fatal. In September the CDC published their first set of recommended precautions for health-care workers and allied professionals designed to prevent "AIDS transmission". In the UK, people who might be particularly susceptible to AIDS were asked not to donate blood.

In October, the first European World Health Organization (WHO) meeting was held in Denmark. At the meeting it was reported that there had been 2,803 AIDS cases in the USA.

That meeting was followed in November by the first meeting to assess the global AIDS situation. This was the start of global surveillance by the WHO and it was reported that AIDS was present in the U.S.A., Canada, fifteen European countries, Haiti and Zaire as well as in seven Latin American countries. There were also cases reported from Australia and two suspected cases in Japan.

By the end of the year (1983) the number of AIDS cases in the USA had risen to 3,064 and of these 1,292 had died.

Credit: Article excerpted from Kanabus, A. & Fredriksson, J. *History of AIDS up to 1986*. Avert.org. Available from: http://www.avert.org/aids-history-86.htm. Some spelling has been changed from British to American. Some editing has been done to make it more usable in the classroom.

LEVEL ONE QUESTIONS

1. When did general awareness of AIDS begin in the US?

2. In which three groups did AIDS first appear?

a.

b.

c.

3. Give three names by which this disease was first known.

a.

b.

c.

4. What does the name "AIDS" mean?

5. By July of 1982, how many states had reported cases of AIDS?

LEVEL TWO QUESTIONS

6. What alerted the CDC to this new condition?

7. Why was it so difficult for authorities to get a handle on this new disease?

8. How did the public react to the news of the outbreak?

9. Why was there such concern regarding the nation's blood supply?

LEVEL THREE QUESTIONS

10. How might the government have responded differently if this new condition first appeared in the most wealthy and influential people in society?

Name:____________________________ Date:___________ Period:________

Levels of Questioning

HANDOUT

LEVEL ONE QUESTIONS

Level One questions can be answered explicitly by facts contained in the text or by information accessible in other resources. (The answers to Level One questions are clearly in the text).

LEVEL TWO QUESTIONS

Level Two questions are textually implicit, requiring analysis and interpretation of specific parts of the text. (The reader must read between the lines for the answers to questions on this level).

LEVEL THREE QUESTIONS

Level Three questions are much more open-ended and go beyond the text. They are intended to provoke a discussion of an abstract idea or issue. (Level Three questions ask So What; what does it matter?)

Credit: The College Board

Name:________________________ Date:__________ Period:________

Epidemics & the Modern Metropolis

HANDOUT

How Epidemics Helped Shape the Modern Metropolis
By John Noble Wilford
Tuesday, April 15, 2008
The New York Times

On a Sunday in July 1832, a fearful and somber crowd of New Yorkers gathered in City Hall Park for more bad news. The epidemic of cholera, cause unknown and prognosis dire, had reached its peak.

People of means were escaping to the country. The New York Evening Post reported, "The roads, in all directions, were lined with well-filled stagecoaches, livery coaches, private vehicles and equestrians, all panic-struck, fleeing the city, as we may suppose the inhabitants of Pompeii fled when the red lava showered down upon their houses."

An assistant to the painter Asher Durand described the scene near the center of the outbreak. "There is no business doing here if I except that done by Cholera, Doctors, Undertakers, Coffinmakers," he wrote. "Our bustling city now wears a most gloomy & desolate aspect — one may take a walk up & down Broadway & scarce meet a soul."

The epidemic left 3,515 dead out of a population of 250,000. (The equivalent death toll in today's city of eight million would exceed 100,000.) The dreadful time is recalled in art, maps, death tallies and other artifacts in an exhibition, "Plague in Gotham! Cholera in Nineteenth-Century New York," at the New-York Historical Society. The show will run through June 28.

The outbreak, as portrayed in the exhibition and other documentation, highlighted the vulnerabilities of life in overcrowded cities in a time of deplorable sanitation and before medical science recognized the role of germs in disease. Cities were growing faster in population than in understanding what it took to make them fit places to live — an urban problem probably as old as the Sumerians of Mesopotamia.

The initial response to the epidemic, Kenneth Jackson, a professor of history at Columbia University, said recently, exposed more than ever the city's divisions of class, race and religion. The disease hit hardest in the poorest neighborhoods, particularly the slum known as Five Points, where African-Americans and immigrant Irish Catholics were crowded in squalor and stench.

"Other New Yorkers looked down on the victims," said Jackson, editor of The Encyclopedia of New York City. "If you got cholera, it was your own fault."

Unlike most upper-class residents, John Pintard, the respected civic leader who was the historical society's founder, remained in the stricken city. His letters to one of his daughters are included in the exhibition.

The epidemic, he wrote in an attitude typical of his peers, "is almost exclusively confined to the lower classes of intemperate dissolute & filthy people huddled together like swine in their polluted habitations."

In another letter, his judgment was even harsher. "Those sickened must be cured or die off, & being chiefly of the very scum of the city, the quicker [their] dispatch the sooner the malady will cease."

Dr. David Ho, a biomedical scientist at Rockefeller University, noted the similarities between the views on cholera and the initial reaction to a more recent epidemic that took science by surprise: AIDS.

When the first AIDS cases were reported in 1981, the victims were almost all white gay men. They were treated as outcasts.

"It was a repeat of the cholera experience," said Ho, the founding chief executive of the Aaron Diamond AIDS Research Center. "The cause of the disease was unknown, and it affected a subset of the population. It was easy to brand the victims and blame the disease on their lifestyle."

Scientists moved quickly and effectively to isolate the virus that causes AIDS, which is by no means confined to gay men and is rampant in developing countries, particularly in Africa.

Science and medicine advanced more slowly in the 19th century. It was 1883 before the bacterium Vibrio cholerae was discovered to be the agent causing the gastrointestinal disease. But a turning point in prevention came in 1854, when a London physician, Dr. John Snow, established the connection between contaminated water and cholera.

Snow tested the idea by plotting cholera cases on a map of Soho. This showed that most of the victims drew their water from a public pump on Broad (now Broadwick) Street. An infected baby's diapers had been dumped into a cesspool near the well. A recent book, "Ghost Map," by Steven Johnson, recounts the discovery.

The cholera research was an early application of mapping in medical investigations, a technique that has become widespread now that computers facilitate the display and analysis of such data. Historians of medicine credit Snow with advancing the modern germ theory of disease and laying the foundations of scientific epidemiology.

The cholera menace thus prompted cities to begin cleaning up their fouled nests. This came too late for victims of the 1832 epidemic in New York, or one that followed in 1849. By then, the city's population had doubled, to 500,000, and deaths by cholera rose to 5,071.

The city in 1832 had expanded as far north as 14th Street. People were squeezed out of the lower wards by the influx of immigrants. Some, escaping earlier outbreaks of malaria and yellow fever, had sought a haven in the clean air and open land of the village called Greenwich.

Walking in Greenwich Village today, one is struck by the number of small brick houses bearing markers with dates immediately after 1832. It may be no coincidence that John Blauvelt, a carter working the piers, built his on West 10th Street (then Amos Street) the year after the cholera epidemic.

New Yorkers should have suspected that the scourge was on its way. Cholera, originally confined to South Asia, had started spreading in 1817 from seaport to seaport, presumably carried by infected sailors. The disease struck London in 1831 and reached New York the next June.

No one was prepared, not even doctors. They generally believed that miasmas, the noxious vapors from rotting organic matter, carried infections, an idea inspiring literature

The original map drawn by Dr. John Snow (1813-1858), a British physician who is one of the founders of medical epidemiology, showing cases of cholera in the London epidemics of 1854, clustered around the locations of water pumps.

Source: US PD

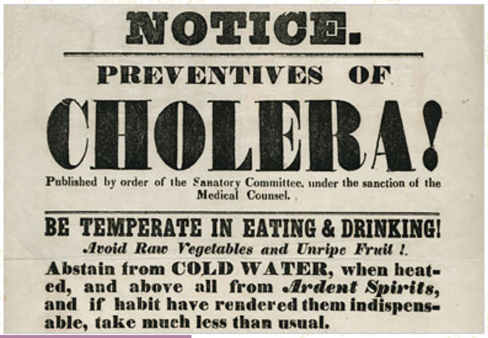
of death in Rome and Venice. The cholera in Five Points seemed to bear out the hypothesis.

Five Points was a slum that had metastasized from an intersection of five streets north of City Hall through the area that is now Foley Square and Chinatown. "All that is loathsome, drooping and decayed is here," Charles Dickens wrote after a visit. Martin Scorsese's movie "Gangs of New York" captures the lowlife there later in the 19th century, when it was still an urban sinkhole.

The exhibition includes illustrations of the thugs and gamblers, the stray dogs and pigs that inhabited the streets of mud and manure. The pigs at least were useful as garbage collectors and sources of food.

For victims, the onset of cholera was sudden: an attack of diarrhea and vomiting, followed by abdominal cramps and then acute shock, signaling the collapse of the circulatory system. Some survived the illness, despite the lack of effective remedies.

Posters from the time described recommended treatments, including laudanum (morphine), calomel (mercury) as a binding laxative, and camphor as an anesthetic. High doses sometimes did more harm than good. Poultices of mustard, cayenne pepper and hot vinegar were also applied, as well as opium suppositories and tobacco enemas.



Circa 1830-1840

Source: New York Historical Society.

Many victims, nearly half the cases at one hospital, died within a day of admission. After private hospitals began turning away patients, the city set up emergency public hospitals in schools and other buildings. One, on Rivington Street, bore the brunt, and sketches of its patients' faces contorted in the throes of death look down from the exhibition walls.

In stark contrast, Asher Durand, who had escaped with his family to their country home in New Jersey, painted his children happily eating apples in a sunny orchard. The idyllic canvas hangs a few feet, and a world, away from the scenes of Five Points.

While many Protestants sat out the epidemic at safe distances, the city's Catholics, many of whom were poor immigrants, mostly Irish, had no choice but to stay. Their nuns and priests also remained to offer comfort and some help, and they emerged as the few heroes in the ordeal. "The Sisters of Charity performed heroic service, and many of them died," said Stephen Edidin, co-curator of the exhibition, with Joseph Ditta. "As a result, there was some reduction of anti-Catholic sentiments and a new respect for the Catholic clergy, who risked their lives in the epidemic. The feeling didn't last, of course."

Despite the epidemics of '32 and '49, people still flocked to New York and other teeming cities. But the first outbreak bolstered support for the Croton Aqueduct system to bring clean upstate water to the city, a project, completed in 1842, that led to the phasing out of private and neighborhood wells that were often polluted with human and animal waste. In 1849, the municipal government banished more than 20,000 pigs to the outer reaches of the city. A similar effort in previous years had provoked riots, but this time a public chastened by epidemic complied.

Finally, after the work of Snow in London and a lesser cholera outbreak in New York in 1866, the Metropolitan Board of Health was established with doctors in commanding roles and broad powers to clean up the city. Inspectors went to houses and burned clothing of people who had just died. They cleared the filth, spread lime and instructed survivors in proper sanitation.

Cities had learned, or should have, that epidemics as a consequence of urbanization were their responsibility to prevent and control.

Cholera is still a threat wherever drinking water is polluted. But Ho says that people should no longer die of it, if they are treated promptly and properly with rehydration fluids to restore their ravaged bodies.

Credit: *New York Times*. Available at http://www.nytimes.com/2008/04/15/health/15iht-15chol.11988148.html.

Name:_____________________________ Date:___________ Period:________

Brief Template

HANDOUT

Problem statement: (In a nutshell, what is the problem that you are investigating?)

Evidence that demands action: (Why should we care about this crisis? Convince us that this problem requires a governmental response.)

Current response: (What is currently being done to help? This may be by individuals, groups, or the government.)

Our plan: (If given the resources, how would you solve the problem or aid the victims? This includes trying to prevent future outbreaks.)

What's the bottom line? (What will it cost us and what problems will there be in the future?)

Name:______________________________ Date:__________ Period:________

Blue Death at 5 Points Scoring Rubric

HANDOUT

CATEGORY	4	3	2	1	0
Preparedness	Students are completely prepared and have obviously rehearsed.	Students seem pretty prepared but might have needed a couple more rehearsals.	The students are somewhat prepared, but it is clear that rehearsal was lacking.	Students do not seem at all prepared to present.	Students did not present.
Stays on Topic	Stays on topic all (100%) of the time.	Stays on topic most (99-80%) of the time.	Stays on topic some (80%-70%) of the time.	At least I knew what the topic was.	Had no idea what the topic was.
Time-Limit	Presentation is 3 minutes long.	Presentation is 2.5 minutes long.	Presentation is 2 minutes long.	Presentation is less than 2 minutes OR more than 4 minutes.	Presentation is less than 1:30 or more than 4:30.
Problem Statement	Group clearly and concisely states the problem.		Unsure as to what the problem is.		No problem statement was given.
Evidence	Evidence is compelling. Convinces us to care about the problem.	Compelling, we will help as long as it does not cost too much.	Somewhat compelling, we care enough to help a little bit.	Not compelling enough to make me miss Monday night Football.	No evidence presented.
Current Response	Clearly describes what is currently being done to solve the problem.		Not too clear on what is being done.		No discussion of current response.
Solution (x2) points	Solution is clearly stated and well thought out.	Solution is not clearly stated or not well thought out.	Not well stated nor is it well thought out.	Barely even there.	No solution given.
Cost (x2) points	Good description of the costs. Shows evidence that students thought about what might happen in the future.	Minimal description of costs, but shows evidence that they thought about what might happen in the future.	Minimal description and not a lot of thought about the future.	Little description of the cost.	No cost was discussed.

Rubric made using RubiStar, http://rubistar.4teachers.org.

LESSON 2
Foreign Policy & Global Health

LESSON

Activity Time: 300 minutes (six 50 minute class periods)

In this lesson, students will complete the "U.S. Foreign Policy" Classroom-Based Assessment (CBA) while focusing on a global health issue. Students will examine the motivations that drive foreign aid.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Globalization:** Countries are inter-related and decisions in one impact others.
- **Foreign Aid:** A country's decision to send foreign aid is influenced by politics and socio-economic status.

Essential Question:

- What role should the government take in aiding other countries?
- How will the decision to help impact the country in need as well as our own country?

Learning Objectives:

Students will know…

- The US government has aided other countries in the past by giving foreign aid.
- The decision to give foreign aid has implications for both countries involved.

Students will be able to…

- Critically analyze the motivations that drive foreign aid.
- Evaluate the impact that foreign aid has on all countries involved.
- Defend a position based on historical facts.

Vocabulary:

- Foreign aid
- Foreign policy

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History 1.3.1** Analyzes and evaluates the causes and effects of US foreign policy on people in the United States and across the world (1890 – present).
- **Social Studies 5.4.1** Evaluates and interprets other points of view on an issue within a paper or presentation.
- **Social Studies 5.4.2.** Creates strategies to avoid plagiarism and respects intellectual property when developing a paper or presentation.
- **Social Studies 5.2.2** Evaluates the validity, reliability, and credibility of sources while researching an issue or event.

Common Student Preconceptions:

- We should solve our problems before we spend money to help other countries.
- The world complains about the U.S. sticking its nose into their issues so why should we help them.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- Access to library and/or computer lab
- U.S. Foreign Policy CBA documents (from the OSPI website)
- *Position Statement Template* Handout (1 per student)
- *Scoring Rubric* Handout(1 per student)
- *Resources List* Handout (1 per student)
- Student journals or blank paper

Preparation:

- Discuss what a Classroom-Based Assessment (CBA) is and how they are used by the state and individual school to assess student learning.
- Review the lessons from the Introduction to Global Health section of the curriculum to remind students of the importance of global health issues.
- Choose which news articles you want students to read to provide them with sufficient background about the Zimbabwe cholera outbreak.
- Make copies of the Student Handouts.

PROCEDURE

Hook

1. Watch the movie trailer for *Black Hawk Down.* This film clip provides an example of why the U.S. chose to help deal with a problem on foreign soil. It also shows some of the problems that occurred because of our involvement.

   Black Hawk Down Trailer
   2:37 minutes
   http://www.youtube.com/watch?v=AUJ6cxWdZwA

Preconceptions

2. Ask students to write down their thoughts about foreign aid in their journals or on a piece of blank paper. What criteria should be used to decide if the U.S. should give aid to another country? What types of aid do you agree with and disagree with?

Day One Activity

3. Explain that students will be completing the U.S. Foreign Policy CBA by examining a current outbreak of cholera in Zimbabwe. Share one or more of the news articles listed in the Resources with students to provide them with background information on this outbreak. The use of cholera in Zimbabwe is for introduction purposes only. Students will be able to choose any topic that falls under the broad topic of "U.S. foreign aid to promote global health." Teachers can use the *Resources for Foreign Policy CBA* Handout page for suggestions.
4. Introduce the U.S. Foreign Policy CBA and the steps needed to complete the activity. Take about 10 minutes to review the CBA documents from the OSPI website.
5. Pass out copies of the *Scoring Rubric*, one per student, and discuss what is required to successfully complete this activity. Explain that students will cite references both in the presentation and in the bibliography.
6. Pass out copies of the *Resources for Foreign Policy CBA* Handout and explain that while students can choose any topic related to "U.S. foreign aid to promote global health," this handout provides a few suggested topics and resources to help jumpstart their research. Because this is such a broad issue it is important for the teacher to narrow the list of possible topics for management purposes. Listed below is a break down of possible topics. Teachers are encouraged to use this list as a starting point and adjust according to school/district expectations.
   - HIV/AIDS in Africa
   - Global influenza pandemics
   - Cholera in Zimbabwe
   - Malaria world wide

Day Two Activity

7. Review the rubric to check for student understanding.
8. Have students identify their chosen topic. Record the choices to use later when forming student groups.
9. Allow time in the library or computer lab for students to begin researching their topic. Remind them to occasionally check the rubric so they do not get off topic.

Day Three and Four Activity

10. Pass out copies of the *Position Statement Template* Handout, one per student. Students will spend time researching and formulating their position. Remind them to check the rubric and keep a record of their resources for their bibliography.

Day Five Activity

11. Ask students to submit a copy of their Position Statement to you. The Position Statement is important because it will ensure that the student has completed the pre-work and is not going to rely on the group to give them the information.
12. Break students into groups based on their individual topics. These groups are for collaboration purposes only. The presentations will be given individually.
13. Ask groups to discuss evidence and research findings. Group members will use this collaboration time to fill in any gaps that they had in their research and thinking about their topic.
14. *Optional:* Consider giving the students a few days to work outside of class before beginning the presentations. This will allow them to formulate and practice their presentations.

Day Six and Seven Activity

15. Schedule each student to give his or her 3-minute presentation to the class. Presentations will be given individually.
16. Take time at the end of each presentation to allow for questions from the class and from you.

Wrap-Up

17. Have students look back at their journals and look for evidence of pre-conceptions and any changes in their thinking of foreign aid.
18. As a class, discuss the importance of promoting global health. What is our responsibility as Americans?

EXTENSION ACTIVITIES

Extension Activities:

- Presentations may be replaced by a 3-5 page research paper.

Adaptations:

- Have students keep a journal as they do this activity. The journal will focus on their opinions about foreign aid.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on cholera can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, a variety of websites with information about U.S. aid to foreign countries is provided in the Resources section below.

Resources:

Black Hawk Down Trailer
2:37 minutes
http://www.youtube.com/watch?v=AUJ6cxWdZwA

U.S. Foreign Policy CBA
Office of the Superintendent of Public Instruction
http://www.k12.wa.us/SocialStudies/CBAs/HighSchool.aspx

Global Issues: US Foreign Aid
http://www.globalissues.org/article/35/us-and-foreign-aid-assistance

USAID
http://www.usaid.gov/

Stop Giving Us Aid, Say Africans
http://blogs.telegraph.co.uk/news/danielhannan/9830677/Stop_giving_us_aid_say_Africans/

Bringing Lessons Home: A Perspective from USAID
http://www.cceia.org/resources/publications/dialogue/1_11/relevance_social/587.html

Does 'Our' Money Help Solve 'Their' Problems?
http://us.oneworld.net/perspectives/foreignassistance/360453-does-our-money-help-solve-their-problems

Who Safeguards Global Public Health?
http://www.pbs.org/wgbh/rxforsurvival/series/politics/who.html

Name:____________________________ Date:___________ Period:________

Position Statement Template

HANDOUT

TOPIC Briefly describe your chosen topic.

POSITION Describe how you feel about the U.S. decision to give aid in this particular situation.

REASONING Provide reasons for your position, supported by evidence of why the policy was implemented for national and/or international interests from three or more of the following social science perspectives: **Geographic, cultural, political, economic, sociological, psychological**.

Use as many rows as needed.

PESPECTIVE	EVIDENCE/ANALYSIS

CONCLUSION

Explain your conclusion about why studying this foreign policy helps us to understand current issues and events.

REFERENCES

List the references that you used. You must have a minimum of 4 "credible" sources. You need to use MLA formatting.

Name:____________________ Date:__________ Period:________

HANDOUT

Resources for Foreign Policy CBA

US AID FOR CHOLERA IN ZIMBABWE

USAID Sends Additional Assistance for Zimbabwe Cholera Outbreak
http://www.usaid.gov/press/releases/2009/pr090128_1.html

USAID Increases Assistance For Zimbabwe Cholera Outbreak
http://www.medicalnewstoday.com/articles/131874.php

Zimbabwe to Receive $6.2 Million from U.S. Aid Agency
http://www.america.gov/st/health-english/2008/December/20081211161620lcnirellep0.8917505.html

Zimbabwe's Cholera Victims 'ten times more likely to die'
http://www.telegraph.co.uk/news/worldnews/africaandindianocean/zimbabwe/3660739/Zimbabwes-cholera-victims-ten-times-more-likely-to-die.html

Zimbabwe Neighbors Should Seal Borders
http://www.alertnet.org/thenews/newsdesk/N11402094.htm

US AID FOR MALARIA

A Global Leader in Fighting Malaria
http://www.usaid.gov/our_work/global_health/id/malaria/

USAID/Brazil's Health Program Focuses on Three Infectious Diseases
http://brazil.usaid.gov/en/node/11

USAID's Malaria Control Plan Risks Public Disapproval
http://ipsnews.net/news.asp?idnews=34871

USAID Provides Malaria Assistance To Zimbabwe
http://www.medicalnewstoday.com/articles/138226.php

President's Malaria Initiative Announces Major Local Program to Battle Disease
http://senegal.usaid.gov/news/articles/07_11_27_PMI_MCP_EN.html

USAID Fights Malaria Blindfolded
http://www.aei.org/article/22336

Accelerating the Fight Against Malaria
http://www.usaid.gov/press/factsheets/2005/fs050915.html

US AID FOR INFLUENZA

Avian and Pandemic Influenza: Preparedness and Response
http://www.usaid.gov/our_work/global_health/home/News/news_items/avian_influenza.html

USAID Strengthens Avian Influenza Surveillance, Biosecurity, and Response in Uzbekistan
http://centralasia.usaid.gov/page.php?page=article-690

USAID strengthens fight against avian influenza globally
http://www.news-medical.net/news/2007/04/02/22832.aspx

"Swine Flu" Outbreak: U.S. Responses to Global Human Cases
http://opencrs.com/document/R40588

USAID Joins Fight Against Bird Flu
http://english.vietnamnet.vn/social/2009/02/830501/

GENERAL RESOURCES FOR U.S. FOREIGN AID

Global Issues
http://www.globalissues.org/article/35/us-and-foreign-aid-assistance

USAID
http://www.usaid.gov/

Stop Giving Us Aid, Say Africans
http://blogs.telegraph.co.uk/news/danielhannan/9830677/Stop_giving_us_aid_say_Africans/

Bringing Lessons Home: A Perspective from USAID
http://www.cceia.org/resources/publications/dialogue/1_11/relevance_social/587.html

Does 'Our' Money Help Solve 'Their' Problems?
http://us.oneworld.net/perspectives/foreignassistance/360453-does-our-money-help-solve-their-problems

Who Safeguards Global Public Health?
http://www.pbs.org/wgbh/rxforsurvival/series/politics/who.html

Name:_______________________ Date:__________ Period:________

HANDOUT

Foreign Policy CBA Scoring Rubric

This rubric has two parts: The first is a general rubric for classroom presentations that can be altered to fit any individual curriculum and the second is the Washington State rubric for assessing this particular CBA. They can be used separately or combined to generate one total score.

CATEGORY	4	3	2	1	0
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat pre-pared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.	Student did not present a presentation.
Enthusiasm	Facial expressions and body language generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language sometimes gener-ate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language are used to try to generate enthu-siasm, but seem somewhat faked.	Very little use of facial expressions or body language. Did not generate much interest in topic being presented.	Showed no enthusiasm.
Speaks Clearly	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces a few words.	Often mumbles or cannot be understood OR mis-pronounces more than a few words.	Mumbles and mispronounces many words.
Posture and Eye Contact	Stands up straight, looks relaxed and confident. Establishes eye contact with everyone in the room during the presentation.	Stands up straight and establishes eye contact with everyone in the room during the presentation.	Sometimes stands up straight and establishes eye contact.	Slouches and/or does not look at people during the presentation.	
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes 1-2 words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (5 or more) words or phrases that are not understood by the audience.	

CATEGORY	4	3	2	1	0
Pauses	Pauses were effectively used 2 or more times to improve meaning and/or dramatic impact.	Pauses were effectively used once to improve meaning and/or dramatic impact.	Pauses were intentionally used but were not effective in improving meaning or dramatic impact.	Pauses were not intentionally used.	
Pitch	Pitch was often used and it conveyed emotions appropriately.	Pitch was often used but the emotion it conveyed sometimes did not fit the content.	Pitch was rarely used OR the emotion it conveyed often did not fit the content.	Pitch was not used to convey emotion.	
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.	Shows no understanding of the topic.
Time-Limit	Presentation is 3 minutes long.	Presentation is 2:45 long.	Presentation is 2:30 long.	Presentation is less than 2:30 OR more than 4 minutes.	Less than 2:00 or more than 5.
Comprehension	Student is able to accurately answer almost all questions posed by classmates about the topic.	Student is able to accurately answer most questions posed by classmates about the topic.	Student is able to accurately answer a few questions posed by classmates about the topic.	Student is unable to accurately answer questions posed by classmates about the topic.	Student does not answer questions.

High School – US Foreign Policy CBA Rubric (Recommended for 11th Grade)

GLE	4 – Excellent	3 – Proficient	2 – Partial	1 – Minimal
A – Position **5.4.1** Evaluates and interprets other points of view on an issue within a paper or presentation.	States a position on the chosen foreign policy that outlines reasons in support of the position. AND Draws a conclusion about why studying this foreign policy helps us to understand current issues and events.	States a position on the effectiveness of the chosen foreign policy that outlines reasons in support of the position.	States a position on the chosen foreign policy but does not outline reasons in support of the position.	Addresses a foreign policy without stating a position.
B – Causes **1.3.1** Analyzes and evaluates the causes and effects of US foreign policy on people in the United States and across the world (1890 – present).	Provides reason(s) for the position supported by evidence. The evidence includes: An analysis of why the policy was implemented for national and/or international interests from three or more of the following social science perspectives: geographic cultural political economic sociological psychological.	Provides reason(s) for the position supported by evidence. The evidence includes: An analysis of why the policy was implemented for national and/or international interests from two of the following social science perspectives: geographic cultural political economic sociological psychological.	Provides reason(s) for the position supported by evidence. The evidence includes: An analysis of why the policy was implemented for national and/or international interests from one of the following social science perspectives: geographic cultural political economic sociological psychological.	Provides evidence for the position WITHOUT using any specific social science perspectives.
C – Effects	Provides reason(s) for the position supported by evidence. The evidence includes an analysis of the effects of the policy including a discussion of: how the policy affected stakeholders in the United States. AND how the policy imposed costs AND provided benefits for other nations.	Provides reason(s)for the position supported by evidence. The evidence includes an analysis of the effects of the policy including a discussion of: how the policy affected stakeholders in the United States. AND how the policy imposed costs OR provided benefits for other nations.	Provides reason(s) for the position supported by evidence. The evidence includes an analysis of the effects of the policy including a discussion of: how the policy affected stakeholders in the United States.OR how the policy imposed costs AND provided benefits for other nations.	States how the chosen foreign policy affected stakeholders in the United States or imposed costs on AND/OR provided benefits for other nations without explicit support from relevant evidence.
D – Sources **5.4.2.** Creates strategies to avoid plagiarism and respects intellectual property when developing a paper or presentation. (10th Grade) (EALR 5.4. Creates a product…) **5.2.2** Evaluates the validity, reliability, and credibility of sources while researching an issue or event.	Makes explicit references within the paper or presentation to **four or more** credible sources that provide relevant information. Cites sources within the paper, presentation, or bibliography.	Makes explicit references within the paper or presentation to **three** credible sources that provide relevant information.Cites sources within the paper, presentation, or bibliography.	Makes explicit references within the paper or presentation to **two** credible sources that provide relevant information. Cites sources within the paper, presentation, or bibliography.	Makes explicit references within the paper or presentation to **one** credible source that provides relevant information. Cites the source within the paper, presentation, or bibliography.

Credit: Washington State Office of the Superintendent of Public Instruction.

influenza

LESSON 1:
Swine Flu Case Study

Activity Time: 100 minutes

In this lesson, students will practice their skills in moving between the four representations of a linear set of data. Students will analyze rates of infections as one of the factors that determines if an influenza virus is considered as endemic, epidemic, or pandemic. Before delivering this lesson, students should know how to graph data and how to find the slope and intercept.

Scheduling Instructions: This lesson should be delivered so that it precedes the *H1N1 Mortality Rates* math lesson, which builds on the concepts introduced in this lesson. This math lesson also compliments the U.S. History lesson plans: *"Spanish Flu" Pandemic of 1918, What Worked and What Didn't?*, and *Swine Flu: Learning from 1976*, all which examine the role of government in responding to disease outbreaks.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Linear Relationships**: Linear relationships can be presented in graph, table, equation, or word form.
- **Rates of Infection:** One of the factors that determines if an influenza virus is considered endemic, epidemic, or pandemic is the rate of infection.
- **Decision-Making:** Mathematical data, such as infection rates and mortality rates, are important tools used by decision-makers faced with an outbreak of an infectious diseases.

Essential Question:

- When should we alert the public to the danger of an influenza virus?

Learning Objectives:

Students will know…

- The infection rate for a given disease is the number of infected people, divided by the total population.
- The meaning of slope can be found by finding a definition for the quotient of the dependent variable, divided by the independent variable (y-units / x-units).

Students will be able to…

- Find the slope and intercept of a graph.
- Present a linear relationship in graph, table, equation, or word form.
- Change a linear relationship from a graph to equation form.
- Change a linear relationship from equation to graph form.
- Create an equation from a written explanation.

Vocabulary:

- Endemic
- Epidemic
- Influenza
- Intercept
- Linear relationship
- Mortality
- Pandemic
- Slope
- Vaccine
- Virus

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.D** Generalize a solution strategy for a single problem to a class of related problems and apply a strategy for a class of related problems to solve specific problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.
- **A2.8.F** Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
- **A2.8.H** Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.

Common Student Preconceptions:

- Vaccines are all old; they are not developed each season.
- Vaccines cost little to develop.
- Once you get a vaccine, you won't get the disease.
- Influenza is "influence" in Spanish.
- The flu is just a really bad cold.
- Only old people die from the flu.
- You get the flu from being cold.

TEACHER PREPARATION

Materials:

- Computer with internet access, speakers, and projector
- Graph paper
- Chart paper or poster paper (for students to create a short presentation)
- *Swine Flu Case Study—Part I* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Preview the **CDC Press Conference** video.
  http://www.youtube.com/watch?v=hE5qGOd8U48
- Photocopy the Student Handout.
- Do the math. Run through the activity yourself so that you are prepared to answer students' questions.
- Students will need to read the Student Background Reading on influenza from the Introduction to Global Health section of the curriculum prior to participating in this math activity. The reading will provide them with background information on the 1918 influenza pandemic that is mentioned in the case study for this math activity.

PROCEDURE

Hook

1. Show students the 4 minute video **Swine Flu Press Conference** from the Center for Disease Control (CDC). http://www.youtube.com/watch?v=hE5qGOd8U48

Preconceptions

2. Ask students if they have heard the following words before, perhaps in a news report. Ask students for their definitions, then share the provided definitions.
   > **Endemic**: a disease that is constantly present in a community (such as seasonal flu).
   > **Epidemic**: a disease that is spreading rapidly and exceeding expectations.
   > **Pandemic**: an epidemic that is reaching multiple continents around the globe (such as the 2009 H1N1 swine flu pandemic).

Group Work

3. Break students into groups of 2 or 3. Pass out copies of the *Swine Flu Case Study* Handout, one per student.
4. After students have read the case study, lead a brief discussion on the following points:
   > Suggestions for how to approach the challenge.
   > Expectations for each group's presentation.
   > Relevant facts in the case study.
   > Procedures for gathering additional information.
5. As the student groups work on the case study, monitor student progress. Be aware that students may get stuck on the vastly different scales of the data sets.
6. Provide graph paper and chart/poster paper for groups to prepare visual aids for their presentation to the class.

Presentations

7. Allow each group three minutes to present their recommendation to the rest of the students, who will play the role of epidemiologists at the Center for Disease Control (CDC). Choose one of the following presentation methods:
   > **Gallery Walk**: After each group makes their presentation, they post their visual aids on the wall to create a gallery. All students then walk through the gallery, using sticky notes to place questions and compliments next to each group's materials.
   > **Jigsaw**: One member from each of the teams meets to form a new group. Each student then shares their presentation within the small group.
   > **Whole Class Presentations**: Each group delivers their presentation in front of the class, allowing time for questions from the audience.

Wrap-Up

8. Lead a class discussion about the reliability of the Mexico data due to how few cases are presented. Discuss the following questions:
   > Should we base a large-scale response on so few cases?
   > Is the death rate great enough that we should warn people?
   > Is the disease infectious enough that we should warn people?
   > Is the problem big enough to warrant a large-scale response?
9. Now that the students have heard each group's recommendations, challenge the class as a whole to come to consensus on one recommendation for how the CDC should respond to this unusual swine flu outbreak.

STUDENT ASSESSMENT

Assessment Opportunities:

- During group work time, look for evidence that the learning targets are being met. Depending on what you choose to emphasize in this lesson, the following content may be taught:
  - > Lines of best fit.
  - > Linear functions.
  - > The meaning of slope.
  - > Epidemic vs. endemic vs. pandemic.
  - > Severity of typical influenza.
  - > Making a decision based on predictions.
  - > Weighing mathematical predictions with other information.
  - > Considering the backlash against a government over-reaction.
  - > Exploring the monetary value of a human life.
  - > Seeing how death rates for different age groups will indicate the severity of a flu strain.
  - > Evaluating the reliability of a prediction.
  - > Generalization of conclusions.
  - > Presenting data in a logical form.
- The posters/presentation can be graded with a rubric.
- Listen to students' questions, comments, and compliments during the presentation time. These student comments are a form of formative assessment.

Student Metacognition:

- Students should be required to make a plan before beginning work on the poster/presentation.
- During group work time, visit each group and ask students to give a status report.

Scoring:

- Participation points can be assigned for working in groups and contributing to class discussions.
- The Teacher Answer Key can be used to score each group's equations.
- Points can also be assigned for each group's presentation and visual aids.

EXTENSION ACTIVITIES

Extension Activities:

- This lesson was developed in June of 2009; any time after that there will be new data that can be incorporated into the lesson. Additional data can be acquired from the CDC or WHO websites.
- This math lesson compliments the U.S. History lesson plans: *"Spanish Flu" Pandemic of 1918, What Worked and What Didn't?*, and *Swine Flu: Learning from 1976*, all which examine the role of government in responding to disease outbreaks.

Adaptations:

- As this is a group work activity, intentional grouping of students with varied ability will provide some support to ELL or SPED students.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information in influenza can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, the Resources section below offers a list of helpful websites.

Resources:

CDC Swine Flu Press Conference video
4/25/09, CNN, 4:24 minutes
http://www.youtube.com/watch?v=hE5qGOd8U48

CDC Flu Activity & Surveillance (Updated Weekly)
http://www.cdc.gov/flu/weekly/fluactivity.htm

CDC Novel H1N1 Flu Situation Update (Updated Regularly)
http://www.cdc.gov/h1n1flu/update.htm

WHO Seasonal Influenza Fact Sheet
http://www.who.int/mediacentre/factsheets/fs211/en/

WHO Number of Laboratory-Confirmed Cases of Pandemic H1N1 2009 (Updated Regularly)
http://gamapserver.who.int/h1n1/atlas.html?select=ZZZ&filter=filter4,confirmed

WHO Influenza A (H1N1) Update
http://www.who.int/csr/don/2009_06_24/en/index.html

Credit:

Data from CDC and WHO.

WHO. (2009). *Swine Flu Illness in the United States and Mexico*.
4/26/09. Available from: http://www.who.int/csr/don/2009_25/en/index.html.

Name:____________________________ Date:___________ Period:________

Swine Flu Case Study – Part 1

HANDOUT

"Are you sure?" you asked in disbelief. "Another human influenza epidemic? Just like the Spanish flu that killed millions in 1918?"

"No, we're not sure," she replied, "but we need to be careful and cover all of our bases."

This is how your meeting with a lead epidemiologist at the Centers for Disease Control (CDC) began. A notice from the World Health Organization (WHO) had just arrived, describing an unusual outbreak of influenza in people living near a large pig farm in Mexico. Although there had only been 26 people hospitalized for pneumonia and other flu-like symptoms, 7 of those people had died within a three week period.

Looking around the meeting, you notice the tension in the room. People aren't calmly doodling on their papers. Everyone is sitting bolt upright and nervously fidgeting. These epidemiologists are the same people that calmly pour over the numbers of Americans that die of every cause, day in and day out. If they are nervous, you think, then something serious must be happening. As the meeting comes to an end, your boss pulls you to the side:

"I've provided you and your team members with some background information on the 1918 influenza pandemic – which I don't need to remind you was the deadliest outbreak of flu in recorded history.

I want you to crunch the numbers and present a recommendation to me tomorrow. There are going to be decision-makers from the White House at the meeting, and they easily get lost in numbers, so you'll need to be able to explain your recommendation to them in a way that they'll understand. We're also going to have other epidemiologists at the meeting, and they'll want to see what equations you came up with for the situation.

Right now we don't have enough information to tell how many people will become infected with this flu virus. This could just be a blip, or it could be the biggest threat to public health in nearly a century."

Back in your office, you and your team members pour over the data provided by your boss. He's provided you with the following resources:

- Current Mexico Swine Flu Outbreak Mortality Rates
- Typical U.S. Seasonal Flu Mortality Rates
- 1918 Influenza Mortality Rates
- WHO Fact Sheet on Swine Flu

Your team has decided to include predictions on how many deaths there will be in three scenarios: 1,000 U.S. Citizens infected; 10,000 U.S. Citizens infected; and 1,000,000 U.S. Citizens infected. You've also decided to compare those predictions to data for typical seasonal flu and the 1918 flu pandemic.

It's going to be important that you don't get lost in the math. We're talking about 7 individual people that have died in one small area of Mexico. Use mathematics as a guide to your recommendation – not the determination of your recommendation.

Current Mexico Swine Flu Outbreak Mortality Rates

Week	Novel Flu Virus (Number of People Infected)	Deaths of Confirmed H1N1 cases (Numbers of Deaths)
1	17	1
2	20	3
3	26	7

Source: WHO 4/26/09
http://www.who.int/csr/don/2009_04_26/en/index.html

Typical U.S. Seasonal Flu Mortality Rates

Week	Seasonal Influenza (Number of People Infected)	Deaths from Influenza & Pneumonia (Numbers of Deaths)
1	834	1
2	1667	2
3	3334	4

Source: CDC

1918 Influenza Mortality Rates

Week	Influenza Cases (Number of People Infected)	Deaths from Influenza & Pneumonia (Numbers of Deaths)
1	11952	300
2	39841	1000
3	159363	4000
4	398406	10000
5	1992032	50000
6	7171315	180000
7	7968127	200000

Source: Fabricated nimbers based on historical reports.

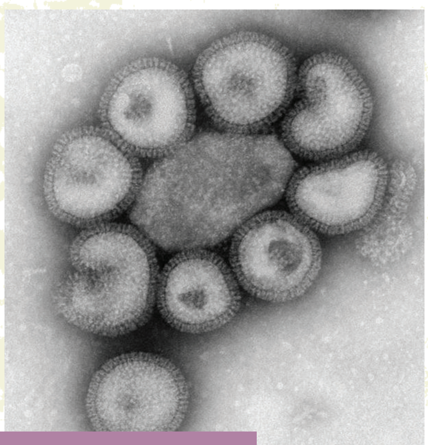
INFLUENZA

World Health Organization
Fact sheet N°211
Revised March 2003

Overview

Influenza is caused by a virus that attacks mainly the upper respiratory tract – the nose, throat and bronchi and rarely also the lungs. The infection usually lasts for about a week. It is characterized by sudden onset of high fever, myalgia, headache and severe malaise, non-productive cough, sore throat, and rhinitis. Most people recover within one to two weeks without requiring any medical treatment. In the very young, the elderly and people suffering from medical conditions such as lung diseases, diabetes, cancer, kidney or heart problems, influenza poses a serious risk. In these people, the infection may lead to severe complications of underlying diseases, pneumonia and death.

Influenza rapidly spreads around the world in seasonal epidemics and imposes a considerable economic burden in the form of hospital and other health care costs and lost productivity. In the United States of America, for example, recent estimates put the cost of influenza epidemics to the economy at US$ 71-167 billion per year.



This negative-stained transmission electron micrograph (TEM) depicts the ultrastructural details of a number of influenza virus particles, or "virions". Source: CDC/ Dr. F. A. Murphy [via pingnews]. ID#: 8432

In annual influenza epidemics 5-15% of the population are affected with upper respiratory tract infections. Hospitalization and deaths mainly occur in high-risk groups (elderly, chronically ill). Although difficult to assess, these annual epidemics are thought to result in between three and five million cases of severe illness and between 250,000 and 500,000 deaths every year around the world. Most deaths currently associated with influenza in industrialized countries occur among the elderly over 65 years of age.

Much less is known about the impact of influenza in the developing world. However, influenza outbreaks in the tropics where viral transmission normally continues year-round tend to have high attack and case-fatality rates. For example, during an influenza outbreak in Madagascar in 2002, more than 27,000 cases were reported within three months and 800 deaths occurred despite rapid intervention. An investigation of this outbreak, coordinated by the World Health Organization (WHO), found that there were severe health consequences in poorly nourished populations with limited access to adequate health care (see "Outbreak of influenza, Madagascar, July-August 2002",Weekly Epidemiological Record). It is not possible to extrapolate the exact annual burden of influenza in the tropics from data from such occasional and severe outbreaks.

The virus

The currently circulating influenza viruses that cause human disease are divided into two groups: A and B. Influenza A has 2 subtypes which are important for humans: A(H3N2) and A(H1N1), of which the former is currently associated with most deaths. Influenza viruses are defined by 2 different protein components, known as antigens, on the surface of the virus. They are spike-like features called haemagglutinin (H) and neuraminidase (N) components.

The genetic makeup of influenza viruses allows frequent minor genetic changes, known as antigenic drift, and these changes require annual reformulation of influenza vaccines.

Pandemic influenza

Three times in the last century, the influenza A viruses have undergone major genetic changes mainly in their H-component, resulting in global pandemics and large tolls in terms of both disease and deaths. The most infamous pandemic was "Spanish Flu" which affected large parts of the world population and is thought to have killed at least 40 million people in 1918-1919. More recently, two other influenza A pandemics occurred in 1957 ("Asian influenza") and 1968 ("Hong Kong influenza") and caused significant morbidity and mortality globally. In contrast to current influenza epidemics, these pandemics were associated with severe outcomes also among healthy younger persons, albeit not on such a dramatic scale as the "Spanish flu" where the death rate was highest among healthy young adults.

Most recently, limited outbreaks of a new influenza subtype A(H5N1) directly transmitted from birds to humans have occurred in Hong Kong Special Administrative Region of China in 1997 and 2003.

Transmission

The virus is easily passed from person to person through the air by droplets and small particles excreted when infected individuals cough or sneeze. The influenza virus enters the body through the nose or throat. It then takes between one and four days for the person to develop symptoms. Someone suffering from influenza can be infectious from the day before they develop symptoms until seven days afterwards.

Disease spreads very quickly among the population especially in crowded circumstances. Cold and dry weather enables the virus to survive longer outside the body than in other conditions and, as a consequence, seasonal epidemics in temperate areas appear in winter.

A health worker gives a child an immunization

Source: PATH

Diagnosis

Respiratory illness caused by influenza is difficult to distinguish from illness caused by other respiratory pathogens on the basis of symptoms alone. However, during laboratory-confirmed influenza outbreaks, the majority of persons seeking medical advice for upper respiratory tract infections are likely to be infected by influenza. Laboratory confirmation will be required between annual influenza epidemics. Rapid diagnostic tests have recently become available that can be used to detect influenza viruses within 30 minutes.

Despite the availability of rapid diagnostic tests, the collection of clinical specimens for viral culture remains critical to provide information regarding circulating influenza subtypes and strains. This is needed to guide decisions regarding influenza treatment and chemoprophylaxis and to formulate vaccine for the coming year.

Pevention: Influenza vaccines

Vaccination is the principal measure for preventing influenza and reducing the impact of epidemics. Various types of influenza vaccines have been available and used for more than 60 years. They are safe and effective in preventing both mild and severe outcomes of influenza (see WHO position paper, "Influenza vaccines", Weekly Epidemiological Record). It is recommended that elderly persons, and persons of any age who are considered at "high risk" for influenza-related complications due to underlying health conditions, should be vaccinated. Among the elderly, vaccination is thought to reduce influenza-related morbidity by 60% and influenza-related mortality by 70-80%. Among healthy adults the vaccine is very effective (70-90%) in terms of reducing influenza morbidity, and vaccination has been shown to have substantial health-related and economic benefits in this age group. The effectiveness of influenza vaccine depends primarily on the age and immunocompetence of the vaccine recipient and the degree of similarity between the viruses in the vaccine and those in circulation. Influenza vaccination can reduce both health-care costs and productivity losses associated with influenza illness. (see "Recommendations for the use of inactivated influenza vaccines and other preventive measures", Weekly Epidemiological Record).

All current inactivated influenza vaccines contain trace levels of egg protein and should not be used by individuals with egg protein allergies.

Constant genetic changes in influenza viruses mean that the vaccines' virus composition must be adjusted annually to include the most recent circulating influenza A(H3N2), A(H1N1) and influenza B viruses.

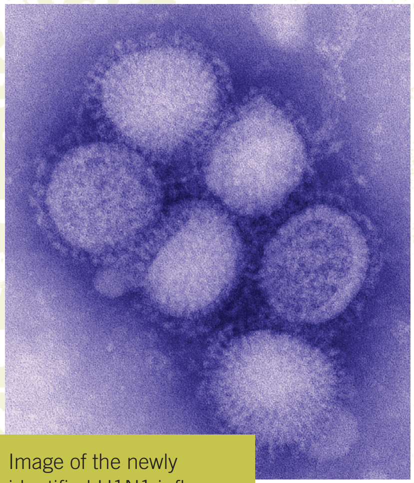


Image of the newly identified H1N1 influenza virus, taken in the CDC Influenza Laboratory. Source: CDC

The WHO's Global Influenza Surveillance Network writes the annual vaccine recipe. The network, a partnership of 112 National Influenza Centres in 83 countries, is responsible for monitoring the influenza viruses circulating in humans and rapidly identifying new strains. Based on information collected by the Network, WHO recommends annually a vaccine that targets the 3 most virulent strains in circulation.

Treatment and prophylaxis: Antiviral agents

For most people influenza is an upper respiratory tract infection that lasts several days and requires symptomatic treatment only. Within days, the person's body will eliminate the virus. Antibiotics, such as penicillin, which are designed to kill bacteria, cannot attack the virus. Therefore antibiotics have no role in treating influenza in otherwise healthy people although they are used to treat complications.

Antiviral drugs for influenza are an important adjunct to influenza vaccine for the treatment and prevention of influenza. However, they are not a substitute for vaccination. For several years, four antiviral drugs that act by preventing influenza virus replication have been available. They differ in terms of their pharmacokinetics, side effects, routes of administration, target age groups, dosages, and costs.

When taken before infection or during early stage of the disease (within two days of illness onset), antivirals may help prevent infection, and if infection has already taken hold, their early administration may reduce the duration of symptoms by one to two days.

For several years, amantadine and rimantadine were the only antiviral drugs. However, whilst relatively inexpensive, these drugs are effective only against type A influenza, and may be associated with severe adverse effects (including delirium and seizures that occur mostly in elderly persons on higher doses). When used for prophylaxis of pandemic influenza at lower doses, such adverse events are far less likely. In addition, the virus tends to develop resistance to these drugs.

A new class of antivirals, the neuraminidase inhibitors, has been developed. Such drugs, zanamivir and oseltamivir, have fewer adverse side effects (although zanamivir may exacerbate asthma or other chronic lung diseases) and the virus less often develops resistance. However, these drugs are expensive and currently not available for use in many countries.

In severe influenza, admission to hospital, intensive care, antibiotic therapy to prevent secondary infection and breathing support may be required.

Credit: Reproduced with permission of WHO. Available from http://www.who.int/mediacentre/factsheets/fs211/en/index.html.

Swine Flu Case Study – Part 1

KEY

Current Mexico Swine Flu Outbreak Mortality Rates

Week	Novel Flu Virus (Number of People Infected)	Deaths of Confirmed H1N1 cases (Numbers of Deaths)
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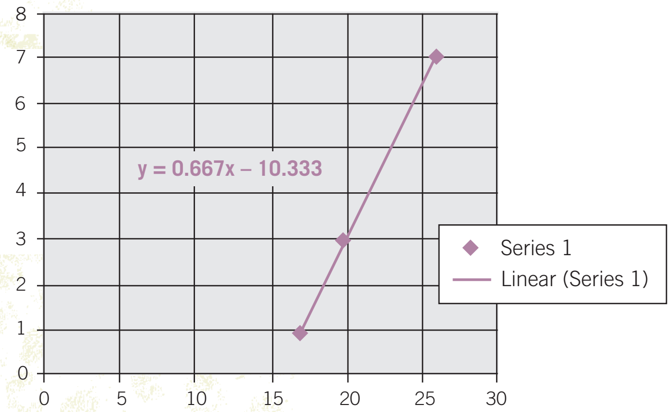
3	26	7

Source: WHO 4/26/09
http://www.who.int/csr/don/2009_04_26/en/index.html



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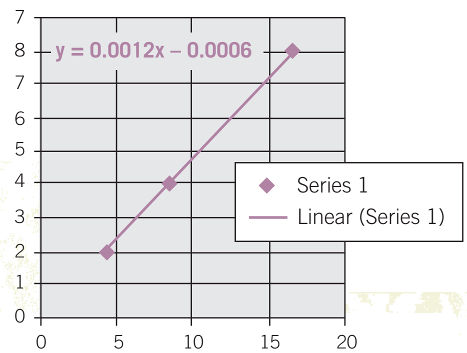

1918 Influenza Mortality Rates

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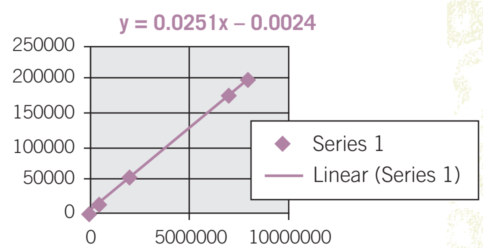


LESSON 2:
H1N1 Mortality Rates

Activity Time: 100 minutes

In this lesson, students use CDC data to predict the severity of an H1N1 outbreak both in terms of infection rates and mortality rates. Before delivering this lesson, students should know how to graph data and how to find the slope and intercept.

This lesson should be presented immediately following the *Swine Flu Case Study* math lesson. This math lesson also compliments the U.S. History lesson plans: *"Spanish Flu" Pandemic of 1918*, *What Worked and What Didn't?*, and *Swine Flu: Learning from 1976*, all which examine the role of government in responding to disease outbreaks.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Linear Approximations**: We can make short term predictions using linear approximations from data, although some data is too non-linear to have an accurate prediction from a linear best-fit line.
- **Mortality Rates**: One of the factors that determines if an influenza virus is considered endemic, epidemic, or pandemic is the mortality rate.
- **Decision-Making**: Mathematical data, such as infection rates and mortality rates, are important tools used by decision-makers faced with an outbreak of an infectious diseases.

Essential Question:

- Should the government respond the same way to a disease that has a high infection rate (infectivity) as to a disease that causes severe symptoms (severity)?

Learning Objectives:

Students will know…

- Mortality rate is the number of people killed by a disease divided by the number of people infected.
- Infectivity of a disease is how rapidly a disease spreads.
- Severity of a disease is how sick people get from the disease.
- Infectivity and severity are not always related.

Students will be able to…

- Draw a best-fit line to linearly correlated data.
- Decide if a line is appropriate for a data set based on the graph.
- Make a prediction based on a best-fit line.
- Find the slope and intercept of a best-fit line.
- Interpret the meaning of the slope and horizontal or vertical intercept of a best-fit line.

Vocabulary:

- Best-fit line
- Infectivity
- Influenza
- Intercept
- Mortality rate
- Severity
- Slope

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.C** Evaluate a solution for reasonableness, verify its accuracy, and interpret the solution in the context of the original problem.
- **A2.8.D** Generalize a solution strategy for a single problem to a class of related problems and apply a strategy for a class of related problems to solve specific problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.
- **A2.8.F** Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
- **A2.8.H** Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.

Common Student Preconceptions:

- Vaccines are all old; they are not developed each season.
- Vaccines cost little to develop.
- Once you get a vaccine, you won't get the disease.
- Influenza is "influence" in Spanish.
- The flu is just a really bad cold.
- Only old people die from the flu.
- You get the flu from being cold.

TEACHER PREPARATION

Materials:

- *Swine Flu Case Study—Part II* Handout (1 per student)
- *U.S. Cumulative Infection and Mortality Rates* Handout (1 per student)
- *California, Illinois, and New York Cumulative H1N1 Cases* Handout (1 per group)
- Teacher Answer Key for Student Handouts

Preparation:

- Due to the lesson's complexity, we are not using a regression method (such as least-squares fit) to find a line of best fit. Therefore, it is essential that you go through each graph and creates a line of best-fit. For graphs that have two distinct sections, choose the latter section and use only that data to draw a line of best-fit.
- Photocopy the Student Handouts.

PROCEDURE

Hook

1. Tell students that they are going to continue their work from yesterday's *Swine Flu Case Study* by analyzing more data and making a prediction.
2. Pass out copies of *Swine Flu Case Study—Part II* (1 per student).
3. Ask students to read the case study. Solicit student reactions to see what students are thinking about the case and the learning task.

Preconceptions

4. Lead a class discussion using the following questions:
   > How would you judge how wide a disease will spread?
   > How would you judge the severity or deadliness of a disease?
5. During the discussion, highlight the following points:
   > A very severe disease will kill more of the people that are infected.
   > A very infectious disease will infect many more people.
   > A disease can be very infectious, but not severe, such as a common cold.
   > A disease can be very severe, but not infectious, such as cancer.
6. Ask students if they can define the terms "infection rate" (the number of people infected with a flu strain, divided by the total population) and "mortality rate" (the number of deaths attributed to a flu strain divided by the total number of infected people).

Case Study

7. Ask students to gather back into the same groups (of 2 or 3 students each) that they were in yesterday when working on the *Swine Flu Case Study—Part I*. Pass out copies of *U.S. Cumulative Infection and Mortality Rates* Handout (1 per student) and *California, Illinois, and New York Cumulative H1N1 Cases* Handout (1 per group).

Modeling

8. Help students to understand the graphs that they will be working with by modeling how to draw a best-fit line.
9. First, use the U.S. Cumulative graphs to show how to draw a best-fit line. Begin with *U.S .Cumulative H1N1 Mortality Rate* (as of May 28, 2009). Draw a box around most of the data points, with the box being on an angle. The line of best-fit will split this box in half lengthwise. Then, students can do a quick check to see if there are almost the same number of points in the top half of the box as the bottom half.
10. Find the slope and intercept of this line. Then, write the equation for the line, and discuss the meaning of the slope and intercept:
    > **Slope**: #dead / #infected (this is the mortality rate, how severe the disease is).
    > **X-intercept**: when the disease became deadly.
    > **Y-intercept**: how many people were dead at the beginning of data recording.
11. Next, use *U.S. Cumulative H1N1 Mortality (vs. Days)* to show when a best-fit line will not work well. Follow the same procedure as above (you will end up with a very large box). When the line is drawn, ask students what they observe:
    > The points above the line will be only at the beginning and end.
    > The data is clearly curved, but the line is not.
    > Any prediction from that line will be too low.

12. Caution students that this is not linear, so we can't use all of the points to make a prediction.
13. Ask students to plot where they think the next point will be. This can be based on the pattern they observe, without the pattern being formalized.
14. Finally, use the *U.S. Cumulative H1N1 Infected Cases (vs. Days)* graph to show that we can sometimes use an end section of data to draw a best-fit line. Ask students if this data is linear or non-linear (curved).
15. Cover the first ½ of the graph, and ask students the linear/non-linear question again.
16. Proceed to box the last 5 data points, and draw a line of best-fit. Ask students to judge the quality of this fit line for predictions. Will it work for predicting what happens on day 80? 100? 200?

Group Work

17. Remind students of their expectations. In a written format, they need to include the following elements in their final recommendation:
    > They will find the best-fit lines for each graph, selecting which part of the graph to use (at least 5 points).
    > They will write the equation for each best-fit line, and explain the meaning of the slope, x-intercept and y-intercept.
    > They will predict what will happen to the # infected and # dead in the next 1 month, 3 months, and 6 months.
    > They will give a subjective confidence in each prediction (%).
    > They will recommend a response level from the CDC Pandemic Flu Response document.
    > They will explain any dissenting views within their group.

Wrap-Up

18. Encourage students to share their recommendations. As a class, discuss some of the following issues that people need to consider when using mathematical data to guide decision-making:
    > Making a decision based on predictions.
    > Weighing mathematical predictions with other information.
    > Evaluating the reliability of a prediction.
    > Generalization of conclusions.
19. In addition, you may wish to discuss with students what the government's actual response was to the 1918 flu pandemic, the 1976 swine flu outbreak, and/or the 2009 swine flu pandemic.

STUDENT ASSESSMENT

Assessment Opportunities:

- During group work time, look for evidence that the learning targets are being met. Depending on what you choose to emphasize in this lesson, the following content may be taught:
    > Lines of best fit.
    > Linear functions.
    > The meaning of slope.
    > Epidemic vs. endemic vs. pandemic.
    > Severity of typical influenza.
    > Making a decision based on predictions.
    > Weighing mathematical predictions with other information.
    > Considering the backlash against a government over-reaction.
    > Exploring the monetary value of a human life.
    > Seeing how death rates for different age groups will indicate the severity of a flu strain.
    > Evaluating the reliability of a prediction.
    > Generalization of conclusions.
    > Presenting data in a logical form.

Student Metacognition:

- During group work time, visit each group and ask students to give a status report.

Scoring Rubric:

- Participation points can be assigned for working in groups and contributing to class discussions. A scoring rubric can also be developed to assign points for each group's prediction and recommendation.

EXTENSION ACTIVITIES

Extension Activities:

- Show students the CDC FluView website http://www.cdc.gov/flu/weekly/ and discuss the decrease in flu cases over the summer.
  - > How will this effect their predictions?
  - > Will this flu strain return in the winter?
  - > Would the severity of the H1N1 flu now mean a greater response in the winter?
- This math lesson compliments the U.S. History lesson plans: *"Spanish Flu" Pandemic of 1918, What Worked and What Didn't?*, and *Swine Flu: Learning from 1976*, all which examine the role of government in responding to disease outbreaks.

Adaptations:

- As this is a group work activity, intentional grouping of students with varied ability will provide some support to ELL or SPED students.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, the Resources section below offers a list of helpful websites.

Resources:

CDC FluView
http://www.cdc.gov/flu/weekly/

CDC Swine Flu Press Conference
4/25/09, CNN, 4:24 minutes
http://www.youtube.com/watch?v=hE5qGOd8U48

CDC Flu Activity & Surveillance (Updated Weekly)
http://www.cdc.gov/flu/weekly/fluactivity.htm

CDC Novel H1N1 Flu Situation Update (Updated Regularly)
http://www.cdc.gov/h1n1flu/update.htm

WHO Seasonal Influenza Fact Sheet
http://www.who.int/mediacentre/factsheets/fs211/en/

WHO Number of Laboratory-Confirmed Cases of Pandemic H1N1 2009 (Updated Regularly)
http://gamapserver.who.int/h1n1/atlas.html?select=ZZZ&filter=filter4,confirmed

WHO Influenza A (H1N1) Update
http://www.who.int/csr/don/2009_06_24/en/index.html

Credit:

Data from CDC.

Name:____________________________ Date:___________ Period:________

Swine Flu Case Study – Part 2

HANDOUT

"I'm really pleased with your work on the swine flu outbreak so far," your boss had told you. "How would you like to stay on the team and analyze the latest reports from the field?"

Those words are still bouncing around in your head as you return back to your office. What a compliment! You did some work at the very beginning of the outbreak, and now it looks like your team will be on the very forefront of this disease.

Your team of epidemiologists at the Centers for Disease Control (CDC) has been watching the progress of an unusual swine flu virus for two months now, and the President is demanding that you make adjustments to your previous recommendation for action. Now that time has passed, you have more data for how this flu strain is spreading across the United States and the entire globe.

Unfortunately, this time the data is not quite so clean. Because you have field reports from around the United States, you need to do some data analysis and make a prediction of what will likely happen in the next few weeks.

Sitting at your desk, you flip through the files that your boss just emailed you. The field reports provide information from three states, as well as data for the U.S. as a whole.

Here's what you have to work with:

- New York Longitudinal Mortality Data graph
- California Longitudinal Mortality Data graph
- Illinois Longitudinal Mortality Data graph
- U.S. Cumulative H1N1 Mortality Data to Date graph

"You know what I like the best about this career?" your officemate asks. Before you have a chance to answer, she says, "I know that what I do here could actually save hundreds of lives."

"That's true," you say, "and I used to think that all of those math classes in school were going to be worthless. Here, it's the first objective way I have of looking at a situation."

"Well, this project is going to be a lot of work. We'd better start with the regional predictions."

"Okay," you agree. "Let's split up and come up with a linear function for each graph he gave us. Then we'll check each other's work and come up with a final recommendation."

You are challenged to analyze the data, make predictions, and present your recommendation. In order to decide on your recommendation, you will:

- Find the best-fit lines for each graph, selecting which part of the graph to use (at least 5 points).
- Write the equation for each best-fit line, and explain the meaning of the slope, x-intercept ,and y-intercept.
- Predict what will happen to the # infected and # dead in the next 1 month, 3 months, and 6 months.
- Give a subjective confidence for each prediction (%).
- Recommend a response level from the CDC Pandemic Flu Response document.
- Explain any dissenting views within your group.

CDC GOVERNMENT PANDEMIC FLU RESPONSE LEVELS

Phase 1 – Caution & Evaluation

Encourage hand washing as typical flu reminder

Contact WHO

Contact hospitals in major cities for increased flu samples

Contact Disease Control for other countries

Send out field agents to Mexico for evaluation of the severity

Phase 2 - Public Notification

Stockpile anti-viral

Jump-start vaccine production

Encourage people to stay indoors

Encourage hand washing and higher levels of sanitation for public locations

Phase 3 – Epidemic Response

Doctors must track disease

Recommend reduced travel for public

Temporary (5 day) school closures in infected locations

Recommend cancellation of some public events

Public information campaign

Stockpile vaccines

Governments-run vaccination campaign

Phase 4 – Pandemic Response

Close borders

Close airports

Enact Martial Law

Government-mandated vaccination campaign

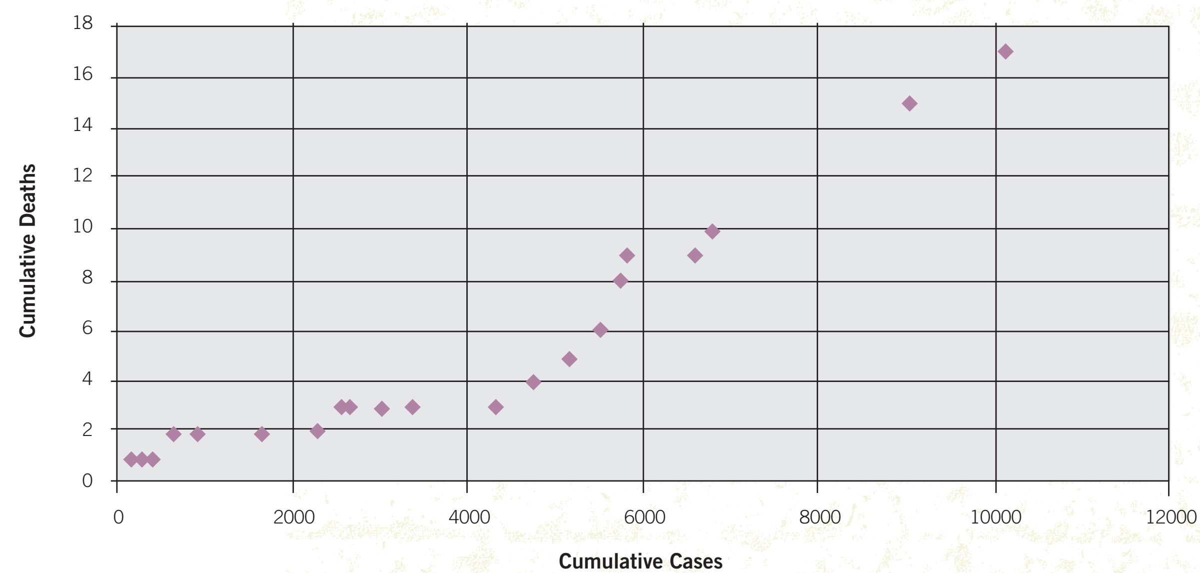
Freak out!

Name:____________________ Date:__________ Period:________

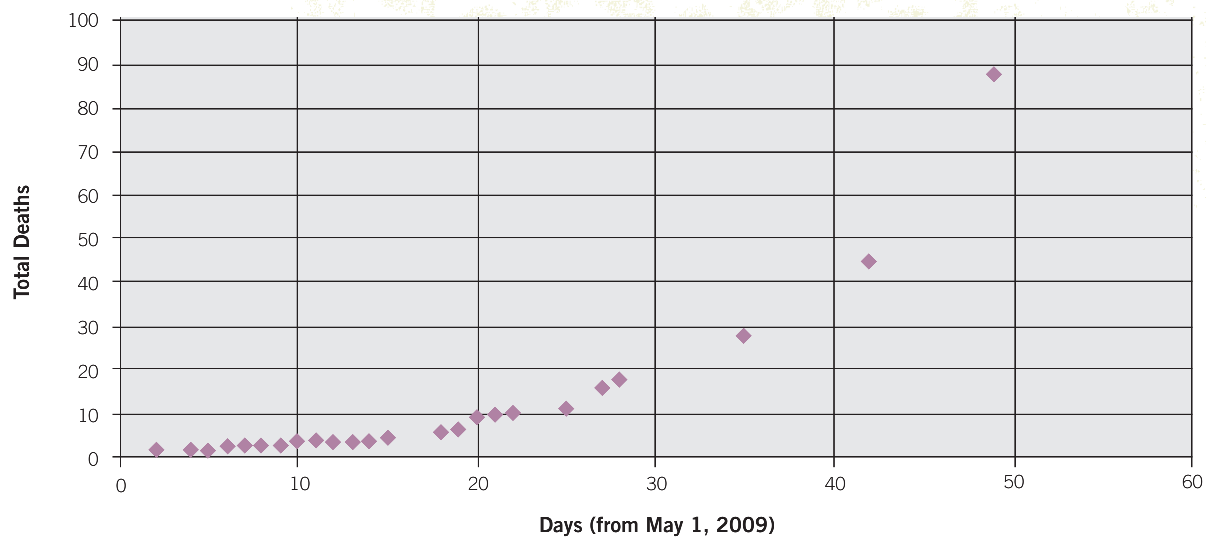
U.S. Cumulative Infection & Mortality Rates

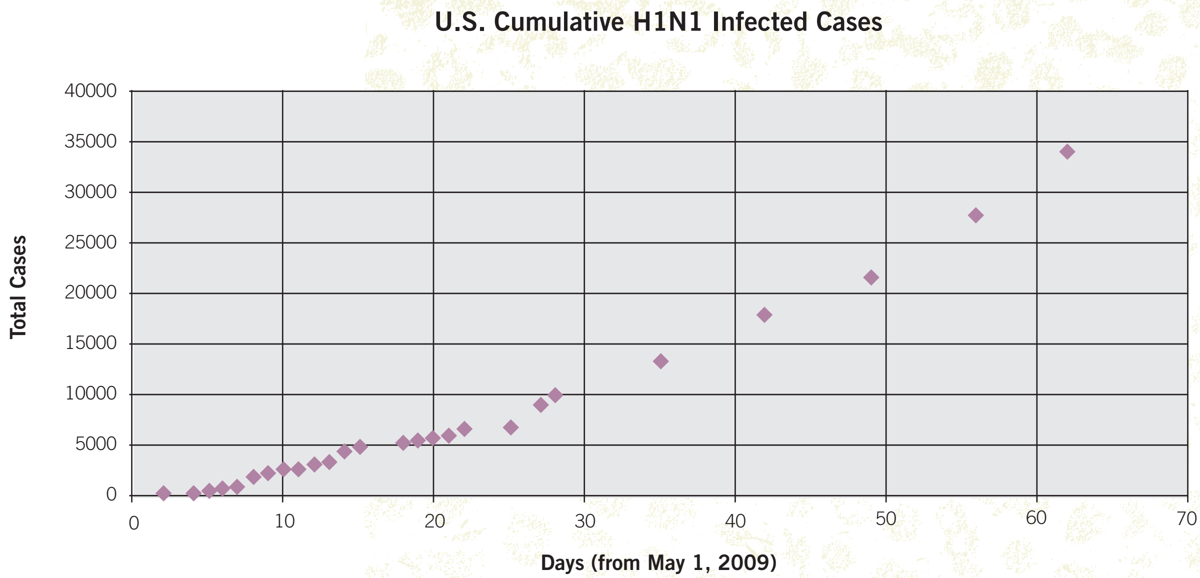
HANDOUT

U.S. Cumulative H1N1 Mortality Rate (as of May 28, 2009)



U.S. Cumulative H1N1 Mortality



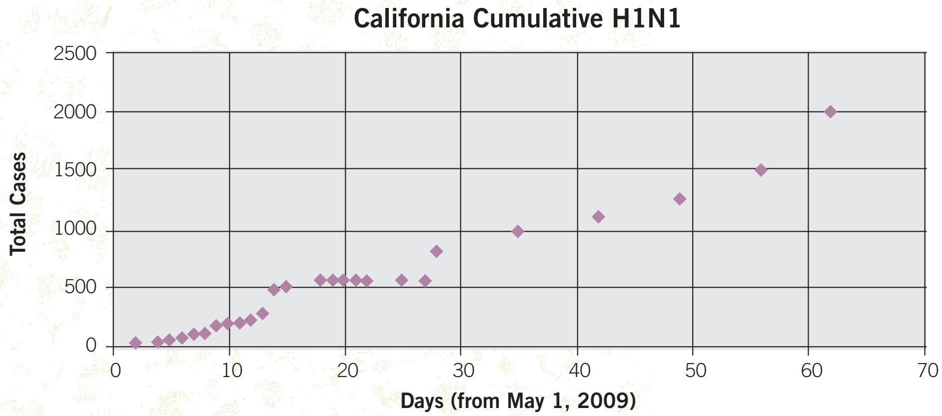

U.S. Cumulative H1N1 Infected Cases
Total Cases
40000
35000
30000
25000
20000
15000
10000
5000
0
0
10
20
30
40
50
60
70
Days (from May 1, 2009)

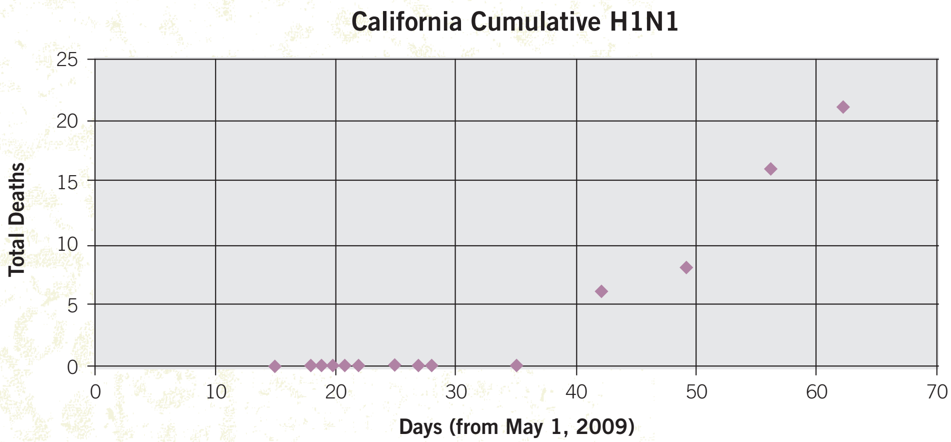
Name:______________________________ Date:____________ Period:_________

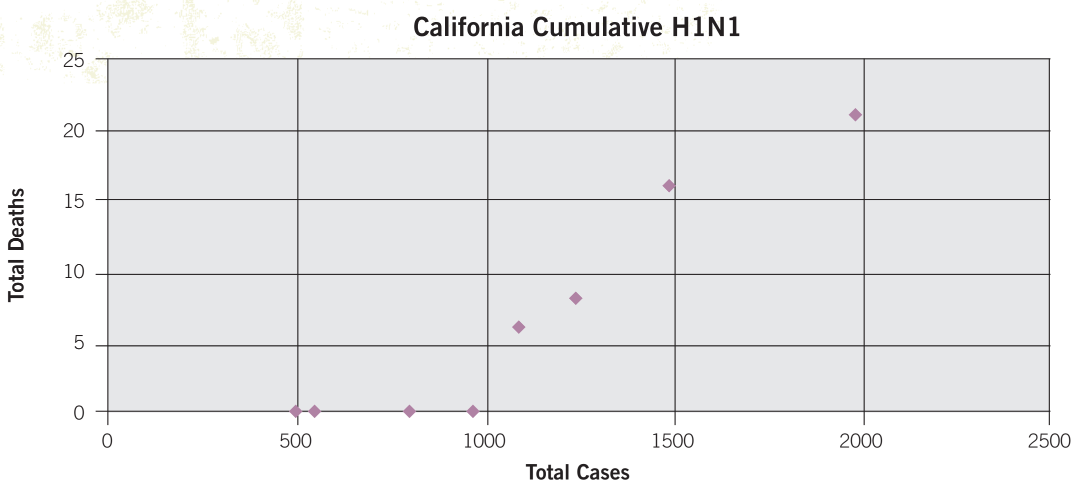
California, Illinois & New York Cumulative H1N1 Cases

HANDOUT

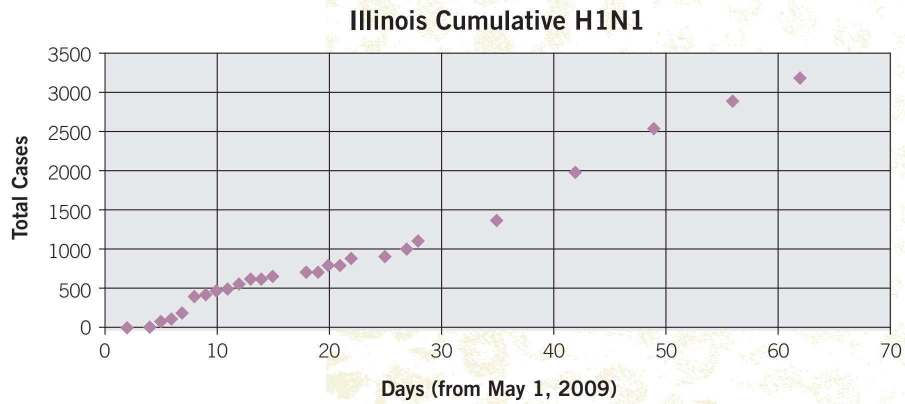
CALIFORNIA DATA

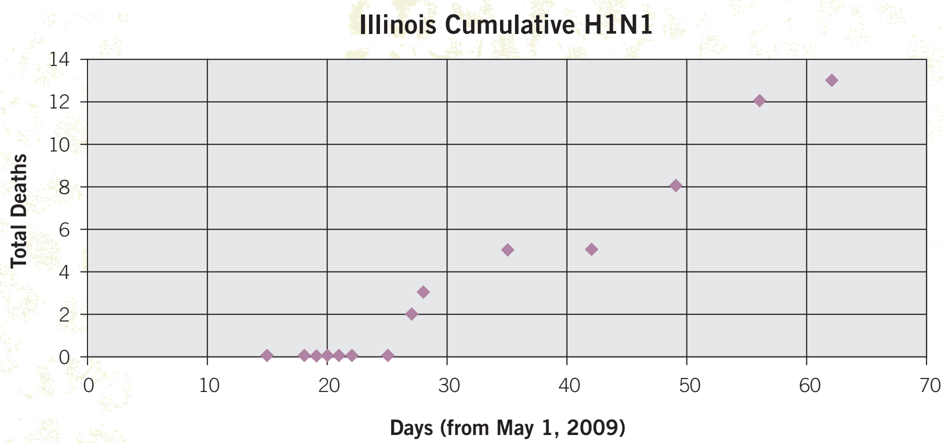


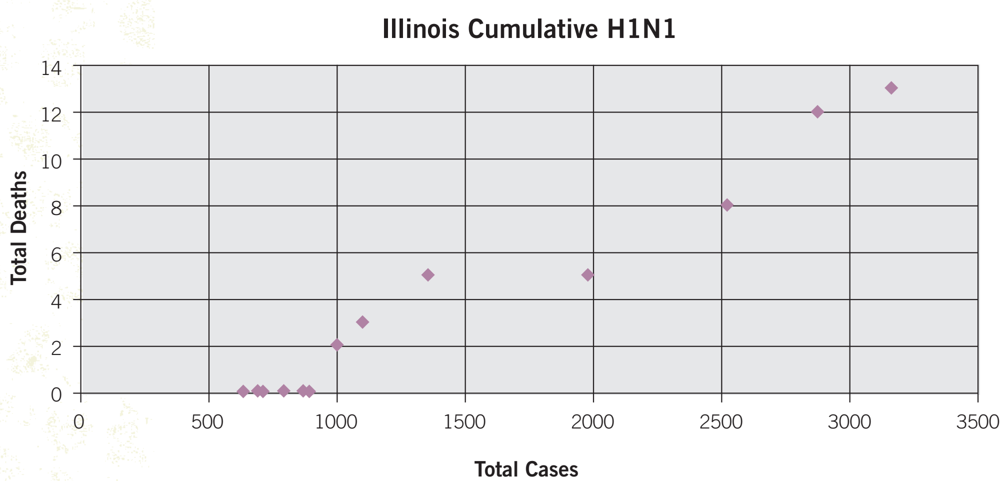




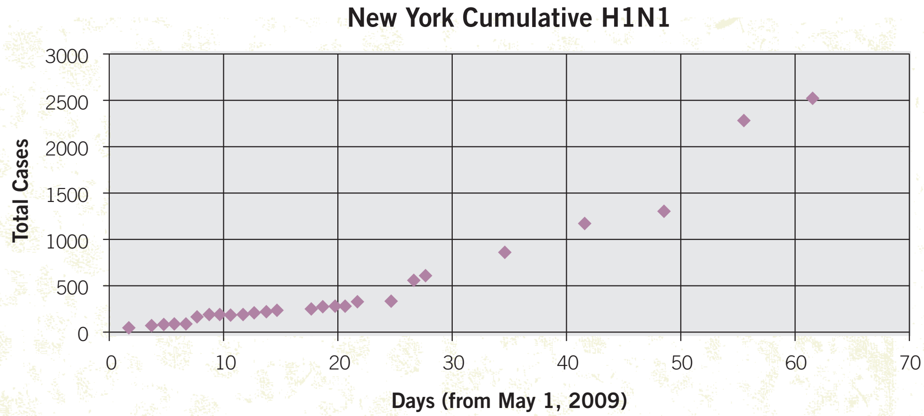
ILLINOIS DATA

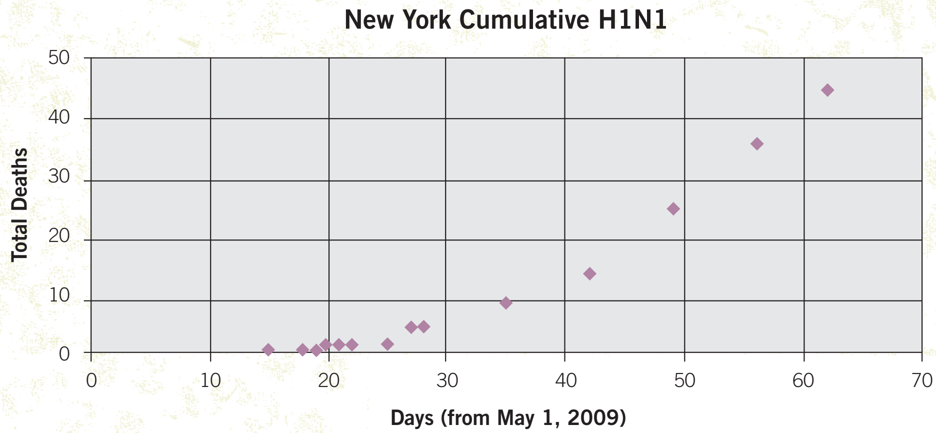


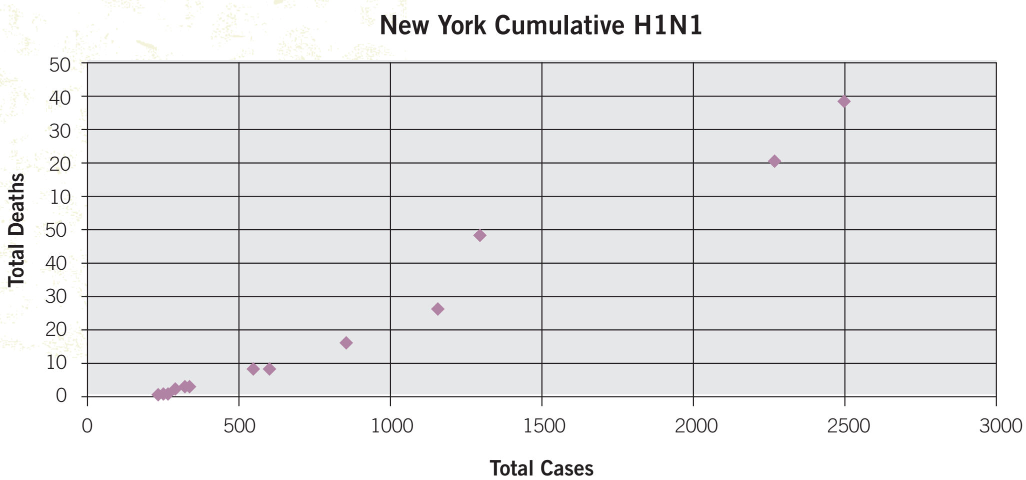




NEW YORK DATA

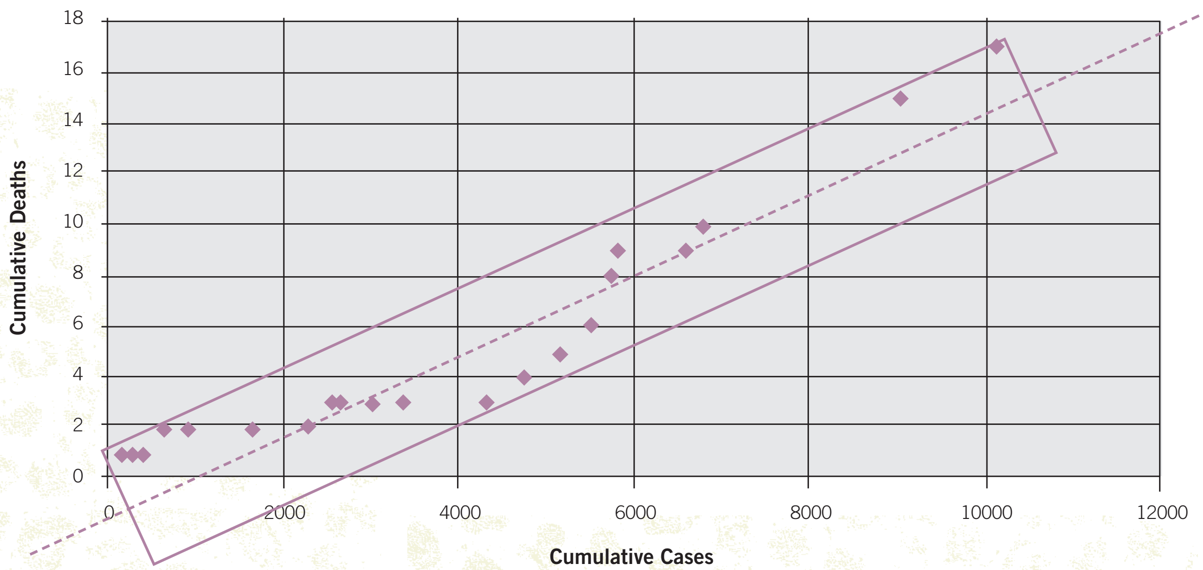




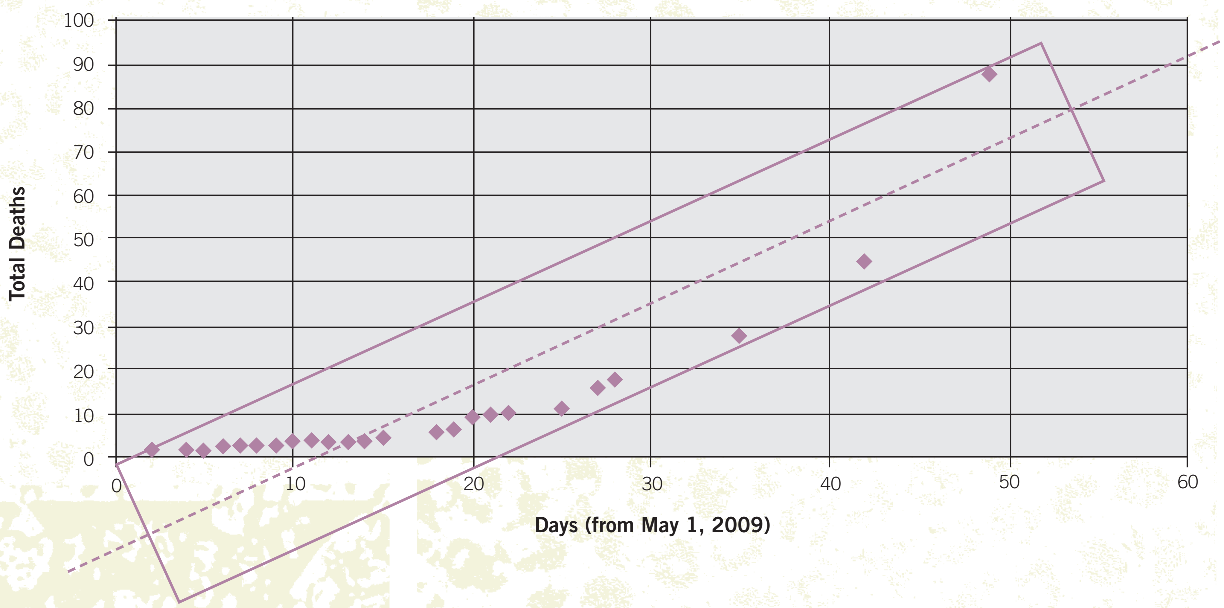


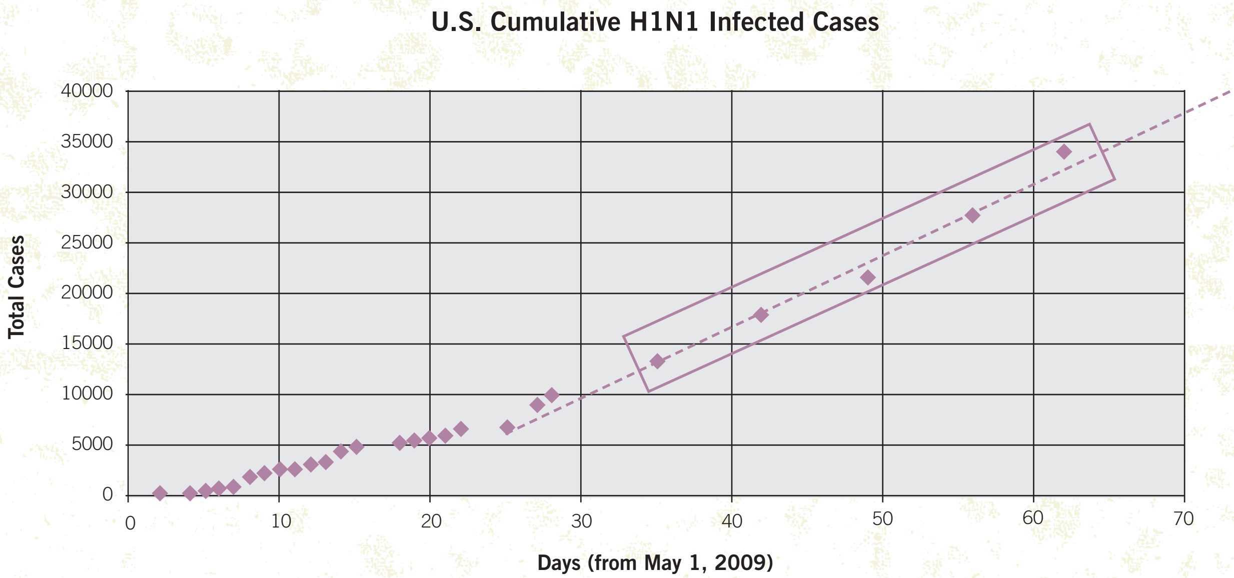
Swine Flu Case Study – Part 2

U.S. Cumulative H1N1 Mortality Rate (as of May 28, 2009)

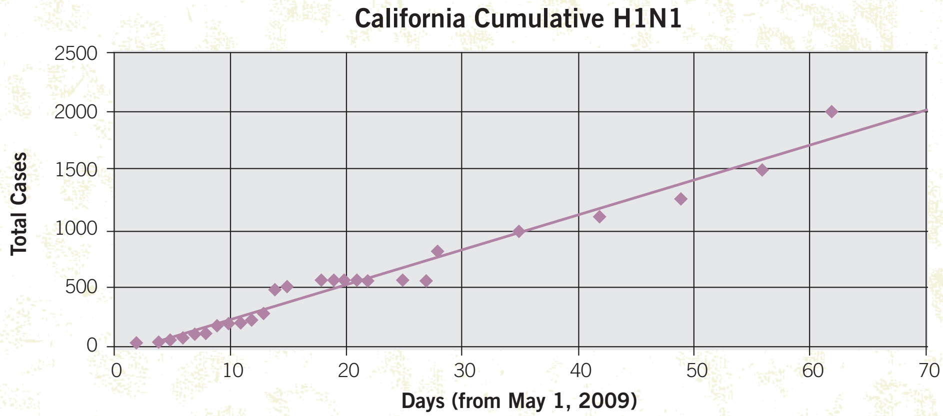


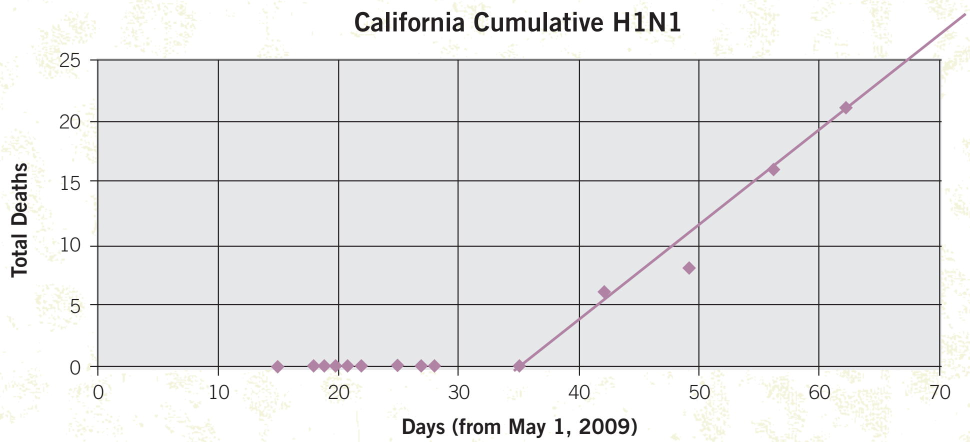
U.S. Cumulative H1N1 Mortality

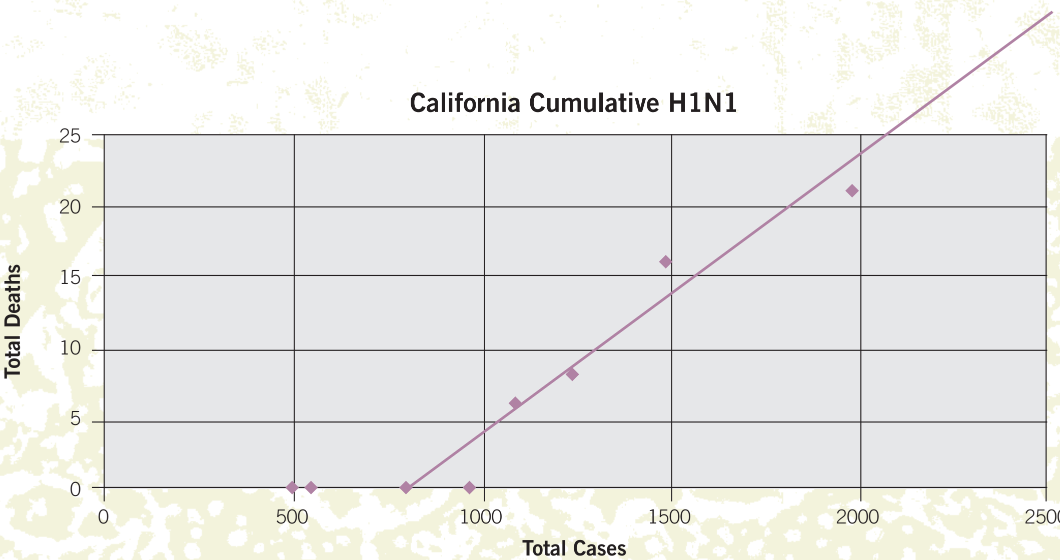



U.S. Cumulative H1N1 Infected Cases
Total Cases
40000
35000
30000
25000
20000
15000
10000
5000
0
0
10
20
30
40
50
60
70
Days (from May 1, 2009)

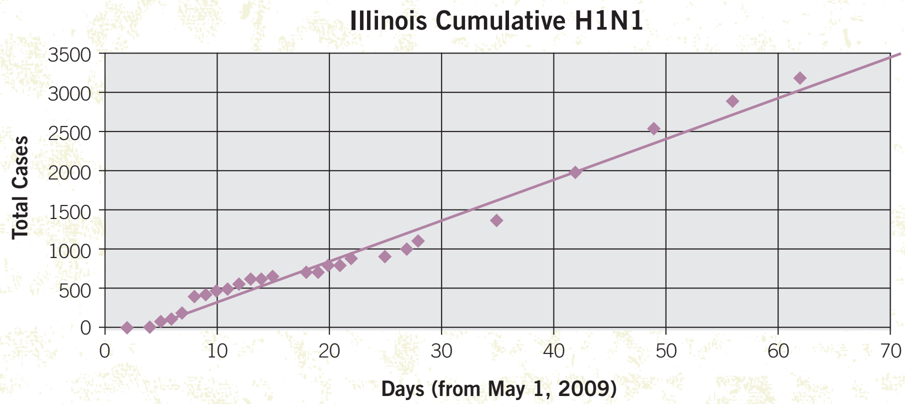
CALIFORNIA DATA

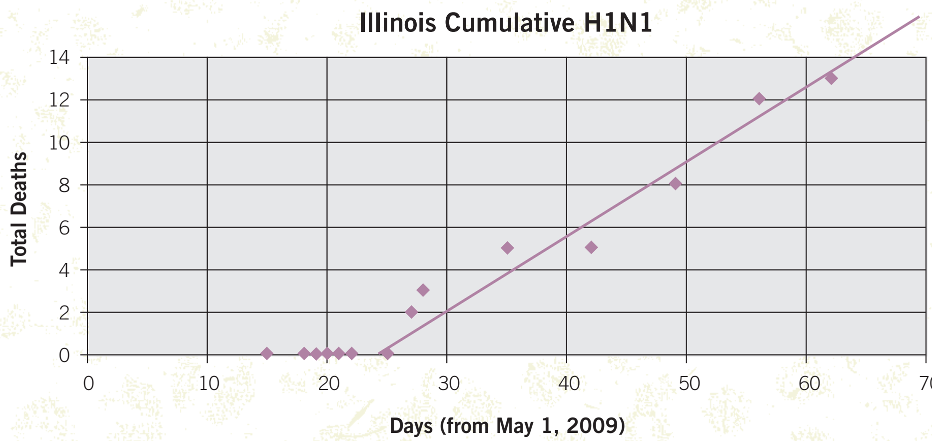


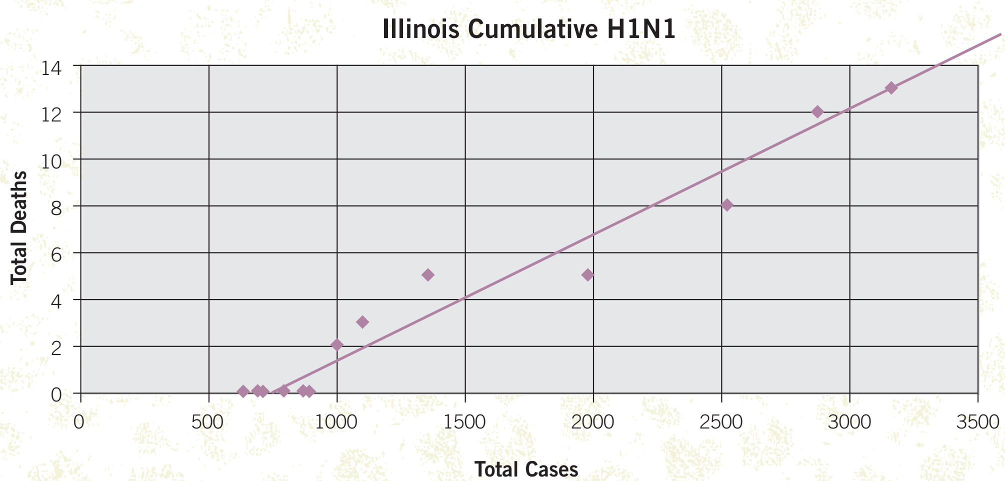




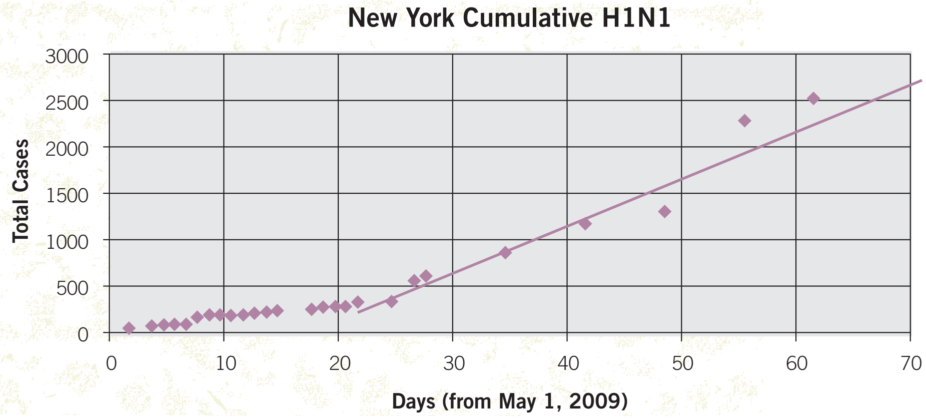
ILLINOIS DATA

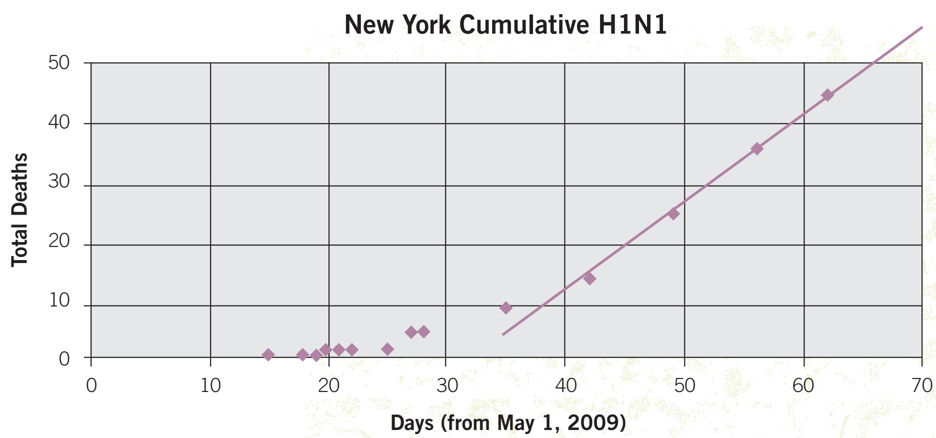


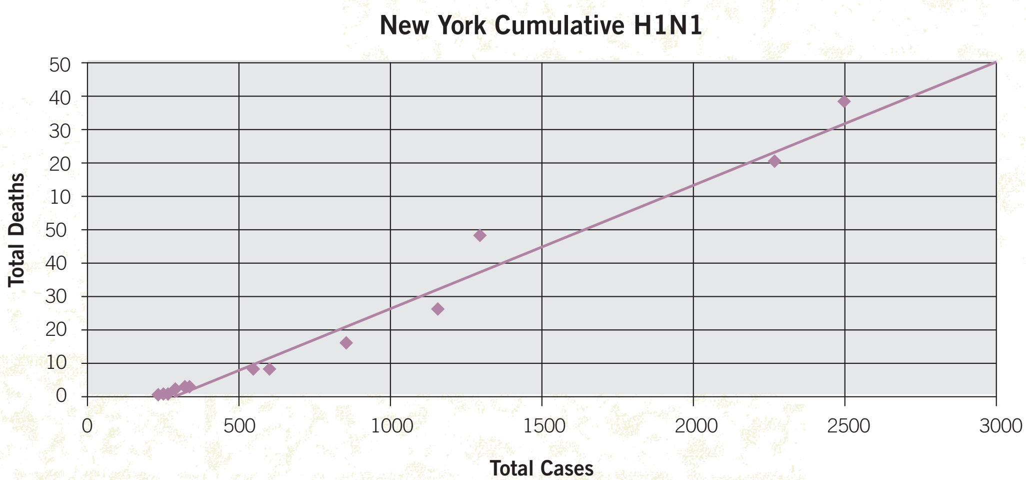




NEW YORK DATA







LESSON 3: Outbreak in Infectburg

Activity Time: 100 minutes

In this lesson, students will solve systems of equations using graphing, equations, charts or pictures. They will use these solutions to guide their logistical planning to respond to an influenza outbreak in a rural town called Infectburg.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Systems of Equations**: Systems of equations are useful tools when considering situations with multiple related variables.

Essential Question:

- How will we protect a small town from an infectious virus?

Learning Objectives:

Students will know…

- Anti-virals are used to combat influenza, but are most effective when used within 1-2 days of infection.
- Vaccines are used to combat influenza, but work best used before exposure to the virus.

Students will be able to…

- Set up a system of equations to solve a problem with two variables and constraints.
- Solve a system of equations using graphs.
- Solve a system of equations using equations.

Vocabulary:

- Anti-viral
- Constraint
- Dose
- Influenza
- Vaccine
- Variable
- Virus

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.1.B** Solve problems that can be represented by systems of equations and inequalities.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.C** Evaluate a solution for reasonableness, verify its accuracy, and interpret the solution in the context of the original problem.
- **A2.8.D** Generalize a solution strategy for a single problem to a class of related problems and apply a strategy for a class of related problems to solve specific problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.
- **A2.8.F** Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
- **A2.8.H** Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.

Common Student Preconceptions:

- Vaccines are all old, they are not being developed each season.
- Vaccines cost little to develop.
- Once you get a vaccine, you won't get the disease.
- Influenza is "influence" in Spanish.
- The flu is just a really bad cold.
- Only old people die from the flu.
- You get the flu from being cold.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- Graph paper
- Chart paper
- *Outbreak in Infectburg* Handout (1 per student)
- *Annual Influenza Vaccine Timeline* Handout (1 per student)
- Teacher Answer Keyfor Student Handouts

Preparation:

- Photocopy the Student Handouts.
- Run through the problems and find the solutions. Determine the amount of scaffolding your students require to be successful with this activity.

PROCEDURE

Hook

1. Show the trailer for the movie "Outbreak" about a hypothetical outbreak of a highly infectious disease.

   Outbreak trailer (1995, 1:57 minutes)
   http://www.youtube.com/watch?v=Mj9SUJdpJS4

Preconceptions

2. As a warm-up activity, ask students to make a list of all of the things that you would need to do in order to hand-deliver a package to a relative that lives more than one hour away. Indicate where you would have to spend money and how long the different steps would take. Ask students to share their lists.
3. Lead a class discussion about the things that are required in order to deliver health supplies to a remote location. Some ideas include:
   - Transportation
   - People to make the delivery
   - Food and water
   - Directions and maps
   - Supplies

Part One

4. Hand out copies of the *Outbreak in Infectburg* Handout, one per student. Read through Part One of the handout.
5. Explain what an anti-viral drug is and what it is used for. Use students' personal experiences with influenza vaccines and childhood vaccinations to talk about vaccines. If students haven't already read the *WHO Influenza Fact Sheet* provided in the *Swine Flu Case Study—Part One* lesson plan, it can be used to provide students with background information on vaccines and anti-viral drugs.
6. Explain that public health officials have to plan well in advance to be able to adequately respond to a new strain of seasonal influen-

za. Not only do public health officials need to plan the logistics of delivering and administering anti-virals and vaccines, but it can take up to a year to develop a novel influenza vaccine and stock-pile enough vaccines to be ready to respond to a serious outbreak. Hand out copies of the *Annual Influenza Vaccine Production Timeline* Handout and review the steps and time needed to be prepared for the seasonal flu each year.

7. Provide some guided practice for the students by running through the setup of the first problem together. The following diagram may be helpful for students to organize their equations:

	Variable: #anti-virals 'A'	Variable: #vaccines: 'V'
Constraint: Cost $20,000	$20 * A	$6 * V
Constraint: Treatments 5,600	3 * A	2 * V

8. Break students into pairs to answer the questions and solve the system. Encourage students to use graphs, tables, or pictures to justify their answers.
9. As students work in groups, monitor student progress. Be on the look out for the following components, which may be difficult for some students:
   - What to put on the axis of the graph.
   - 2 graphs vs. 1 graph.
   - Creating one equation with variable A and one with variable V.
   - Choosing the wrong variables.
10. After students have completed Part One of the handout, select and sequence two or three groups work to show multiple solution strategies. Try to show a graph, table or chart first. Then ask a group to present using elimination or substitution. Emphasize how the different representations show the same solution

Part Two

11. Read through Part Two of the handout with the students. Discuss the situation presented in the handout. Students may need to explain what an All-Terrain Vehicle (ATV) is, and why an ATV would be able to deliver the medications more quickly than the trucks.
12. Emphasize that students must show their solution using two different strategies.
13. Provide time for student groups to complete the problem and to share their solutions with the class.

Wrap-Up

14. Using the following prompt for an Exit Ticket: If you were a resident of Infectburg, what other problems or potential complications would you tell the CDC to plan for?

STUDENT ASSESSMENT

Assessment Opportunities:

- The discussions in the Preconceptions section of the lesson provide opportunities to capture students' preconceptions about the vaccines, anti-virals, and the complexities involved in delivering medical supplies to remote locations.
- The Exit Ticket prompts students' to think more deeply about the provided scenario and captures students' understanding of the complexities of the hypothetical scenario.
- During group work time, listen in on the groups' discussions for areas of difficulty, confusion, and understanding.
- The Student Handout can be graded.

Student Metacognition:

- After students have solved Part One of the handout, have them create a list of mis-steps that they had while solving the problem. Next to that list, have them list how they overcame or moved beyond their mistake or mis-step. Encourage students to use this list to guide their work on Part Two of the handout.

Scoring:

- Points can be assigned for the questions on the Student Handout. Participation points can also be assigned for working in groups and contributing to class discussions.

EXTENSION ACTIVITIES

Extension Activities:

- If students enjoyed this learning activity, then they may also enjoy the *Outbreak* lesson plan from the Cholera section of this curriculum. The *Outbreak* math lesson engages students in the investigation of a potential cholera outbreak in Mutoko, Zimbabwe.

Adaptations:

- As this is a group work activity, intentional grouping of students with varied ability will provide some support to ELL or SPED students.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Outbreak movie trailer
1995, 1:57 minutes
http://www.youtube.com/watch?v=Mj9SUJdpJS4

CDC Pandemic Flu
http://www.pandemicflu.gov/index.html

Credit:

Annual Vaccine Production Timeline reproduced with permission of Sanofi Pasteur Inc.

Name:________________________ Date:__________ Period:________

Outbreak in Infectburg

PART ONE

What happens when there is an outbreak of an infectious disease in a community? What types of logistical (planning) decisions need to be made by government officials in order to respond to the outbreak? The situation presented here is simplified, but the issues being considered are quite real.

The first situation deals with two tools that public health officials use to help prevent and control an influenza outbreak:

- **Vaccines** are used to help prevent people from getting sick from the flu. An influenza vaccine is basically deconstructed viruses that are injected into the body. These deconstructed viruses "teach" the body's immune system about the virus, so that the immune system will recognize the flu virus and react quicker when exposed to a contagious person.
- **Anti-virals** are drugs given to people after they have already caught influenza from a contagious person. Anti-virals reduce the severity of flu symptoms. These drugs work best when they are administered within 1-2 days of the appearance of flu symptoms.

Our situation unfolds when an influenza outbreak is detected in a rural, small town called Infectburg. The town of Infectburg is nestled in the rugged Cascade Mountains of Washington State, at the end of a paved road. You are a worker for the CDC responsible for planning a response plan.

You've been given a small budget of $20,000 and a truck to carry anti-viral drugs and vaccines.

You need to bring enough supplies to treat 5,600 people in the town. Each package of anti-viral medication contains 3 doses and will cost you $20. Each package of vaccines contains 2 doses and will cost you $6.

---

1. If you choose only to use the vaccines, how many packages would you need? How much of your budget would you use?

2. Given that vaccines work best if given well before a person is exposed to the virus, what is a drawback of this strategy?

3. If you choose only to use the anti-virals, how many packages would you need? How much of your budget would you use?

4. Given that anti-virals work best if given shortly after a person is exposed to the virus, what is a drawback of this strategy?

5. Your supervisor has informed you that your budget is use it or lose it. She's also told you that you should buy as many anti-viral doses as possible, while still treating 5,600 people. Use equations to find the number of anti-viral doses and vaccines that use your entire budget.

a. Determine your variables: what two quantities are you trying to determine?

b. Create two equations that include both variables. What quantities are given that relate to the variables you have chosen?

c. Using substitution or elimination, solve for one of the variables.

d. Using your known variable, solve for the other variable.

6. Once you have a solution using equations, justify your solution with graphs, tables, or a written explanation.

PART TWO

Now that you have delivered your supplies to Infectburg, you learn that 860 of the town's residents live out in the mountains surrounding the town. You must get treatment to these residents or the outbreak will not be contained. A group of Infectburg residents have volunteered to help you in your efforts by delivering medications to each resident. The CDC has given you 22 hours to complete this task, starting first thing tomorrow morning.

The next morning at 8:00 am, 30 locals show up at the meeting spot with two types of vehicles—all-terrain vehicles (ATVs) and 4x4 trucks—each of which can travel over different terrain. Those on ATVs can only carry one cooler that holds 20 doses, and need one driver to deliver all doses. Those in 4x4 trucks can carry one cooler that holds 60 doses, but for each truck you will use 2 drivers to deliver all doses.

Find the number of trucks and ATVs to use given your constraints. You may use any tool to solve the problem (graphs, pictures, tables, equations) but you must check your answer using a different tool (ex: graph to solve, table to justify/check).

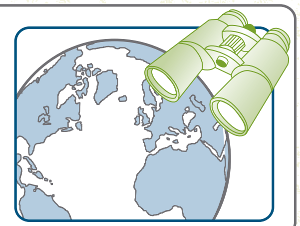
Name:___________________________ Date:__________ Period:________

Annual Influenza Vaccine Timeline

Step 1 — Surveillance

- Influenza vaccine protects against three prominent virus strains, which must first be identified before production can begin each year.
- Ongoing global surveillance is key to predicting which three strains will circulate each influenza season.

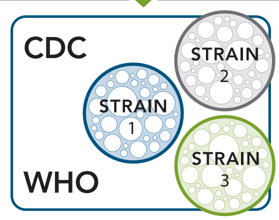
YEAR-ROUND



Step 2 — Strain Selection

- World health officials [1] analyze and identify the dominant circulating strains.
- The strains are submitted to the Food and Drug Administration (FDA) to recommend which three to include. The FDA distributes seed viruses to manufacturers to begin the production process.
- Manufacturers' scientists predict the circulating strains for the coming season and begin preparing vaccine at risk before final FDA selection. [2]

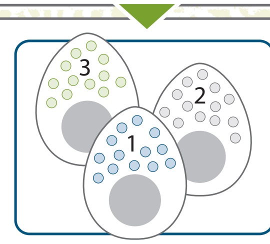
JANUARY-MARCH



Step 3 — Manufacturing and Production [3,4]

- Each virus strain is produced separately and later combined to make one vaccine.
- Millions of specially prepared chicken eggs are used to produce the vaccine. For seven months, fertilized eggs are delivered to the manufacturer. Each egg is cleaned with a disinfectant spray and injected with one strain.
- The eggs are incubated for several days to allow the virus to multiply. After incubation the virus-loaded fluid is harvested.

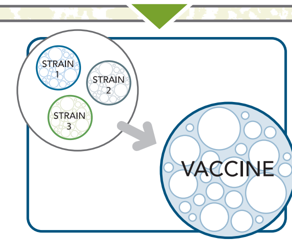
JANUARY-JULY



Step 4 — Purification and Testing [3,4]

- The virus fluid undergoes multiple purification steps and a special chemical treatment to ensure the virus is inactivated, or "killed." [5]
- The virus is split by chemically disrupting the whole virus.
- Viral fragments from all three strains are collected from different batches, and combined upon completion of quality control tests.
- Manufacturers and the FDA test the vaccine concentrate to determine amount and yield of the virus to ensure concentrate is adequate for immunization.

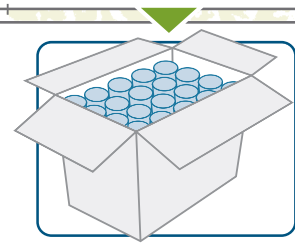
JUNE-OCTOBER



Step 5 — Filling and Packaging

- Upon FDA approval and licensing, the vaccine is released for distribution in time for immunization.
- Manufacturers begin filling the doses into vials and syringes, which are then sealed and carefully inspected before labels are applied to show the vaccine batch, lot numbers and expiration date.
- Each lot must be specifically "released" by the FDA before manufacturers can ship.

JULY-DECEMBER

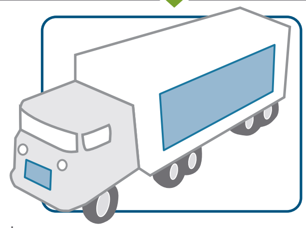


Step 6

Shipping

- Vaccine shipments typically begin in August/September and continue into November.
- With CDC's support, partial shipments are sent early in the season to all customers to ensure broad access for high-risk patients.
- Depending on viral yields and virus activity, additional doses may be released and distributed into December and beyond to support late season immunization.

AUGUST-NOVEMBER; BEYOND AS NEEDED

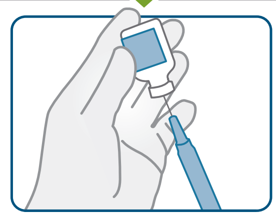


Step 7

Vaccination

- The CDC recommends particular high-risk populations at risk for influenza and related complications to be immunized every year. Other persons who wish to reduce their risk for influenza may choose to be immunized.
- Immunization generally begins in October or as soon as vaccine becomes available and continues through the influenza season which typically ends in March.
- Immunity develops approximately two weeks following vaccination. [6]

OCTOBER AND BEYOND



Credit: Sanofi Pasteur Inc.

Outbreak in Infectburg

KEY

PART ONE

1. If you choose only to use the vaccines, how many packages would you need? How much of your budget would you use?

5,600 vaccines / 2 vaccines per pkg = 2,800 pkgs
2,800 pkgs * $6 per pkg = $16,800

2. Given that vaccines work best if given well before a person is exposed to the virus, what is a drawback of this strategy?

*vaccines take time to be effective
*vaccines only work for those who haven't been infected yet
*some people may be allergic to the vaccine

3. If you choose only to use the anti-virals, how many packages would you need? How much of your budget would you use?

5,600 doses / 3 doses per pkg = 1867 pkgs
1867 pkgs * $20 per pkg = $37,340

4. Given that anti-virals work best if given shortly after a person is exposed to the virus, what is a drawback of this strategy?

*won't work for people who haven't been infected
*they need to be administered shortly after infection

5. Your supervisor has informed you that your budget is use it or lose it. She's also told you that you should buy as many anti-viral doses as possible, while still treating 5,600 people. Use equations to find the number of anti-viral doses and vaccines that use your entire budget.

a. Determine your variables: what two quantities are you trying to determine?

b. Create two equations that include both variables. What quantities are given that relate to the variables you have chosen?

c. Using substitution or elimination, solve for one of the variables.

d. Using your known variable, solve for the other variable.

$20{,}000 = 20A + 6V$
$5{,}600 = 3A + 2V$

$A = 291$ pkgs of anti-viral (873 doses)
$V = 2{,}354$ pkgs of vaccines (4,728 doses)

6. Once you have a solution using equations, justify your solution with graphs, tables, or a written explanation.

   Answers will vary.

PART TWO

Find the number of trucks and ATVs to use given your constraints. You may use any tool to solve the problem (graphs, pictures, tables, equations) but you must check your answer using a different tool (ex: graph to solve, table to justify/check).

A = # of ATVs   T = # of trucks
860 doses = 20 A + 60 T
30 drivers = 1 A + 2 T

T = 13 trucks used
A = 4 ATV's used

LESSON 1: Vaccine Chemistry

Activity Time: 60 – 120 minutes

In this lesson, students will learn how dilution calculations and titrations can play a role in the administering of the influenza vaccine. Students will also learn the process that is undertook in developing the flu vaccine and learn of new research for making the flu vaccine go further with the use of an adjuvant. Students also participate in an acid/base titration lab.

Before delivering this lesson, students need to have an understanding of pH and be familiar with titrations. This lesson can be used as students' first titration lab or can be presented as a problem-based lesson that challenges students to apply their understanding of pH values and titrations.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **pH:** The pH scale provides a way of measuring the acidity or basicity of a solution.
- **Acid-Base Titration:** An unknown concentration of an acid or base can be determined by neutralizing the solution with an acid or base of a known concentration.

Essential Question:

- What are the strengths and challenges of using adjuvants in the development and manufacture of an influenza vaccine?

Learning Objectives:

Students will know…

- That the development of a vaccine is at least a 10 month process, from manufacturer to delivery to patient.
- Bases can be neutralized using an acid.
- The unknown concentration of a base can be determined by titrating with a known acid concentration.

Students will be able to…

- Complete an acid/base titration of a strong base solution and determine how much hydroxide ions were present in the solution.

Vocabulary:

- Acid
- Adjuvant
- Base
- Indicator
- Influenza
- Innoculation
- Titration
- Vaccine/vaccination
- Virus

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 INQA** (Question) Scientists generate and evaluate questions to investigate the natural world.
- **9-12 INQB** (Investigate) Scientific progress requires the use of various methods appropriate for answering different kinds of research questions, a thoughtful plan for gathering data needed to answer the question, and care in collecting, analyzing, and displaying the data.
- **9-12 INQC** (Explain) Conclusions must be logical, based on prior evidence, and consistent with prior established knowledge.
- **9-12 INQD** (Communicate Clearly) The methods and procedures that scientists use to obtain evidence must be clearly reported to enhance opportunities for further investigation.
- **9-12 APPE** Perfect solutions do not exist. All technological solutions involve trade-offs in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended, others not.
- **9-11 PS2H** Solutions are mixtures in which particles of one substance are evenly distributed through another substance. Liquids are limited in the amount of dissolved solid or gas that they can contain. Aqueous solutions can be described by relative quantities of the dissolved substances and acidity or alkalinity (pH).

Common Student Preconceptions:

- Acids eat away at materials and this is the only way to identify them.

TEACHER PREPARATION

Materials:

- 15 ring stands
- 15 Burets
- 15 Buret clamps
- 30 250mL beakers
- 15 125mL or 250mL Erlenmeyer flasks
- DI water
- 3-5 Syringes or volumetric pipettes
- Nitric Acid - HNO_3
- Calcium Hydroxide - $Ca(OH)_2$
- Computer with internet, speakers, and projector
- *Rx for Survival* DVD
- *Vaccine Chemistry* Handout (1 per student)

Preparation:

- Make copies of the Student Handout.
- Set up lab stations with lab materials and chemicals.
- Review your lab safety guidelines with students.

Preparing the 0.100M Nitric Acid Solution

- Add 6.33 mL of 15.8M HNO3 to about 500mL DI water in a 1 L volumetric flask. Once solution is mixed, add DI water till solution is 1L. Mix thoroughly.

Preparing the Unknown Calcium Hydroxide Solutions

- You can make just one unknown base solution for students to test or you can create several different molarities. If you make more than one unknown solution, label each solution with a different letter of the alphabet.
- For a 0.1M $Ca(OH)_2$ solution, combine 1.85 g $Ca(OH)_2$ with DI water in a 250mL volumetric flask. Mix until completely dissolved. Then add DI water untill measured to 250mL of solution.
- To make a variety of solutions, use different amounts of $Ca(OH)_2$ to make your different molarities.

Unknown Concentrations	$Ca(OH)_2$ Needed
0.100M	1.85g $Ca(OH)_2$
0.200M	3.7g $Ca(OH)_2$
0.300M	5.56g $Ca(OH)_2$

PROCEDURE

Hook

1. Show "The First Vaccines" segment of the Disease Warriors section of the *Rx for Survival* DVD. If time allows, also show the "The Smallpox Campaign" segment.
2. Depending on time, you may choose to show this video at the beginning of a class period, or at the end of a class period and then assign Part One of the Student Handout as homework.

Preconceptions

3. Ask students to share what they currently know about the influenza vaccine. Their knowledge could come from their own experience, from articles or books they have read, from word-of-mouth, etc. Write students' responses on the board.
4. Challenge students to consider what they currently know about the role that chemistry plays in the development, manufacture, storage, and delivery of the influenza vaccine. As students brainstorm ideas, record their responses on the board.

Activity

5. Pass out copies of the *Vaccine Chemistry* handout, one per student. Ask students to read the articles and complete the questions in Part One of the handout. Students can work alone or with their lab partners.
6. When students have completed Part One of the handout, review students' questions, answers, and misunderstandings about the reading and problems.
7. If time allows, transition to the lab activity, or begin the lab during the following day's class period.
8. Review your lab safety guidelines. Then ask students to go to their lab stations and read Part Two of their handout. Review the "Safety" and "Disposal" sections of the lab protocol.
9. Allow time for lab partners to work together to complete the acid/base titration lab related to vaccine and adjuvant interactions. The Student Handout provides complete instructions on how students should proceed with the lab activity.

Wrap-Up

10. Ask students to complete a formal write-up of the lab, using your normal class expectations for lab write-ups. Time can be provided in-class, or the write-up can be given as a homework assignment.
11. Once student have completed the lab and write-up, discuss questions 6 and 7 from the "Post-Lab Questions" portion of their handout.
12. Return to the preconceptions list that you made at the beginning of the activity. Ask students to update the list with any new knowledge, and to correct any misconceptions.

STUDENT ASSESSMENT

Assessment Opportunities:

- The formal lab write-up and the post-lab questions provide an opportunity to assess students' understanding and thinking.

Student Metacognition:

- Have students reflect on how to do a titration and what a titration determines. Have the students reflect on how a vaccine is made, especially noting the speed at which it takes to develop the flu vaccine.
- Have students compare their initial preconceptions with what they know after completing the activity.

Scoring:

- The Student Handout can be scored.
- Students' lab write-ups can be scored.

EXTENSION ACTIVITIES

Extension Activities:

- If time allows, show students the entire Disease Warriors section of the *Rx for Survival* DVD.
- Have students write a story about how the influenza virus has impacted populations over the past 100 years, noting specific examples from their U.S. History class. Challenge students to include information on how the field of chemistry has helped to control influenza.

Adaptations:

- Provide large font copies of the Student Handout for visually impaired students.
- Allow students with limited mobility to work with partners when completing the titration, as reaching the endpoint can be difficult with limited fine motor skills.
- If you do not have access to the *Rx for Survival* DVD, some video segments can be viewed directly from the Rx for Survival website.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Rx for Survival Video Segments
http://www.pbs.org/wgbh/rxforsurvival/series/video/index.html

CDC Influenza Vaccination Resources
http://www.cdc.gov/flu/professionals/vaccination/index.htm

Influenza Vaccines Information
http://pandemicflu.gov/individualfamily/vaccination/index.html

Influenza Virus: A Tiny Moving Target
http://www.nescent.org/eog/documents/MicrosoftWord-InfluenzaVirus.pdf

A Case Study Involving Influenza and the Influenza Vaccine
http://www.sciencecases.org/influenza/influenza.asp

Credit:

Lab activity adapted from *Acid/Base Titration Lab* from Westlake High School's PreAP Chemistry Course, Austin, Texas. Available from: http://whs.eanes.k12.tx.us/departments/science/chemistry/PreAP%20Chem/Unit%2016/Titration%20Lab.doc.

Annual Vaccine Production Timeline reproduced with permission of Sanofi Pasteur Inc.

How Vaccines Work illustration reproduced with permission of The Free Dictionary by Farlex. Illustration by the Electronic Illustrators Group.

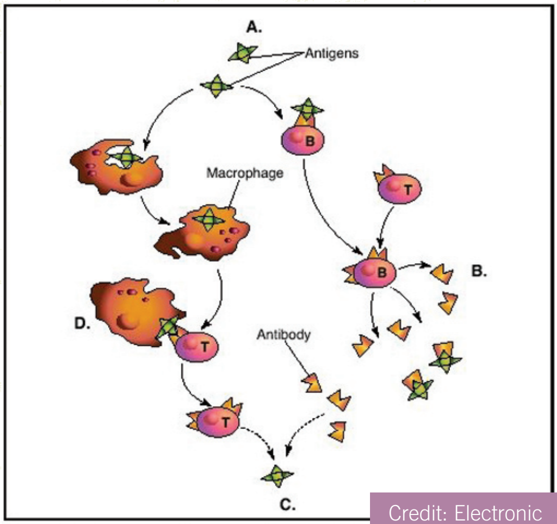
Name:____________________________ Date:___________ Period:________

Vaccine Chemistry

PART ONE THE INFLUENZA VACCINE

Influenza (the flu) is a contagious respiratory illness caused by influenza viruses. It can cause mild to severe illness, and at times can lead to death. The best way to prevent the flu is by getting a flu vaccination each year.[1] The burden of influenza in the U.S. is currently estimated to be 25–50 million cases per year, leading to 150,000 hospitalizations and 30,000–40,000 deaths. If these figures are extrapolated to the rest of the world, the average global burden of inter-pandemic influenza may be on the order of ~1 billion cases of flu, ~3–5 million cases of severe illness and 300,000–500,000 deaths annually.[2] Some people, such as older people, young children, and people with certain health conditions, are at high risk for serious flu complications.

Each vaccine contains three influenza viruses: one A (H3N2) virus, one A (H1N1) virus, and one B virus. The viruses in the vaccine change each year based on international surveillance and scientists' estimations about which types and strains of viruses will circulate in a given year. About 2 weeks after vaccination, antibodies that provide protection against influenza virus infection develop in the body.[3]



Credit: Electronic Illustrators Group

How vaccines work

A. Vaccines contain antigens (weakened or dead viruses, bacteria, and fungi that cause disease and infection). When introduced into the body, the antigens stimulate the immune system response by instructing B cells to produce antibodies, with assistance from T-cells.

B. The antibodies are produced to fight the weakened or dead viruses in the vaccine.

C. The antibodies "practice" on the weakened viruses, preparing the immune system to destroy real and stronger viruses in the future.

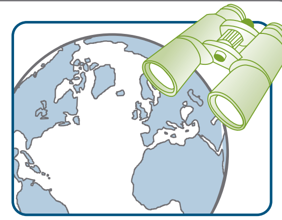
D. When new antigens enter the body, white blood cells called macrophages engulf them, process the information contained in the antigens, and send it to the T-cells so that an immune system response can be mobilized.

Annual Vaccine Production Timeline

Step 1

Surveillance

- Influenza vaccine protects against three prominent virus strains, which must first be identified before production can begin each year.
- Ongoing global surveillance is key to predicting which three strains will circulate each influenza season.

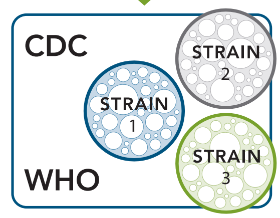


YEAR-ROUND

Step 2

Strain Selection

- World health officials[1] analyze and identify the dominant circulating strains.
- The strains are submitted to the Food and Drug Administration (FDA) to recommend which three to include. The FDA distributes seed viruses to manufacturers to begin the production process.
- Manufacturers' scientists predict the circulating strains for the coming season and begin preparing vaccine at risk before final FDA selection.[2]

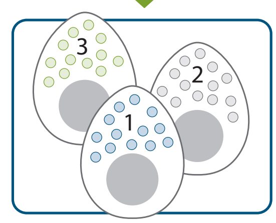


JANUARY-MARCH

Step 3

Manufacturing and Production[3,4]

- Each virus strain is produced separately and later combined to make one vaccine.
- Millions of specially prepared chicken eggs are used to produce the vaccine. For seven months, fertilized eggs are delivered to the manufacturer. Each egg is cleaned with a disinfectant spray and injected with one strain.
- The eggs are incubated for several days to allow the virus to multiply. After incubation the virus-loaded fluid is harvested.

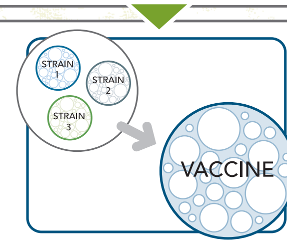


JANUARY-JULY

Step 4

Purification and Testing[3,4]

- The virus fluid undergoes multiple purification steps and a special chemical treatment to ensure the virus is inactivated, or "killed."[5]
- The virus is split by chemically disrupting the whole virus.
- Viral fragments from all three strains are collected from different batches, and combined upon completion of quality control tests.
- Manufacturers and the FDA test the vaccine concentrate to determine amount and yield of the virus to ensure concentrate is adequate for immunization.

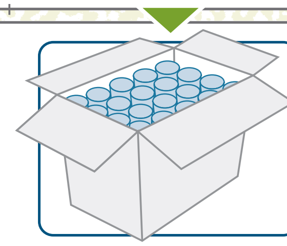


JUNE-OCTOBER

Step 5

Filling and Packaging

- Upon FDA approval and licensing, the vaccine is released for distribution in time for immunization.
- Manufacturers begin filling the doses into vials and syringes, which are then sealed and carefully inspected before labels are applied to show the vaccine batch, lot numbers and expiration date.
- Each lot must be specifically "released" by the FDA before manufacturers can ship.

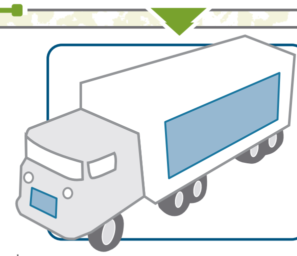


JULY-DECEMBER

Step 6

Shipping

- Vaccine shipments typically begin in August/September and continue into November.
- With CDC's support, partial shipments are sent early in the season to all customers to ensure broad access for high-risk patients.
- Depending on viral yields and virus activity, additional doses may be released and distributed into December and beyond to support late season immunization.

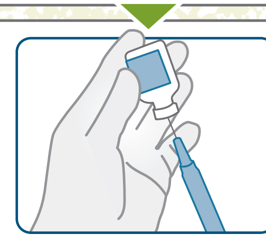


AUGUST-NOVEMBER; BEYOND AS NEEDED

Step 7

Vaccination

- The CDC recommends particular high-risk populations at risk for influenza and related complications to be immunized every year. Other persons who wish to reduce their risk for influenza may choose to be immunized.
- Immunization generally begins in October or as soon as vaccine becomes available and continues through the influenza season which typically ends in March.
- Immunity develops approximately two weeks following vaccination.[6]



OCTOBER AND BEYOND

Credit: Sanofi Pasteur Inc.

1. In a 5-6 sentence paragraph, summarize the Annual Vaccine Prodution Timeline illustration describing the manufacture of a vaccine.

Dosage Forms and Strengths: Adjuvants and Dilutions

In the 2009-10 flu season, health officials were worried that there would not be enough influenza antigen in the world for the expected demand. At the time, six influenza vaccine manufacturers were projecting that as many as 119 million doses of influenza vaccine would be available for the 2009-10 influenza season.[4] Using an adjuvant can help a little antigen go a long way. An immunologic adjuvant is defined as any substance that acts to accelerate, prolong, or enhance antigen-specific immune responses when used in combination with specific vaccine antigens.[5] Until very recently there was no known adjuvant for the flu vaccine.

2. Read the following press release and highlight new vocabulary words.

BioSante Pharmaceuticals Reports 100% Protection From H1N1 Challenge When Using BioVant™ Adjuvanted Vaccine

Lincolnshire, Illinois (August 17, 2009) – BioSante Pharmaceuticals, Inc. (NASDAQ: BPAX) announced today's presentation of H1N1 vaccine results at the Immunotherapeutics Vaccine Summit in Providence, RI. BioSante's vaccine adjuvant, BioVant™, increased the protective effect of vaccines for multiple flu strains, including a potential new vaccine against H1N1 (swine flu), which resulted in 100 percent protection from symptoms of illness, including weight loss, and death in animal studies…

…The studies concluded that swine and bird flu vaccines using BioSante's BioVant may allow for availability of a greater number of lower-dose vaccines, due to its dose sparing characteristics, and intranasal administration could provide more convenient and wider distribution during a flu pandemic…

"The results of the BioVant-influenza studies suggest that BioVant can increase the efficacy of a potential adjuvant-enhanced H1N1 vaccine," said Michael Snabes, BioSante's vice president of clinical development. "The exciting prospect is that BioVant also may allow use of lower doses of H1N1 swine flu vaccines in order to stretch potentially limited vaccine supplies."

…An adjuvant is a substance that, when added to a vaccine, increases the vaccine's effectiveness by enhancing the body's immune response… [6]

3. List four new vocabulary words from the reading and provide a definition in your own words that you can derive from the text.

4. Prior experience with the 1976 swine flu suggests that as little as 15 ug in a 0.5ml vaccine dose will be enough to protect a person from getting ill.[7] There are 6.8 billion people in the world. What volume of vaccine will be needed to be able to deliver protection to all people?

5. Currently only 825,000 L of 30 ug/mL flu vaccine are produced per year. Assuming that every person on earth would have access to the vaccine if it were available, how many people are unable to obtain a vaccine due to a shortage in production?

6. If the new BioVant™ adjuvant enables scientists to increase the efficacy of the vaccine and therefore only need a concentration of 9 ug/mL for each vaccine, how many people could then receive the vaccine with the current supply?

[1] CDC. *Seasonal Influenza: The Disease*. Available from: http://www.cdc.gov/flu/about/disease/index.htm.
[2] WHO *Influenza*. Available from: http://www.who.int/immunization/topics/influenza/en/index.html.
[3] CDC. *Key Facts About Seasonal Flu Vaccine*. Available from: http://www.cdc.gov/flu/protect/keyfacts.htm.
[4] CDC. *Seasonal Influenza Vaccine Supply for the U.S. 2009-10 Influenza Season*. Available from: http://www.cdc.gov/flu/about/qa/vaxsupply.htm.
[5] Sasaki, S. and Okua, K. (2000). The use of conventional immunologic adjuvants in DNA vaccine preparations. In D.B. Lowrie and R.G. Whalen (editors), *DNA Vaccines: Methods and Protocols*, Humana Press.
[6] BioSante Pharmaceuticals. (2009). *BioSante Pharmacueticals Reports 100% Protection from H1N1 Challenge When Using Biovant™ Adjuvanted Vaccine.* Available from: http://www.biosantepharma.com/News-Releases.php?ID=081709.
[7] Drugs.com. *Flulaval.* Available from: http://www.drugs.com/pro/flulaval.html.

PART TWO ACID/BASE TITRATION LAB

You are a scientists working at InfluVac Inc., a biotech company that manufactures influenza vaccines. One of your co-workers, an immunologist, has suggested that you include a chemical adjuvant in the vaccine formula to make the vaccine more effective. Really, it will allow you to use less antigen in each dose that is administered.

Your problem? This new antigen is REALLY basic. In fact when it is added to the vaccine solution, the adjuvant bumps up the solution to a pH higher than is safe for inoculating humans. Assume that the ideal pH for the flu vaccine is at 7.5 since it has to be injected into human blood which has a similar pH. In this acid/base titration lab, you will determine how much acid you need to add to get to your ideal pH, which will ensure a safe inoculation. You will be determining the concentration of the hydronium ions in a solution.

Background:

Titration involves the addition of a solution whose concentration is known to a solution whose concentration is unknown. The volume of the known solution required to react completely with a known volume of the solution whose concentration is being determined is measured. An indicator is added to the solution to mark the point at which the two quantities reach equivalence.

In this experiment, nitric acid of known concentration will be added to an unknown volume of calcium hydroxide (mimicking the behavior of the adjuvant in solution) to determine the molarity of the calcium hydroxide (adjuvant). Bromothymol blue will be used as the indicator. Bromothymol blue is blue in a basic solution, greenish in a neutral solution, and yellow in an acidic solution.

Objective:

To determine the molarity of an unknown concentration of hydrochloric acid.

Safety:

Wear goggles and aprons at all times. Both acids and bases are corrosive and can cause eye and/or skin damage. *Do not pour the Nitric Acid above eye level! Be sure to hold the buret below eye level when filling it.*

Disposal:

Pour the contents of the Erlenmeyer flask down the drain. Follow your teacher's directions for any remaining acid or base.

Materials:

- 1 Ring stand
- Buret
- Buret clamp
- 2 Beakers
- 1 Erlenmeyer flask (125 or 250mL)
- 1 Graduated cylinder (100 mL)
- Funnel
- 10 mL Syringe or volumetric pipette
- Bromothymol blue
- DI water
- Unknown base
- 0.5 M HNO_3

Procedure:

1. Set up the equipment using the ring stand, buret, and buret clamp. Be sure that the buret remains vertical at all times.
2. Check for leaks by adding some DI water to the buret. If there are no leaks, drain the DI water completely from the buret. If there is a leak, get help from your teacher.
3. Carefully pour the HNO_3 into the buret. The buret tip needs to be filled, so you will need to drain some of the HNO_3 from the buret. Fill the buret so that the meniscus of the HNO_3 is sitting on the 0.00 mL mark with the tip filled.
4. Using the graduated cylinder, add about 60 mL of DI water to a 250 mL Erlenmeyer flask (or add 20 mL of DI water to a 125 mL Erlenmeyer flask).

5. Use the syringe or volumetric pipette to add exactly 10 mL of the unknown base to the DI water in the Erlenmeyer flask. Make sure that you write down the letter from the label of the unknown base that you used.
6. Add 2 – 3 drops of bromothymol blue to the base solution in the Erlenmeyer flask.
7. Place the Erlenmeyer under the buret. Place a sheet of white paper under the Erlenmeyer flask to help you use the color more clearly.
8. It is time to begin titrating! Carefully add 1 mL of the HNO_3 from the buret into the Erlenmeyer flask. Swirl the flask to mix. Continue adding 1 mL increments until you begin to see a green color. The green color should appear briefly and then quickly disappear as you swirl the flask.
9. Once you have seen the green color, begin adding the HNO_3 more slowly and in smaller amounts. Remember to swirl the flask after each addition of HNO_3. As you near the end of the titration, the green color should remain a bit longer, but will still disappear when the flask is swirled. The longer the green color stays, the smaller your next increment of HNO_3 should be. You want to eventually be adding the HNO_3 **one drop at a time** until the palest green color appears and stays, even after you swirl the flask.
10. When the pale green color appears and stays you have reached the endpoint (which is called the neutralization point). Record the buret reading to the nearest 0.01 mL.
11. Clean out the Erlenmeyer flask by pouring the solution in the flask down the drain. The Erlenmeyer does not need to be dry, but does need to be clean.
12. Repeat steps 4 – 11 two more times. You will not need to add more HNO_3 to the buret for the second trial. However, before you start the third trial, make sure that you have enough HNO_3 in the buret to complete the titration.
13. Clean out the Erlenmeyer flask and dispose of any remaining solutions according to your teacher's instructions. Clean up your lab station and put away all equipment.

Data Table

Unknown Base Letter _____

	Trial 1	Trial 2	Trial 3
Final Buret Reading (mL)			
Initial Buret Reading (mL)			
Volume of Acid (mL)			
Molarity of Acid (M)			
Volume of Base (mL)			
Molarity of Base (M)			
Average Molarity of Base (M)		-----------------	-----------------

Processing the Data

Use a separate piece of paper to answer these questions.

1. Write a balanced equation for the reaction in this titration.
2. Calculate the molarity of the base. Show all work.
3. Calculate the average molarity of the base. Show all work.
4. Calculate the standard deviation of your molarity. You may do the work on your calculator or refer to a previous lab for the formula.

Post-Lab Questions

Use a separate piece of paper to answer these questions.

1. We did not use the volume of the water added initially to the Erlenmeyer in our calculations. Why?
2. Describe the apparent relationship between $[H_3O^{+1}]$ and $[OH^{-1}]$ when the endpoint is reached in an acid-base titration.
3. If 30.0 mL of 0.500 M KOH are needed to neutralize 10.0 mL of HCl of unknown concentration, what is molarity of the HCl?
4. How many mL of 0.100 M NaOH are needed to titrate 20.0 mL of 0.300 M H_2SO_4?
5. Assuming that you have 1500 L batches of vaccine that are mixed with the adjuvant, how much HNO_3 will you need to bring the pH down for this batch of vaccine?
6. Summarize how chemistry and global health work together to solve this problem of not enough vaccine to protect the population?
7. If you were not able to vaccinate everyone, who would you give the vaccine to first and why? (Explain your answer).

Activity Write-Up

Complete a write-up for this lab activity. Remember that a write-up contains the following components:

- Title – your choice.
- Objective – in a sentence.
- Hypothesis – (if appropriate) in a sentence.
- Materials – as a list.
- Procedure – step-by-step, in sentences.
- Data – as a table or graph, also shows calculations.
- Analysis – interprets your data and calculations and answers the questions above.
- Conclusion
  - > Summarizes the whole activity.
  - > Answers the hypothesis and why (if appropriate).
  - > Error Analysis - describes the experimental errors.

Each lab partner will complete a write-up. Only the Materials, Procedure, and Data sections can be word-for-word exact copies between lab partners. All other sections must be original to the individual writer.

Credit: Lab activity adapted from *Acid/Base Titration Lab* from Westlake High School's PreAP Chemistry Course, Austin, Texas. Available from: http://whs.eanes.k12.tx.us/departments/science/chemistry/PreAP%20Chem/Unit%2016/Titration%20Lab.doc.

LESSON

LESSON 1: "Spanish Flu" Pandemic of 1918

Activity Time: 90 minutes (can be extended to several class periods)

In this lesson, students will become familiar with the Spanish Flu pandemic of 1918. Students will see how governments, communities, and individuals struggled to cope with the staggering losses and challenges of this pandemic.

This lesson should be delivered so that it precedes the lesson *1918: What Worked and What Didn't*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Public Health Crises:** The United States has faced serious public health crises in the past that have been more devastating than any wars.
- **Government Response:** The government plays a critical role in helping communities and individuals cope with this type of crisis.
- **Individual's Response:** I may be called upon to help my community in a serious crisis.

Essential Question:

- What is the role of the government in my life?
- What would I do in the case of a serious pandemic?

Learning Objectives:

Students will know…

- Governments have an important role in safe guarding public health.
- Disease impacts all aspects of human life in direct and indirect ways.
- The scope and serious impacts of the 1918-1919 Influenza pandemic.

Students will be able to…

- Identify the steps that governments have taken that have been successful/unsuccessful in safe-guarding public health.

Vocabulary:

- Antibiotics
- Epidemic
- Influenza
- Pandemic
- Pathogen
- Pneumonia
- Vaccine
- Virus

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History EALR 4, GLE 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.

Common Student Preconceptions:

- A deadly flu pandemic hit the world in 1918.
- People don't die from the flu.
- Many public health professionals predict another influenza pandemic in our lifetimes.

TEACHER PREPARATION

Materials:

- Projector or television and DVD player
- Chart paper
- *Influenza 1918* DVD
- Influenza books and articles (See Resources section)

Preparation:

- Collect extra copies of a number of books through library requests.
- Queue the DVD to the correct episode.
- Create groups of 3 to 4 students each.
- Provide chart paper for each group.

PROCEDURE

Hook

1. Show students clips from the American Experience PBS program *Influenza 1918*. In particular, show the interview with a woman who remembers being put on the back porch and left for dead and another interview in which a man remembers playing on coffins piled up outside a funeral home.

Preconceptions

2. Ask students to respond to the following questions through a Think-Pair-Share. Students will first write in their journals for two minutes, then share with a partner for two minutes, and a few students will share with the entire group. During the group-share, record on chart paper the responses shared with the entire group.
   - What do you think of when you think of influenza or the flu?
   - How does the flu impact us as a community, a country, and the world?
   - What do you think the government must have done to respond to such a large public health problem?
3. Ask students to add to their list of preconceptions any vocabulary words that came up during the film. Work as a group to define the words and record the definitions on the chart.

Activity

4. Break students into groups of 3-4 and pass out a sheet of chart paper to each group. Based on the introduction, ask students what they would like to learn about the 1918 influenza pandemic. Have students share these ideas and record their questions on chart paper.
5. The next step in the activity is for students to build their background knowledge about the influenza pandemic through independent reading and note-taking. Students should use Cornell Notes or whatever form of note-taking that they may be been previously taught.
6. Students will select individual readings and read independently or in partners for 30 to 40 minutes while taking notes. A list of suggested articles and books on the 1918 influenza pandemic is included in the Resources section.
7. After providing time for individual reading, ask students to get back into their groups of 3-4 students and hand out a sheet of chart paper to each group.
8. Ask students to spend 10 minutes sharing within their groups and recording in detail what they have learned from their reading on the 1918 influenza pandemic. Encourage students to organize their sharing and recording by using the following categories: important terms, vocabulary, concepts, events, and answers to questions they developed before reading.
9. Taking turns, have each group share out with the rest of the class, starting with the prompt: What strikes you about what you read?
10. Meanwhile, create a record on chart paper of what everyone has learned.
11. Challenge the students to add to the chart their thoughts on the following prompts:
    - What do we want to know now?
    - What did the government do to respond to the flu pandemic?

Wrap-up:

12. Hand out Exit Tickets with the following questions:
    - What did you learn about the 1918 Flu Pandemic?
    - What did the government do to respond to the 1918 flu pandemic?
    - What do you want to know now?

STUDENT ASSESSMENT

Assessment Opportunities:

- Student knowledge will be recorded on chart paper and shared with the group.
- Teacher will confer with students during independent reading time to assess individual and general group understandings.

Student Metacognition:

- Students are asked to consider their preconceptions during the Think-Pair-Share activity, and also to develop a list of questions they have about influenza.
- The Exit Ticket questions ask students to reflect on their learning.
- At the end of the class period, students could be asked the following questions: What helped you learn today? What did you notice about your learning? What was confusing to you and why?

Scoring:

- Journals and chart paper can be scored.
- The Exit Ticket question "What did the government do to respond to the 1918 flu epidemic?" can be graded.
- Points can be awarded for participation to group work and class discussions.

EXTENSION ACTIVITIES

Extension Activities:

- Depending on the level of student interest, independent reading may be extended to a few additional days.
- A possible activity is to provide time in the library for students to explore answers to particular questions that arose during the class discussion.
- The entire film can be shown.

Adaptations:

- Provide a variety of texts at different reading levels.
- If it is too difficult to assemble the books, you can ask students to read the articles on the websites listed in the Resources section.
- Show the film in its entirety, stopping to support comprehension and note-taking, rather than having students read independently about the pandemic of 1918.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

American Experience: Influenza 1918 DVD
PBS, 1998, 60 minutes
http://www.shoppbs.org

American Experience: Influenza 1918
http://www.pbs.org/wgbh/amex/influenza/

The Influenza Pandemic of 1918
http://virus.stanford.edu/uda/index.html

Flu: The Story of the Great Influenza Pandemic of 1918 and The Search for the Virus That Caused It by Gina Kolata. Touchstone, 2001.

The Great Influenza: The Story of the Deadliest Pandemic in History by John Barry. Penguin Books, 2005.

"America's Deadly Rendezvous with the 'Spanish Lady'" in *Smithsonian Magazine* (Jan. 1989)

The Purple Death: The Mysterious Flu of 1918 by David Getz. Henry Holt and Co., 2000. (easier reading level)

Epidemic! The 1918 Influenza Pandemic by Stephanie True Peters. Marshall Cavendish Children's Books, 2004. (easier reading level)

LESSON 2
1918: What Worked and What Didn't?

Activity Time: 100 minutes

In this lesson, students will read about government and community responses to influenza pandemics. Students will research different cities' and states' responses to the 1918 pandemic, including Boston, San Francisco, Philadelphia, Washington, and Georgia.

This lesson should be delivered so that it is preceded by the lesson *"Spanish Flu" Pandemic of 1918*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Public Health Crises:** The United States has faced serious public health crises in the past that have been more devastating than any wars.
- **Government Response:** The government plays a critical role in helping communities and individuals cope with this type of crisis.
- **Individual's Response:** I may be called upon to help my community in a serious crisis.

Essential Question:

- What is the role of the government in my life?
- What would I do in the case of a serious pandemic?

Learning Objectives:

Students will know…

- Disease impacts all aspects of human life in direct and indirect ways.

Students will be able to…

- Describe the scope and serious impacts of the 1918-1919 influenza pandemic.
- Explain how a number of different cities responded to the influenza pandemic of 1918.
- Evaluate which responses were most effective and what responses should be implemented again given a similar situation.

Vocabulary:

- Influenza
- Reportable disease

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.

Common Student Preconceptions:

- Nothing can be done to protect public health in the case of a major pandemic.

TEACHER PREPARATION

Materials:

- Computer lab with internet
- Student journals or blank paper
- Chart paper
- *What Did They Do?* Handout (1 per student)

Preparation:

- Reserve time in a computer lab, preferably a library setting where students can spread out into groups after reading from computer screens.
- If computers are not available or desired, the teacher will need to create handouts from the websites listed in the Resources section.

PROCEDURE

Preconceptions

1. Ask students to respond in their journals to the following prompt: What do you think life was like in 1918?
2. Challenge students to write one paragraph about what they think people did for fun, what kind of work did people do, and how might life have been different for different social groups?

Hook

3. Explain to students that the will investigate what life was like in 1918 by exploring The Great Pandemic website.

   The Great Pandemic
   http://1918.pandemicflu.gov/
4. The students' task is to read at individual computers and compare what they learned to what they entered in their journals during the entry task. Encourage students to take notes in their journals.
5. After about 10 minutes, ask students to Pair-Share with a partner, and then with the whole class. During the group share out, record students' contributions on chart paper.

Activity

6. Explain that students will be working in groups to investigate how a particular American city or state responded to the 1918 influenza pandemic. Students will need to answer the following questions:
   - Name 4 actions taken by your city or state.
   - Which actions do you think were helpful? Why?
   - Which actions do you think were probably not helpful? Why?
   - What do you think should or could have been done to help protect public health?
   - What actions were ineffective due to lack of understanding of the disease at the time?
7. Break students into four groups and assign each group one of the following cities/states: San Francisco, Philadelphia, Washington, or Georgia. Pass out copies of the *What Did They Do?* Handout, one per student. Also hand out chart paper to each group.
8. Each group needs to prepare a poster and a three minute oral report to present the poster. The oral report should answer the questions listed above.

Wrap-Up

9. Give each group three minutes to present their oral report and poster to the class. Allow time for questions from the audience.
10. Hand out Exit Tickets with the following questions:
    - Why did some strategies work while others failed?
    - What did you learn that was different from what you knew or understood previously?
    - What strikes you that you learned today?
11. If time allows, ask several students to share their Exit Tickets.

STUDENT ASSESSMENT

Assessment Opportunities:

- Posters and presentations can be assessed

Student Metacognition:

- The journal prompt gets students thinking about their ideas of life in 1918.
- The Exit Ticket questions challenge students to reflect on their learning.

Scoring:

- Evaluate students' posters and oral reports based on how well students answered the five key questions.
- Participation points can be awarded for contributing to class discussions and group work.

EXTENSION ACTIVITIES

Extension Activities:

- Have students choose one other state to research, using the pandemicflu.gov website.
- Have students play The Great Flu game at http://www.thegreatflu.com to explore how difficult it is to manage an influenza pandemic.

Adaptations:

- If computers are not available or desired, create handouts from the websites listed in the Resources section.
- If you need to break students into more than five groups, assign another state and use the pandemicflu.gov website to locate information about that state.

EXTENSION ACTIVITIES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

The Great Pandemic: Life in 1918
http://1918.pandemicflu.gov/

1918 Flu Pandemic in San Francisco
www.pbs.org/wgbh/amex/influenza/sfeature/sanfran.html

1918 Flu Pandemic in Philadelpia
www.pbs.org/wgbh/amex/influenza/sfeature/philadel.html

Events in Washington State
http://1918.pandemicflu.gov/your_state/washington.html

Events in Georgia
http://1918.pandemicflu.gov/your_state/georgia.html

Events in Other States
http://1918.pandemicflu.gov/your_state

The Great Flu Game
http://www.thegreatflu.com

Credit:
Activity inspired by: *The Spanish Flu and Its Legacy: Science Cases for Classroom Use*, The College Board, 1999.

Name:____________________________ Date:___________ Period:________

HANDOUT

What Did They Do?

You will be reading about actions taken in San Francisco, Philadelphia, Washington State, Georgia, or another state of your choice. (If you choose another state make sure the reading includes 4 actions taken by the local government.)

The city/state you will be researching:______________________________

The websites below will provide you with background information on how the city/state responded to the 1918 influenza pandemic.

1918 Flu Pandemic in San Francisco
www.pbs.org/wgbh/amex/influenza/sfeature/sanfran.html

1918 Flu Pandemic in Philadelphia
www.pbs.org/wgbh/amex/influenza/sfeature/philadel.html

Events in Washington State
http://1918.pandemicflu.gov/your_state/washington.html

Events in Georgia
http://1918.pandemicflu.gov/your_state/georgia.html

Events in Other States
http://1918.pandemicflu.gov/your_state

Your group will prepare a poster and 3 minute presentation (answering the question below) to share with the class.

Respond to the following prompts:

- Name 4 actions taken by your city or state.
- Which actions do you think were helpful? Why?
- Which actions do you think were probably not helpful? Why?
- What do you think should or could have been done to help protect public health?
- What actions were ineffective due to lack of understanding of the disease at the time?

Have fun!

LESSON

LESSON 3
Swine Flu: Learning from 1976

Activity Time: 30–40 minutes

In this lesson, students will read news stories to learn about an unsuccessful public response to a possible influenza pandemic.

This lesson should be delivered so that it is preceded by the lesson *1918: What Worked and What Didn't* and is followed by the lesson *The Next Plague*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Government Response:** Government plays an important role in my life by safeguarding public health, although not all programs have been successful.
- **Lessons from History:** We can learn from previous public health mistakes.

Essential Question:

- What is the role of government in my life?
- How does the government act to safeguard public health?

Learning Objectives:

Students will know…

- Governments have an important role in safeguarding public health.
- Governments sometimes overreact to public health scares if information is inadequate or incorrect.

Students will be able to…

- Describe the public health policy mistakes made in the 1976 "Swine Flu Fiasco."
- Describe the differences between the 1976 flu and 1918 flu in terms of what actually happened.
- Describe the differences between the 1976 flu and the 1918 flu in terms of the government response.
- Identify possible reasons for the government actions that were taken in 1976 and describe lessons that should be learned from this public health "fiasco."

Vocabulary:

- Adenovirus
- Influenza

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History EALR 4, GLE 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.

Common Student Preconceptions:

- The 2009 swine flu pandemic is the first time anything like this has happened.
- I've never heard of the 1976 swine flu scare.

TEACHER PREPARATION

Materials:

- *Swine Flu Debacle* Handout (1 per student)
- *Lessons Learned from 1976* Handout (1 per student)
- *Reading Guide* Handout (1 per student)
- Student journals or blank paper

Preparation:

- Search for the following book using Google Books: *Flu: The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus that Caused It* by Gina Kolata. Find page 121 of the book.
- Make copies of Student Handouts.

PROCEDURE

Hook

1. Read aloud pages 121- 123 from Gina Kolata's *Flu*. This passage describes the soldier who fell ill and died at Fort Dix of Swine flu in 1976 and what researchers initially thought should be done.

Preconceptions/Entry Task

2. Write the following questions on the board:
    - When do we know how to respond to a public health threat?
    - How do we know a threat is a threat?
3. Ask students to write their response to these questions in their journals. Then, lead a brief class discussion about the questions.

Activity

4. Pass out copies of the two articles and the reading guide. Provide time for students to read both articles.
5. Break students into discussion groups of 3-4 students. Ask students to discuss the reading guide questions and entry task questions as a small group. Tell them to record their answers in their journals.

Wrap-Up

6. Have students reassemble as a large group and share out discussion points from their small groups.
7. Hand out Exit Tickets with the same questions as on the entry task:
    - When do we know how to respond to a public health threat?
    - How do we know a threat is a threat?
    - How has your thinking changed since we read and discussed these articles? What changed your thinking?

STUDENT ASSESSMENT

Assessment Opportunities:

- Look for evidence of students' awareness of their own thinking and learning processes in the Exit Tickets and journal entries.
- Students should be able to identify some criteria for government and community action around a public health threat.

Student Metacognition:

- The Exit Tickets ask students to identify how their thinking changed since the start of class.

Scoring:

- Students may be given a participation grade for participating in class and small group discussions and for completing the Exit Ticket.

EXTENSION ACTIVITIES

Extension Activities:

- Students may be given this primary document: February, 1976 *New York Times Op-ed*, "Flu to the Starboard! Man the Harpoon. Fill 'em with Vaccine! Get the Captain!" The article can be purchased for a small fee from the New York Times' online archive website.
- Students should read the document and compare the differences between what this author suggested in February 1976 and what government action was actually taken. Students should speculate on why a different course of action was taken and what they would have recommended had they been president. On page 127 of *Flu*, the author Kilbourne comments on the difference between his intentions and the way the issue was presented in the *New York Times*. How does this relate to the impact of media on our lives?

Adaptations:

- The suggested extension activity can be used as a more challenging assignment.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

February, 1976 *New York Times Op-ed*, “Flu to the Starboad! Man the Harpoon. Fill ‘em with Vaccine! Get the Captain!”

Flu by Gina Kolata (pages 121-186).

CDC Reflections on the 1976 Swine Flu Vaccination Program
http://www.cdc.gov/ncidod/eid/vol12no01/05-1007.htm

Credit:

Roan, S. (2009). Swine flu ‘debacle’ of 1978 is recalled. *LA Times*, 4/27/09.

Rubin, R. (2009). Lessons learned from the 1976 swine flu ‘fiasco’. *USA Today*, 5/5/09.

Name:____________________________ Date:___________ Period:________

Swine Flu Debacle

Swine flu 'debacle' of 1976 is recalled. The episode triggered an enduring public backlash against flu vaccination, embarrassed the federal government and cost the director of the CDC his job.

By Shari Roan
April 27, 2009, *LA Times*

Warren D. Ward, 48, was in high school when the swine flu threat of 1976 swept the U.S. The Whittier man remembers the episode vividly because a relative died in the 1918 flu pandemic and the 1976 illness was feared to be a direct descendant of the deadly virus.

"The government wanted everyone to get vaccinated," Ward said. "But the epidemic never really broke out. It was a threat that never materialized."

What did materialize were cases of a rare side effect thought to be linked to the shot. The unexpected development cut short the vaccination effort — an unprecedented national campaign — after 10 weeks.

The episode triggered an enduring public backlash against flu vaccination, embarrassed the federal government and cost the director of the U.S. Center for Disease Control, now known as the Centers for Disease Control and Prevention, his job.

The pandemic fears of the time and the resulting vaccine controversy may be fueling some of the public's — and media's — anxiety about the current outbreak, said health officials who recalled the previous event.

Ward said his family discussed the vaccine in 1976 and decided not to get it. If a vaccine is ordered for this latest threat, he said, "I'm not getting it. I felt back then like it was a bunch of baloney."

The swine flu brush of 1976 — some call it a debacle — holds crucial lessons for the government and health officials who must decide how to react to the new swine flu threat in the days and weeks ahead, said those involved in the 1976 experience.

For starters, officials must keep the public informed. They must admit what they know and don't know. They must have a plan ready should the health threat become dangerous. And they must soothe everyone's nerves with reassurances that there is no need to worry in the meantime.

It's a tall order. Doubts about the government's ability to handle a possible flu pandemic linger from three decades ago, said Dr. Richard P. Wenzel, chairman of internal medicine at Virginia Commonwealth University, who diagnosed some of the early cases in 1976.

However, health experts today know much more about influenza, vaccines and the public's reaction to both, he said.

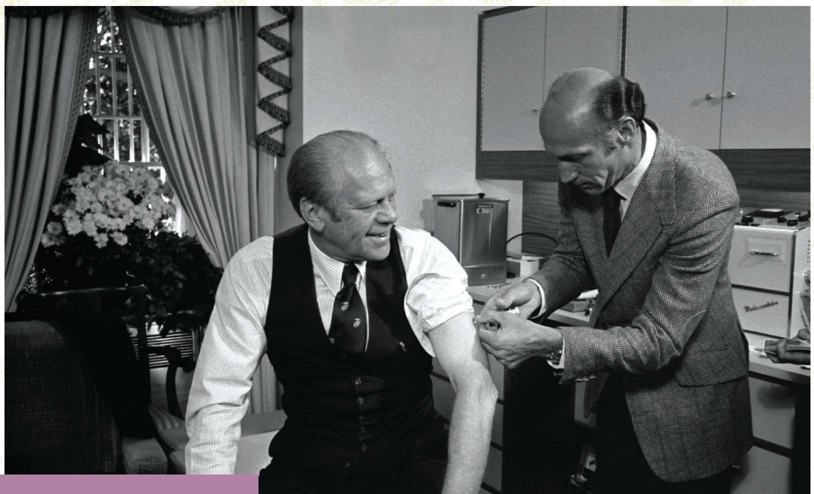
"I think we're going to have to be cautious," Wenzel said. "Hopefully, there will be a lot of good, honest public health discussion about what happened in 1976."

Officials should be prepared for plenty of second-guessing, especially for any decisions regarding vaccination, which was at the core of the 1976 controversy, said Dr. David J. Sencer, the CDC director who led the government's response to the threat and was later fired.

"There were good things and bad things about it," said Sencer, who is retired and lives in the Atlanta area. "People have to make science the priority. They have to rely on science rather than politics."

The question of whether politics overtook science in 1976 still haunts those involved and has been the fodder of books, articles and discussions for 33 years.

The panic in 1976 was due in part to the belief — now known to be erroneous — that the 1918-19 flu pandemic, which killed half a million Americans and an estimated 20 million people worldwide, was caused by a virus with swine components. Recent research suggests instead that it was avian flu — but that seems unlikely to assuage the anxiety over the current outbreak.



President Ford receives a swine flu inoculation from his White House physician, Dr. William Lukash. October 14, 1976.

Credit: Courtesy Gerald R. Ford Library

The episode began in February 1976, when an Army recruit at Ft. Dix, N.J., fell ill and died from a swine flu virus thought to be similar to the 1918 strain. Several other soldiers at the base also became ill. Shortly thereafter, Wenzel and his colleagues reported two cases of the flu strain in Virginia.

"That raised the concern that the original cluster at Ft. Dix had spread beyond New Jersey," said Wenzel, former president of the International Society for Infectious Diseases.

At the CDC, Sencer solicited the opinions of infectious disease specialists nationwide and, in March, called on President Ford and Congress to begin a mass inoculation. The $137-million program began in early October, but within days reports emerged that the vaccine appeared to increase the risk for Guillain-Barre syndrome, a rare neurological condition that causes temporary paralysis but can be fatal.

Waiting in long lines at schools and clinics, more than 40 million Americans — almost 25% of the population — received the swine flu vaccine before the program was halted in December after 10 weeks.

More than 500 people are thought to have developed Guillain-Barre syndrome after receiving the vaccine and 25 died. No one completely understands what causes Guillain-Barre in certain people, but the condition can develop after a bout with infection or following surgery or vaccination. The federal government paid millions in damages to people who developed the condition or their families.

However, the pandemic, which some experts estimated at the time could infect 50 million to 60 million Americans, never unfolded. Only about 200 cases of swine flu and one death were ultimately reported in the U.S., the CDC said.

The public viewed the entire episode as political farce, said Sencer, instead of a dedicated, science-based effort to protect public health. He said the government chose to err on the side of caution and risk scorn — something that experts working on the current outbreak may also face.

"If we had that knowledge then, we might have done things differently," Sencer said. "We did not know what sort of virus we were dealing with in those days. No one knew we would have Guillain-Barre syndrome. The flu vaccine had been used for many years without that happening. If that hadn't happened, no one would have had any concern about the program."

Wenzel also recommended vaccination in 1976.

"It was a tremendous program," he said. "It was a great effort. It just had unexpected, unfortunate side effects."

In Mexico, where several dozen people have died from the current swine flu outbreak, government officials are under fire for their handling of the situation. But people fail to understand the challenges faced by health officials in the face of a mysterious threat, said Dr. Peter Katona, an infectious disease expert at UCLA.

"You have to look at not only 1976 but 1918," he said. "The pandemic flu that occurred in 1918 lasted a year and a half. In 1976, we didn't know what was going to happen. The virus might burn out. It might proliferate. These viruses have a mind of their own, and we don't know how to predict what will happen."

CDC officials have been wisely circumspect in their comments about the current outbreak, Sencer said.

"I like the fact that they have said, 'We may change our minds,' " he said. "Don't expect health officials to have the answers overnight. These things need time to be sorted out. We're still in the learning curve."

Added Katona: "Do you get too concerned and then nothing happens and you turn people off? Or do you get not too concerned and then it gets really bad and you're accused of dropping the ball? Public health officials have incomplete information. They know some things but they don't have all the information that they need."

One of the most difficult decisions will be whether to initiate work on a vaccine, which could take months to develop with no way of knowing the scope of the outbreak six months from now, experts said.

No decision has been made yet, although CDC officials are working on a so-called seed vaccine, an early version that can be used, if needed, for mass production of a vaccine.

"If the situation evolves to the point where we need to use a vaccine we would hope to have it within six months," CDC spokesman Tom Skinner said Sunday.

Since the 1976 episode, annual flu vaccines have been provided without the serious side effects seen then. A study from CDC scientists published in the current issue of the journal Drug Safety concludes that evidence exists for a link between the 1976 swine flu vaccine and Guillain-Barre syndrome but not for most other vaccines developed in the last 55 years. But debate continues in scientific circles over the risk of Guillain-Barre posed by vaccination.

The technology involved in developing vaccines has improved and safety is not a great concern, Wenzel said. But some people may refuse any immunization recommendation based on the 1976 experience.

"People called it the 'swine flu fiasco,' " he said. "And for years the public's willingness to accept vaccines was diminished for all kinds of vaccines, but particularly for the flu. It was an unfortunate setback."

Public health officials are in an unenviable position, other experts said. In a retrospective of the 1976 swine flu experience published three years ago in the journal Emerging Infectious Disease, various health experts debated how the situation was handled and what could be learned from it.

The person who headed the National Institute of Allergy and Infectious Diseases in 1976, Dr. Richard Krause, noted drolly that public health officials involved in the next pandemic flu threat "have my best wishes."

Credit: Roan, S. (2009). Swine flu 'debacle' of 1978 is recalled. *LA Times*, 4/27/09.

Name:____________________ Date:________ Period:______

Lessons Learned from 1976

Lessons learned from the 1976 swine flu 'fiasco'
By Rita Rubin
5/5/2009, *USA TODAY*

Former Health and Human Services secretary Michael Leavitt urged current Cabinet members last week to read *The Swine Flu Affair: Decision-making on a Slippery Disease*.

The Swine Flu Affair isn't an "instant book" rushed into print because of the worldwide outbreak of H1N1 flu: It was published in 1978, and its title refers to the swine flu of 1976, when public health officials urged all Americans to get immunized against an epidemic that never materialized. Dozens of Americans fell ill with a rare condition linked to the 1976 flu vaccine, and some died.

The ghosts of flu and severe acute respiratory syndrome (SARS) both haunt and inform today's response to H1N1.

When it comes to controlling the flu, says Harvey Fineberg, co-author of *The Swine Flu Affair*, public health and political leaders seem to have learned that they can prepare to take action without prematurely committing to it.

Just because they've decided to develop an H1N1 vaccine doesn't mean they have to use it. As Anthony Fauci, head of the National Institute for Allergy and Infectious Diseases noted last week, "there's a big difference between having it ready and distributing it."

The 1976 swine flu program was "overwhelmingly recalled as a 'fiasco,' a 'disaster,' or a 'tragedy,' " wrote Fineberg and co-author Richard Neustadt, the late founder of Harvard's Kennedy School of Government.

The government signed off on developing a vaccine and using it at the same time, without ever reassessing the need for immunizing against the unpredictable flu virus.

Specter of the 1918 pandemic

In January 1976, public health officials identified a handful of swine flu cases among new army recruits at Fort Dix, N.J. No subsequent cases of person-to-person swine flu transmission were reported anywhere in the world.

And yet, in March 1976, David Sencer, head of the Centers for Disease Control, wrote a memo comparing the outbreak to the 1918 Spanish flu pandemic, which killed at least 20 million worldwide. Sencer called for mass immunization. Less than two weeks later, President Ford announced he was recommending such a move.

"You can't overstate the specter of 1918 that was hovering in the background," says Fineberg, now president of the Institute of Medicine. "That was the worst natural cataclysm of the 20th century." In addition, he says, when the Hong Kong flu pandemic broke out in early fall 1957, "there was a sense that the vaccine came too late."

So the vaccine for the 1976-1977 flu season included swine flu, Fineberg says, "and the argument was 'Why store it on the shelf? Why not store it in people? Protect them already.' "

The first shots were given Oct. 1, 1976. By Dec. 14, 54 cases of Guillain-Barré syndrome, in which the immune system attacks the nerves, causing paralysis, had been reported in 10 states. Thirty had received the swine flu shot in the month before symptoms appeared.

The government suspended the shots on Dec. 16, but not before 40 million Americans had received them. "The risk of developing Guillain-Barré syndrome seemed to be 11 times greater with vaccination than without," wrote Fineberg and Neustadt. Still, they noted, the risk was remote, about 1 in 105,000.

A 1976 New Jersey Influenza (swine flu) Immunization Campaign. Use of jet injector for immunization.

Source: CDC

'Cooler heads are prevailing'

Joseph Califano, who became Jimmy Carter's Health, Education, and Welfare secretary in January 1977, asked Neustadt and Fineberg to investigate the swine flu program "in search of lessons for the future, not of fault in the past," as he writes in their book's introduction.

In an interview this week, though, Califano, chair of the National Center on Addiction and Substance Abuse at New York's Columbia University, placed blame on Sencer. "The guy who was running the CDC wrote a scary memo that was like a gun to the head of the president," said Califano, who fired Sencer. Today, Califano says, "I think cooler heads are prevailing."

Barry Bloom, Fineberg's successor as Harvard School of Public Health dean, also praised public health officials' handling of H1N1: "The world is capable of creating a global alert without creating panic. That's a major difference from SARS." SARS first appeared in China in November 2002, but China didn't tell the World Health Organization until February 2003.

Credit: Rubin, R. (2009). Lessons learned from the 1976 swine flu 'fiasco'. *USA Today*, 5/5/09.

Name:______________________________ Date:___________ Period:________

Reading Guide

HANDOUT

Answer the following questions in your journal or on a separate piece of paper:

Swine Flu "Fiasco" and "Debacle" of 1976

1. Describe the public health policy mistakes made during the 1976 "Swine Flu Fiasco."
2. Describe the differences between the 1976 flu and 1918 flu in terms of what actually happened.
3. Describe the differences between the 1976 flu and the 1918 flu in terms of the government response.
4. Identify possible reasons for the government actions that were taken in 1976 and describe lessons that should be learned from this public health "fiasco."

"Smart Talk" Guide

5. My raw idea (answer to the question: what lessons should be learned from this public health "fiasco"):
6. Group members' ideas (give names):
7. Synthesis of our ideas (how have my group members changed my thinking or contributed to my thinking?)

LESSON

LESSON 4
The Next Plague

Activity Time: 90 minutes

In this lesson, students will view the film *The Next Plague: Avian Influenza* and will describe how governments have responded to avian influenza outbreaks.

This lesson should be delivered so that it is preceded by the lesson *Swine Flu: Lessons Learned from 1976* and is followed by the lesson *Recommendations for Protecting Public Health*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Government Response:** Government plays an important role in my life by safeguarding public health, although not all programs have been successful.
- **Lessons from History:** We can learn from previous public health mistakes.

Essential Question:

- What is the role of government in my life?
- How does the government act to safeguard public health?

Learning Objectives:

Students will know…

- Public health officials make recommendations for preparing for a possible avian flu pandemic.

Students will be able to…

- Describe scientists' predictions about a possible avian flu pandemic.

Vocabulary:

- Anti-viral medicines
- Avian influenza
- Bird flu
- H5N1 influenza virus
- Pandemic
- Vaccines

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History EALR 4, GLE 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.

Common Student Preconceptions:

- Students probably do not understand the differences between different types of influenza viruses.
- Bird flu is a type of flu that makes birds sick.

TEACHER PREPARATION

Materials:

- DVD player and TV/projector
- Computer with internet, speakers, and projector
- *The Next Plague: Avian Influenza* DVD
- *The Next Plague Viewing Guide* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Prepare TV/Projector and DVD player for viewing the program.
- Preview the film so that you are prepared to lead discussions about its content.
- Be aware that the film shows images that may be disturbing to some students, such as images of hospitals, morgues, and dead bodies.

PROCEDURE

Hook

1. Show the photographs that accompany the *National Geographic* article, "Tracking the Next Killer Flu." The photographs can be accessed from the magazine's website.

   Tracking the Next Killer Flu
   http://ngm.nationalgeographic.com/ngm/0510/feature1/

Activity

5. Pass out copies of *The Next Plague Viewing Guide* Handout, one per student.
6. Show the 44 minute film, *The Next Plague: Avian Flu*. The film has several natural breaks where the film can be paused, either for discussion, or to continue during the next day's class session. However, it is recommended that the film be stopped with enough time before the end of the class period to allow some discussion time, as the content of the film may be disturbing for some students.
7. While watching the film, students should use the Viewing Guide to take notes. After finishing the film, students should complete all the questions on the handout.
8. Lead a class discussion about students' responses to the film. In particular, discuss students' opinion about whether or not the film could be considered propaganda, and if so, what perspective is the film's producers advocating?

Wrap-Up

9. Pass out Exit Tickets with the following question:
   - In no more than four sentences, describe scientists' predictions about a possible avian flu pandemic.
   - List 2-3 ways that you think the government should respond to an influenza pandemic. Give a reason supporting each suggestion.

STUDENT ASSESSMENT

Assessment Opportunities:

- The Viewing Guide and Exit Ticket can be used to assess changes in student understanding.

Scoring:

- The Viewing Guide can be graded using the provided Teacher Answer Key.

Student Metacognition:

- At the beginning of the lesson, students are asked to consider their preconceptions about the dangers of the flu. On the Viewing Guide, students are asked to reflect on how the film changed their thinking about the flu and infectious diseases.
- The Exit Ticket questions ask students to suggest how the government should respond to an influenza pandemic and to support their thinking with reasoning.

EXTENSION ACTIVITIES

Extension Activities:

- Share with students some of the readings from the USDA on avian influenza. See the Resources section.
- Ask students to complete the Bird Flu Today Public Awareness Campaign webquest. See the Resources section.

Adaptations:

- If you do not have access to the DVD, as an alternative students can read the *National Geographic* article "Tracking the Killer Flu" and view related photos. There's also a multimedia feature narrated by photographer Lynn Johnson. See the Resources section.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum as well as the websites provided in the Resources section below.

Resources:

The Next Plague: Avian Flu DVD
History Channel, 43:44 minutes, 2005, Available for instant view on Netflix or for purchase
http://www.amazon.com/Next-Plague-Avian-History-Channel/dp/B000FBFYY6

Tracking the Next Killer Flu
National Geographic, October 2005
http://ngm.nationalgeographic.com/ngm/0510/feature1/

USDA Understanding Avian Influenza
http://www.csrees.usda.gov/avianlessonplan.pdf

Webquest: Bird Flu Today Public Awareness Campaign
Koshland Science Museum, http://www.koshland-science-museum.org/teachers/wq-id_bf_002.jsp

WHO Avian Influenza
http://www.who.int/csr/disease/avian_influenza/en/index.html

CDC Avian Influenza
http://www.cdc.gov/flu/avian/

Name:________________________ Date:__________ Period:________

The Next Plague Viewing Guide

1. What are some characteristics of avian influenza that makes it "one of the most serious public health problems" and the greatest risk for a catastrophic global pandemic?

2. The film discusses the many dimensions of an influenza pandemic. Use the table below to take notes on government responses and the consequences of these multiple dimensions.

Ethical	Political/Legal	Economic
Infrastructure	**Social/Cultural**	**Psychological**

3. Go back to the notes you made in the table. What is one way that you think the government should respond to an influenza pandemic? Explain your reasoning.

4. Provide one example of an ethical dilemma that may arise in the face of an influenza pandemic. Does the government have a role in influencing this dilemma?

5. Provide one example of a serious economic consequence that might result from an influenza pandemic. Does the government have a role in influencing this consequence?

6. Did anything in the film change the way that you think about the flu or infectious diseases in general? Do you think the film will in anyway alter your thinking or behavior?

7. Do you think the film provide multiple, balanced perspectives or could it be considered as propaganda? Why or why not?

Name:______________________ Date:__________ Period:________

The Next Plague Viewing Guide

KEY

1. What are some characteristics of avian influenza that makes it "one of the most serious public health problems" and the greatest risk for a catastrophic global pandemic?

Possible answers include:

- The virus can be shed prior to the presentation of symptoms.
- The virus can live outside of the body, on surfaces like handrails and doorknobs.
- Once inside the body, the virus spreads rapidly.
- The virus can quickly mutate.
- The virus can mutate so that it can be transmitted from animals-to-humans and from humans-to-humans.
- People don't usually have natural immunity to avian influenza.

2. The film discusses the many dimensions of an influenza pandemic. Use the table below to take notes on government responses and the consequences of these multiple dimensions.

Ethical	Political/Legal	Economic
• Prioritizing medical equipment like ventilators and medications like Tamiflu • Providing medical care and funeral services for people without insurance/funds • Poor people are the most impacted	• Instituting medical checks on international flights • Stockpiling and administering vaccines and anti-virals • Increases police presence to deal with heightened crime and public panic • Grounding of international flights • Closure of borders, airports and seaports • Closure of schools • Public gatherings prohibited • Marshall law enacted	• Cost to treat uninsured people • Cost to insurance companies • Costs for police and military presence • Closure of businesses, schools and workplaces • Interruption of global transportation and commerce • Borders sealed • Trillion dollar impact to global economy

Infrastructure	Social/Cultural	Psychological
• Setting up isolation rooms and wards in hospitals • Lack of hospital beds, staff, ventilators • Breakdown of burial and cremation services • Setting up makeshift morgues • Availability of food, water, and basic services ceases • Crime rates soar	• Urban flight as people try to escape to rural locations • Quarantines • Psychological impacts to health-care workers • Grief • Breakdown of all routines of daily life • Increase in crime	• Development of new vaccine and anti-virals

3. Go back to the notes you made in the table. What is one way that you think the government should respond to an influenza pandemic? Explain your reasoning.

Answers may include any of the government responses included in the table above.

4. Provide one example of an ethical dilemma that may arise in the face of an influenza pandemic. Does the government have a role in influencing this dilemma?

Answers may include any of the ethical dilemmas included in the table above.

5. Provide one example of a serious economic consequence that might result from an influenza pandemic. Does the government have a role in influencing this consequence?

Answers may include any of the economic situations included in the table above.

6. Did anything in the film change the way that you think about the flu or infectious diseases in general? Do you think the film will in anyway alter your thinking or behavior?

Answers will vary.

7. Do you think the film provide multiple, balanced perspectives or could it be considered as propaganda? Why or why not?

Answers will vary.

LESSON

LESSON 5
Recommendations for Protecting Public Health

Activity Time: 90 minutes (less time if assignment is given as homework)

Students will identify and evaluate recommendations for safeguarding public health in the case of an influenza pandemic. Students will communicate their recommendations in the form of a letter to a newspaper editor, a public health official, or an elected official.

This lesson should be delivered so that it is preceded by the lesson *The Next Plague*. In the lesson *The Next Plague*, students viewed a video that showed how daily life might be changed from a catastrophic avian influenza pandemic. This lesson plan gets students thinking government planning and preparation for pandemic flu, and also encourages students to think about the effects of an influenza pandemic in their own community.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Government Response:** Government plays an important role in my life by safeguarding public health, although not all programs have been successful.
- **Lessons from History:** We can learn from previous public health mistakes.
- **Role of Science:** We can learn from research on infectious diseases and make informed decisions.

Essential Question:

- What is the role of government in my life?
- How does the government act to safeguard public health?

Learning Objectives:

Students will know…

- Government agencies, such as local public health departments, the CDC, and WHO, make recommendations about responding to current influenza risks.

Students will be able to…

- Describe public health officials' recommendations about preparing for a possible influenza pandemic.
- Decide what recommendations should be stressed in messages to decision makers in their communities.
- Write a persuasive letter.

Vocabulary:

- Influenza
- Pandemic
- Persuasive letter

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **History 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.
- **Writing 2.1** Adapts writing for a variety of audiences.
- **Writing 2.2** Writes for different purposes.

Common Student Preconceptions:

- Students may not have experience with thinking about various public health recommendations.
- There's nothing we can do to prepare for pandemic flu.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- Computer lab
- Sticky notes (8 pads)
- *Recommendations for Protecting Public Health* Handout (1 per student)

Preparation:

- Preview the video.
- Make copies of the Student Handout.
- If students are not familiar with persuasive writing, deliver a mini-lecture on persuasive writing technique, language, and format.

PROCEDURE

Hook

1. Show students the 20 minute video **Business Not As Usual: Preparing for a Pandemic Flu** from Public Health—Seattle & King County. The video shows the interdependences of services (food/water, energy, economic, social, law enforcement and fire, etc.) and how local government agencies can lead their communities in planning for the continuation of these services in the face of pandemic flu.

   Business Not As Usual: Preparing for a Pandemic Flu Video
   http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu/video.aspx

2. Lead a brief class discussion about the video. What was most striking about the video? What were some examples presented in the video about how communities can plan for pandemic flu?

Preconceptions

3. Ask students to share their thoughts on the following question: What do you think are the most important actions our community should take to prepare for pandemic flu?

Activity

4. Students are challenged to develop their own recommendations for how to protect public health in the face of pandemic flu, and to communicate their recommendations in the form of a letter to a newspaper editor, a public health official, or an elected official. Students will use the knowledge they have developed thus far in their study of influenza, along with new knowledge obtained from public health websites, to develop their recommendations and write their letter.
5. Break students into four groups (one group for each of the areas of focus) or alternatively, allow students to choose on their own. The areas of focus include:
   - Individuals and families
   - Schools and child care programs
   - Businesses and employers
   - Social service providers, homeless shelters and churches
6. Pass out copies of the *Recommendations for Protecting Public Health* Handout, one per student. Review the learning task with the students.
7. Allow time for writing and revising in class, or assign the task as homework to be shared and turned in during the next class period.

Wrap-Up

8. Break students into small groups of 4 students. If possible, form groups so that there is one student representing each of the four areas of focus in each group. Pass out pads of sticky notes to each group.
9. Explain to the groups that as each student reads their letter aloud, the other students will listen and write comments on the sticky notes about what they thought were the strengths of the letter.
10. Ask students to attach the sticky notes to their letters, staple the handout to the front page, and turn them in for credit.

STUDENT ASSESSMENT

Assessment Opportunities:

- The students' letters can be graded using the criteria provided in the Scoring section to the right.
- Students can be assigned participation points for contributing to class and small group discussions.

Student Metacognition:

- Students could be asked to respond, in writing, to the sticky note comments provided by their peers.
- The learning task challenges students, based on research, to develop their own recommendations and to support those suggestions with factual information.

Scoring:

- In order to receive full credit, each student letter will include:
  1. Uses a formal letter format.
  2. Uses persuasive language.
  3. Identifies and explains 5 actions that will protect public health in the case of an influenza pandemic.
  4. Identifies 2-3 action items that the student thinks are most important to implement in the case of an influenza pandemic. Explains how each action item will protect public health.
  5. Explains why these 2-3 action items are the most important.
  6. For each action item, identifies one counter-argument and explain how that concern can be resolved, or why it is not a valid concern.
  7. Identifies one action item that some people may think is necessary, but that the student does not recommend. Explains their reasoning.

EXTENSION ACTIVITIES

Extension Activities:

- Ask students to complete the **Bird Flu Today Public Awareness Campaign** webquest. See the Resources section.

Adaptations:

- Instead of writing a persuasive letter, students could produce a comic book similar to the **No Ordinary Flu** comic published by Seattle and King County Public Health (See Resources section). Students' comic should outline needed public health policies that must be taken by the government.
- Instead of writing a persuasive letter, students could design a public awareness message in one of the following formats: brochure, radio, television, or website.
- Instead of writing a persuasive letter, challenge students to write a grant proposal for influenza pandemic preparedness/response to the Bill & Melinda Gates Foundation. See the **NOW with Bill Moyers** lesson plan in the Resources section.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on influenza can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

Business Not As Usual: Preparing for a Pandemic Flu Video
Public Health—Seattle & King County, 20 minutes
http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu/video.aspx

Pandemic Flu Preparedness
Public Health—Seattle & King County
http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu.aspx

***No Ordinary Flu* Comic Book**
Seattle and King County Public Health
http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu/comicbook.aspx

Webquest: Bird Flu Today Public Awareness Campaign
Koshland Science Museum
http://www.koshland-science-museum.org/teachers/wq-id_bf_001.jsp

NOW with Bill Moyers: Global Health Lesson Plan
http://www.pbs.org/now/classroom/globalhealth.html

WHO Influenza Pandemic
http://www.who.int/csr/disease/influenza/pandemic10things/en/index.html

Pandemicflu.gov
http://pandemicflu.gov

Name:______________________________ Date:____________ Period:_________

Recommendations for Protecting Public Health

HANDOUT

As the global community experienced in 1918, an influenza pandemic can be catastrophic. However, preparedness and planning can help governments to be ready to respond to an influenza pandemic.

You will write a persuasive letter to communicate your own recommendations for safeguarding public health in the face of an influenza pandemic. Using the information you have gained during your study of influenza in U.S. history, you will form a persuasive argument about how to best protect public health.

1. First, let's narrow down the focus of this task. Which of the following segments of society will you be developing your recommendations for (circle one)?

- Individuals and families
- Schools and child care programs
- Businesses and employers
- Social service providers, homeless shelters, and churches

2. Second, choose whether you want to focus the content of your letter on a possible H1N1 or H5N1 pandemic (circle one):

- H1N1 (swine flu) pandemic
- H5N1 (bird flu) pandemic

3. Now, choose who is the audience for your letter (circle one):

- Newspaper editor
- Public health official (local or national?)
- Elected official (local or national?)

4. In order to be persuasive, your letter needs to include factual information. Feel free to use any of your notes or handouts from your study of influenza over the last few days. In addition, the following websites from Public Health—Seattle & King County will be helpful. You may also want to look at your local county's public health department website.

Individuals & Families
Get Ready for Flu
http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu/swineflu/general.aspx#planning

Schools & Child Care Programs
Preparing for the Flu: A Communication Toolkit for Schools (Grades K-12)
http://www.cdc.gov/h1n1flu/schools/toolkit/pdf/schoolflutoolkit.pdf

Social Service Providers, Homeless Shelters & Churches
FAQ sheets
http://www.kingcounty.gov/healthservices/health/preparedness/pandemicflu/swineflu/community.aspx

For Businesses and Employers
Preparing for the Flu: A Communication Toolkit for Businesses and Employers
http://www.cdc.gov/H1N1flu/business/toolkit/pdf/Business_Toolkit.pdf

5. Now it's time to write your letter. Use a formal letter format. Remember to use persuasive language and to back-up any suggestions or assertions with factual information. Your letter needs to include the following components:

- Identify and explain 5 actions that will protect public health in the case of an influenza pandemic.
- Identify 2-3 action items that you think are most important to implement in the case of an influenza pandemic. Explain how each action item will protect public health.
- Explain why these 2-3 action items are the most important.
- For each action item, identify one counter-argument and explain how that concern can be resolved, or why it is not a valid concern.
- Identify one action item that some people may think is necessary, but that you do not recommend. Explain your reasoning.

6. When you have edited and revised your letter and are ready to turn it in for grading, staple this handout to the front of your letter.

malaria

LESSON 1: Climate Change & Malaria

(or Why Mosquitoes Don't Want You to Know about Climate Change)

Activity Time: 50 minutes

In this lesson, students will use an exponential graph and equation to determine the relationship between temperature and incubation time of the malaria-causing parasite, *Plasmodium falciparum*, in mosquitoes.

This lesson fits well within an exponential and logarithmic functions unit. Before beginning this activity, students should be familiar with the general form of an exponential equation: $y=a \cdot b^x$.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Relationships:** There is a relationship between temperature and incubation time of the *Plasmodium falciparum*.
- **Exponential Functions:** Exponential functions can be used to model the relationship between temperature and incubation time of the malaria parasite.

Essential Question:

- How can an exponential function model the relationship between temperature and incubation time of the *Plasmodium falciparum*?

Learning Objectives:

Students will know…

- Malaria is caused by the parasite, *Plasmodium falciparum*, which is transmitted through the bite of an infected female Anopheles mosquito.

Students will be able to…

- Interpret an exponential graph.
- Determine an equation that fits the graph.

Vocabulary:

- Exponential decay
- Incubation
- Malaria
- Parasite
- *Plasmodium falciparum*

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.1.D** Solve problems that can be represented by exponential and logarithmic functions and equations.
- **A2.4.C** Solve exponential and logarithmic equations.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.

Common Student Preconceptions:

- There can't be a non-zero asymptote for an exponential function.
- Malaria only affects people in Africa.
- Malaria isn't a serious disease, you just need to take medicine to get better.
- When traveling to some parts of the world, you need to take anti-malarial medicines.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *Climate Change & Malaria* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Be sure you are able to play the video.
- Make copies of the Student Handout.
- Students will need to read the Student Background Reading on malaria from the Introduction to Global Health section of the curriculum prior to participating in this math activity.

PROCEDURE

Hook:

1. Show the 2.5 minute video **Highland Malaria in Kenya** to get students interested in the connections between temperature, climate change, and malaria.

   Highland Malaria in Kenya
   2:41 minutes
   http://www.youtube.com/watch?v=g2XQWUjtIH4

Preconceptions:

2. Before beginning this activity, students should be familiar with the general form of an exponential equation: $y = a{\cdot}b^x$. This equation only applies when the function has a horizontal asymptote at $y = 0$. It may be good to introduce an alternate form of the general exponential equation: $y = a{\cdot}b^x + c$ where c is the value of the horizontal asymptote. If students are unfamiliar with this vertical shift of the exponential graph, then it may be necessary to look at a couple of vertically shifted exponential graph examples before beginning the lesson.

Activity:

3. Hand out copies of the *Climate Change & Malaria* Handout, one per student.
4. Review the background information that is provided on the Student Handout.
5. As students work on the problems presented on the handout, monitor student progress.

Wrap-up:

6. When students have completed all the problems on the handout, discuss what difference will an increase of 0.5 degrees in temperature will make for some communities around the world?

STUDENT ASSESSMENT

Assessment Opportunities:

- Students' understanding of the video can be assessed by asking comprehension questions.

Scoring:

- The Student Handout can be scored using the Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- You may want to share another video with students which discusses how climate change will likely bring malaria to first world countries, with a focus on the U.K.

  UK Doctors Warn Over Climate Change
  British Satellite News, 2008, 3:47 minutes
  http://www.youtube.com/watch?v=5bnKirxp3Tc&feature=PlayList&p=39775007DC864C45&playnext=1&playnext_from=PL&index=14

Adaptations:

- If students aren't yet familiar with the general form of an exponential equation: $y = a \cdot b^x$, provide instruction on this topic prior to delivering this lesson.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, the data used in this lesson is from an article published in the *Proceedings of the National Academy of Sciences of the U.S.A.*

Patz, J.A. & Olson, S. H. (2006). Malaria risk and temperature: Influences from global climate change and local land use practices. *Proceedings of the National Academy of Sciences of the Unites States of America*. April 11, 2006, vol. 103, no. 15, 5635-5636. Available at http://www.pnas.org/content/103/15/5635.full.

Resources:

Highland Malaria in Kenya Video
IrinFilms, 2009, 2:41 minutes
http://www.youtube.com/watch?v=g2XQWUjtlH4

UK Doctors Warn Over Climate Change Video
British Satellite News, 2008, 3:47 minutes
http://www.youtube.com/watch?v=5bnKirxp3Tc&feature=PlayList&p=39775007DC864C45&playnext=1&playnext_from=PL&index=14

Climate Change May Alter Malaria Patterns
2/12/09 *Science Daily*
http://www.sciencedaily.com/releases/2009/02/090214162631.htm

Malaria and Dengue the Sting in Climate Change
11/20/08 *Rueters News*
http://www.reuters.com/article/environmentNews/idUSTRE4AJ2RQ20081120

Malaria Risk and Temperature
Proceedings of the National Academy of Sciences of the United States of America, 2006
http://www.pnas.org/content/103/15/5635.full.

Credit:

Data in this lesson plan is from: Patz, J.A. & Olson, S. H. (2006). Malaria risk and temperature: Influences from global climate change and local land use practices. *Proceedings of the National Academy of Sciences of the United States of America*. April 11, 2006, vol. 103, no. 15, 5635-5636. Available at http://www.pnas.org/content/103/15/5635.full.

Name:______________________________ Date:___________ Period:________

Climate Change & Malaria

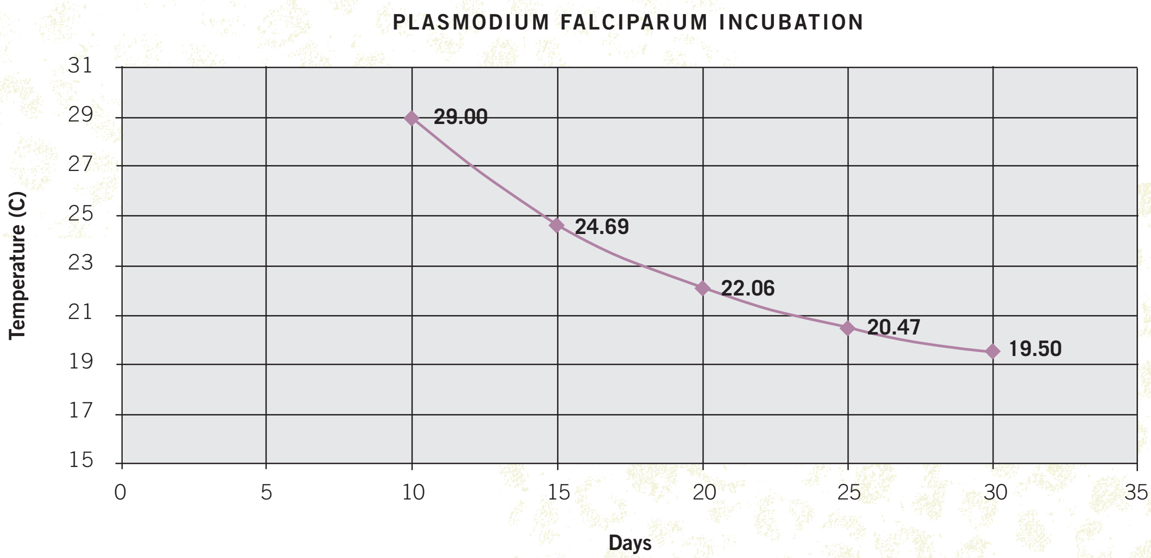
(or Why Mosquitoes Don't Want You to Know about Climate Change)

Background Information:

Malaria grips many of the impoverished regions throughout the world, killing between 700,000 and 2.7 million people each year. And as Earth warms, researchers only expect the problem to get worse.

Temperature is critical to malaria's spread. An Anopheles mosquito picks up the *Plasmodium* parasite that carries the disease when it bites an infected human, and it carries the parasite in its gut, where it matures—a process that takes about 10 to 14 days at about 25°C. At temperatures below about 18°C the parasite doesn't mature fast enough, and the mosquito dies before it can pass it on. Temperatures above 40°C kill the parasite.

Below is a graph of temperature and incubation days for *Plasmodium falciparum*, the parasite that causes malaria.



1. Referring to the background information above, what might you expect the horizontal asymptote of the graph above to be?

2. Looking at the shape of the graph and knowing that it has a horizontal asymptote, what type of function do you think it might be?

3. In order to find the equation for this function, you will need to know the general form of the function. Write the general form for your function in terms of Temp (T) and Days (D). Because the function has a non-zero asymptote, you will need to add the value of the asymptote to the end of your function.

4. Using the two endpoints from the graph, determine the specific equation of the graph.

5. The average lifespan of an Anopheles mosquito is 2 – 3 weeks. What is the coolest temperature that an average mosquito could host the *Plasmodium* and have the *Plasmodium* mature?

6. The community of Nanyuki, Kenya lies at an altitude of approximately 6500 feet and so is above what was once considered the "mosquito line" – an elevation where communities are generally malaria-free. If the average temperature in Nanyuki is around 21°C, how many incubation days does this temperature correspond with? Is it longer or shorter than the average lifespan of a mosquito?

7. If deforestation of the surrounding area leads to an average increase of temperature of 0.5 degrees Celsius, what is the corresponding new incubation time for the *Plasmodium*? Is it longer or shorter than the average lifespan of a mosquito?

Climate Change & Malaria

(or Why Mosquitoes Don't Want You to Know about Climate Change)

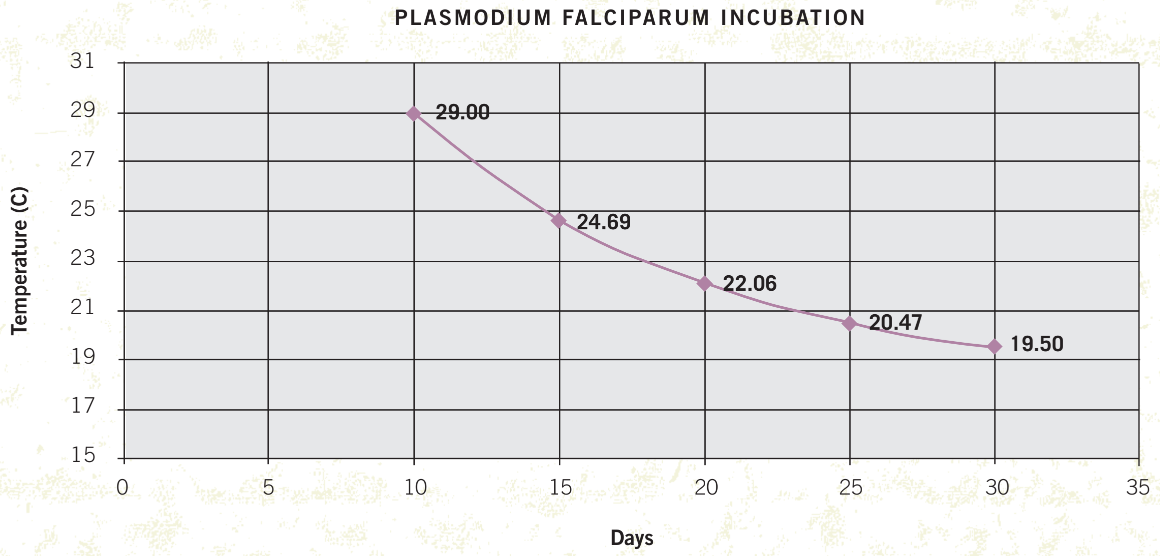
KEY

Background Information:

Malaria grips many of the impoverished regions throughout the world, killing between 700,000 and 2.7 million people each year. And as Earth warms, researchers only expect the problem to get worse.

Temperature is critical to malaria's spread. An Anopheles mosquito picks up the Plasmodium parasite that carries the disease when it bites an infected human, and it carries the parasite in its gut, where it matures—a process that takes about 10 to 14 days at about 25°C. At temperatures below about 18°C the parasite doesn't mature fast enough, and the mosquito dies before it can pass it on. Temperatures above 40°C kill the parasite.

Below is a graph of temperature and incubation days for *Plasmodium falciparum*, the parasite that causes malaria.



1. Referring to the background information above, what might you expect the horizontal asymptote of the graph above to be?

   18ºC

2. Looking at the shape of the graph and knowing that it has a horizontal asymptote, what type of function do you think it might be?

   Exponential function

3. In order to find the equation for this function, you will need to know the general form of the function. Write the general form for your function in terms of Temp (T) and Days (D). Because the function has a non-zero asymptote, you will need to add the value of the asymptote to the end of your function.

   $T = a \cdot b^{D} + 18$

4. Using the two endpoints from the graph, determine the specific equation of the graph.

   $29 = a \cdot b^{10} + 18 \qquad 19.5 = a \cdot b^{30} + 18$

   $11 = a \cdot b^{10} \qquad 1.5 = a \cdot b^{30}$

   $$\frac{1.5 = a \cdot b^{30}}{11 = a \cdot b^{10}} \rightarrow .136 = b^{20}$$

   $b = 0.9052$

   $11 = a \cdot 0.9052^{10}$

   $a = 27.7881$

   $T = 27.7881 \cdot 0.9052^{D} + 18$

5. The average lifespan of an Anopheles mosquito is 2 – 3 weeks. What is the coolest temperature that an average mosquito could host the *Plasmodium* and have the *Plasmodium* mature?

   $T = 27.7881 \cdot 0.9052^{21} + 18$

   $T = 21.679°C$

6. The community of Nanyuki, Kenya lies at an altitude of approximately 6500 feet and so is above what was once considered the "mosquito line" – an elevation where communities are generally malaria-free. If the average temperature in Nanyuki is around 21°C, how many incubation days does this temperature correspond with? Is it longer or shorter than the average lifespan of a mosquito?

   $21 = 27.7881 \cdot 0.9052^{D} + 18$

   $0.1080 = 0.9052^{D}$

   $$\frac{\log 0.1080}{\log 0.9052} = D = 22.35 \text{ days}$$

   22.35 days is longer than the average lifespan of a mosquito

7. If deforestation of the surrounding area leads to an average increase of temperature of 0.5 degrees Celsius, what is the corresponding new incubation time for the *Plasmodium*? Is it longer or shorter than the average lifespan of a mosquito?

   $21.5 = 27.7881 \cdot 0.9052^{D} + 18$

   $0.1260 = 0.9052^{D}$

   $$\frac{\log 0.1260}{\log 0.9052} = D = 20.80 \text{ days}$$

   20.80 days is within the range of the average lifespan of a mosquito

LESSON 2:
Bumba's Dilemma:
Malaria & Drug Resistance

Activity Time: 100 minutes

In this lesson, students consider a case study involving a district health officer from the Democratic Republic of the Congo who is considering whether to purchase new anti-malarial drugs, since the drugs he has been using are losing their effectiveness as the parasite develops drug resistance. Students use matrices and graphing calculators to find the coefficients of a polynomial that fits all of the data points given.

This lesson fits well within a polynomial functions unit. Students should already have competence working with matrices and finding the equation for a quadratic function given three points, and solving systems of equations. The lack of these skill can be supported through additional modeling by the teacher.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Matrices:** Matrices can be used to generate various polynomial equations to fit data points.

Essential Question:

- From what you have learned about parasites' ability to become drug resistant, what needs to be done for communities to combat the effects of malaria?

Learning Objectives:

Students will know…

- Any set of data can be fit perfectly by a polynomial with the same degree as the number of points.
- There are times where a linear best-fit will not work as well as a polynomial fit.
- An anti-malarial drug can lose its effectiveness over time as the *Plasmodium* parasite develops resistance to that particular drug.

Students will be able to…

- Set up a matrix to find the coefficients for a higher-degree polynomial fit.

Vocabulary:

- Anti-malarial drug
- Cubic
- Drug resistance
- Linear
- Malaria
- Matrix
- Polynomial
- Quadratic
- Quartic

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.1.C** Solve problems that can be represented by quadratic functions, equations, and inequalities.
- **A2.5.D** Plot points, sketch, and describe the graphs of cubic polynomial functions of the form $f(x) = ax^3 + d$ as an example of higher order polynomials and solve related equations.
- **A2.8.C** Evaluate a solution for reasonableness, verify its accuracy, and interpret the solution in the context of the original problem.

Common Student Preconceptions:

- It is not possible to find an equation that can pass through any number of points perfectly.
- Once a drug is developed, its effectiveness doesn't change.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- TI calculators (1 per student)
- *Bumba's Dilemma* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Make copies of Student Handout.
- Work through the Student Handout so that you are prepared to answer students' questions.

PROCEDURE

Hook:

1. Show students the **Malaria Drug Resistance Fears** video. As they watch the video, challenge students to consider how do doctors know if drug resistance is becoming a problem?

   Malaria Drug Resistance Fears Video
   BBC News, 5/29/09, 2:05 minutes
   http://www.1cast.com/l/184591

2. Pass out copies of the *Bumba's Dilemma* Handout, one per student. As a class, read over the first page of the handout.

Preconceptions:

3. Lead a warm up discussion introducing students to the lesson's topics and eliciting students' preconceptions. For each of the following questions, first ask for students' thoughts and ideas before discussing the answer to each question.
   - Where is the Democratic Republic of Congo located? *Please show this on a world map.*
   - What is the climate like there? *Tropical climate, two seasons (rainy and dry), tropical thunderstorms every 2-3 days.*
   - How does the climate affect the mosquito population? *Mosquitoes need warm weather and water. Mosquitoes breed in water; they can breed in a puddle of water as small as the water that fills a cow's hoof print*
   - What is drug resistance? *In the case of malaria, drug resistance is when the malaria parasite develops resistance to the anti-malarial drug, then those parasites with resistance are more able to survives and reproduce. Subsequent generations are less affected by that drug.*

Activity Introduction:

4. After reviewing the scenario on the handout, ask students to suggest what tools they already have that can be used to approach this problem. Some ideas include:
   - Linear best-fit line
   - Possibly exponential functions
   - Using intuition to make an educated guess
   - Creating a quadratic equation from three of the points
5. Introduce the main goal of this lesson—to create a polynomial that fits every single data point. Discuss the differences between a best-fit line and such a polynomial (hitting every data point).
6. On the board, create a graph with only two points, and show (or have students draw) how you could create the following functions using those two points: linear, quadratic, cubic.

7. Ask students to turn and talk to a partner about the following question:
   - Which function makes sense to use for those two points, and why didn't you choose the other two functions?
8. Create a new graph with three points (not in a line), and show (or have students draw) how you could create the linear, quadratic, and cubic functions through those three points.
9. Ask students to turn and talk to a partner about the following question:
   - Which function makes sense to use for those three points, and why didn't you choose the other two functions?
10. Create a graph with four points, and show how a cubic function could hit all four points. Students may need some prompting to understand how to recognize it as a cubic function without an equation.
11. Drive home the following key point: For any set of data ('n' data points), you can fit it with a polynomial of degree (n-1), but this is not always appropriate.

Problem Solving Modeling:

12. Work through problem #2 on the handout with students. Model how to create the equations, without solving for the coefficients. This will be an important step for creating the matrices.
13. Walk through solving for the coefficients using simple algebra.
14. Show students how to use the equations to fill in their matrices on the handout.
15. It would be beneficial for students to multiply out the first two matrices to see how this matrix equation is the same as the equations from above.

Technology Modeling:

16. Walk students through the process of inputting the matrix into their TI calculators.

    2x3 matrix
    [0 1 24
    8 1 120]
17. Show students how to find the **rref**(function (2^{nd} > MATRIX > **MATH > B**).
18. On the main screen, the calculator should show **rref**(and you need to select the matrix that you will operate on from the MATRIX menu.

    Ex: **rref**([A]
19. Show how the matix that is output matches up with the coefficients "a" and "b".
20. Plot the linear function with these two coefficients on the graph.
21. As a class, discuss the following questions:
   - Is this a good function to make a prediction with?
   - Will a prediction from this function be high or low?

Group Work:

22. Ask students to find a partner for the group work part of the activity. Explain your expectations for group work.
23. Remind students that they should find the coefficients by setting up a system of equations before using the matrices.
24. Ask students to work in their pairs on problem #3 – creating the quadratic.
25. Optional: For students that are struggling with creating the quadratic function, pull them into a small re-teaching lesson at the front of the classroom. Use the quadratic as guided practice for these students, having them do the work themselves but conferring on answers and methods after each piece.
26. After students have completed problem #3, discuss their answers as a whole class. Check for understanding before asking students to work on problems #4 and #5. They will not need to solve for the coefficients by elimination or substitution.

27. Discuss the correct coefficients for #4 and #5.

28. The counter-argument question can be required, assigned as extra credit, or simply suggested as a challenge.

Wrap-Up:

29. Ask for volunteers to present their decision for the final questions and justifications. You could also have one group present their decision to purchase the new drugs, and have a second group come up with an argument against using the newer drug (not limited to the data presented).

30. Handout Exit Tickets to each student with the following question:

- If you have a data set of seven points, what degree of polynomial could you fit to every point?

STUDENT ASSESSMENT

Assessment Opportunities:

- The entire activity is an excellent opportunity for informal assessment of students' previous knowledge of matrices, quadratic functions, and solving systems of equations.
- The preconceptions questions provide an opportunity to access students' existing knowledge of the Congo and drug resistance.
- Students can be assessed on their justifications for their decision, rather than the decision itself. This will emphasize the use of mathematics as a piece of evidence or information in making decisions, rather than the determinant of the outcome.

Student Metacognition:

- Students are asked to reflect on what tools they already have that can be applied to the problem.
- The "turn and talk" questions ask students to justify their thinking.
- The Exit Ticket question challenges students to apply their new knowledge to a different situation.

Scoring:

- The Student Handout can be scored using the provided Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- The counter-argument question can be assigned as extra credit.
- Add into the scenario the possibility of selling mosquito nets for $4 each. What balance is best between treatment and prevention strategies?

Adaptations:

- Heterogeneous pairings will address many issues of ELL and SPED students.
- If you are unable to show the video, instead share with students the article *Fears for New Malaria Drug Resistance*.
- Suggestions for how to provide extra support for struggling students are provided in the activity procedures.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section below.

Resources:

Malaria Drug Resistance Fears Video
BBC News, 5/29/09, 2:05 minutes
http://www.1cast.com/l/184591

Fears for New Malaria Drug Resistance
BBC News, 5/29/09
http://news.bbc.co.uk/2/hi/asia-pacific/8072742.stm

World Map: Democratic Republic of Congo
http://www.worldatlas.com/webimage/countrys/africa/cg.htm

CDC: Malaria Drug Resistance
http://www.cdc.gov/malaria/drug_resistance.htm

WHO: Malaria Drug Resistance
http://www.who.int/drugresistance/malaria/en/index.html

Credit:

Fuller, T. (2009). Spread of malaria feared as drug loses potency. *New York Times*, January 26, 2009. Available from: http://www.nytimes.com/2009/01/27/health/27malaria.html?_r=2.

Name:______________________________ Date:__________ Period:________

HANDOUT

Bumba's Dilemma

Bumba worked as the District Health Officer in Bandundu, Democratic Republic of Congo (DRC). One morning, Bumba was worrying about baby Jean-Paul. It seemed that the anti-malarial drug that Bumba had been giving babies for the last 8 years was taking longer and longer to cure his patients. He remembered when his community was first given the anti-malarial. Back then, 24 hours was all it took, and like clockwork, the babies would be given back to their elated mothers, ready to return home, free of malaria. It cost forty cents (half a day's wage) to buy the drug and 24 hours to cure the children Bumba would see every day. But that was 8 years ago.

Bumba looked at Jean-Paul's mother and reassured her that in a few days, she too would be able to take her precious boy home. Bumba knew that instead of 24 hours, it would take 6 days of administering the anti-malarial drug before the deadly parasite would be cleared out of Jean-Paul's bloodstream.

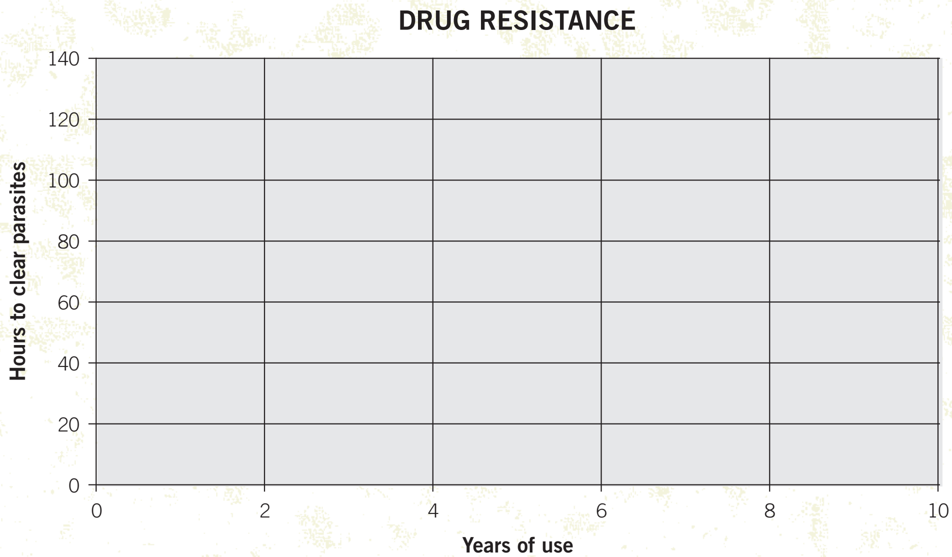
Bumba looked back at his records over the last 8 years of using the anti-malarial drug. Bumba quickly wrote down a table organizing his data. His table showed years of use of the anti-malarial drug and the number of hours it took for the drug to clear the patient's bloodstream of the malaria parasite.

Here is Bumba's dilemma: there was a more effective, but more expensive, anti-malarial drug on the market. But the new drug cost $3 per day of treatment. Bumba was hoping to wait 2 more years before using the new drug. In order to make a decision, Bumba decided that he needed to look more closely at his data.

BUMBA'S DATA TABLE

Number of years Bumba prescribed anti-malaria drug in Bandundu	Hours to clear parasites in bloodstream
0	24
2	30
4	30
6	48
8	120 (6 days)

1. On the graph below, plot the points from the table on the previous page.



The following tasks show some different ways Bumba could look at his data.

2. Finding a **linear function (first degree)** that approximates the 5 points:

a. Substitute the first point into the following general linear equation: ax + b = y

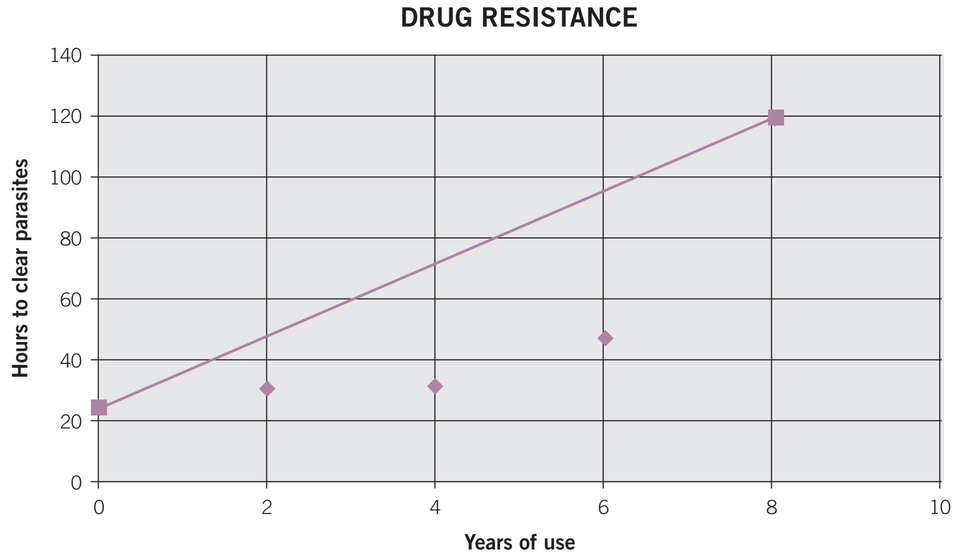
b. Now substitute the last point into the same general linear equation: ax + b = y

c. Fill in the following matrix using the two equations you created above:

$$\begin{bmatrix} \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ \end{bmatrix} \cdot \begin{bmatrix} \mathbf{a} \\ \mathbf{b} \end{bmatrix} = \begin{bmatrix} \_\_\_ \\ \_\_\_ \end{bmatrix}$$

d. Solve your matrix with your calculator using the “rref” feature of your calculator (or another method from your instructor). Write the specific linear equation that goes through the two data points.

e. If you were to plot the function it would look like this:



f. In the 10th year, how many hours does this **linear** equation predict that it will take a patient to clear the parasite from the bloodstream?

3. Finding a **quadratic function (2nd degree)** that approximates the 5 points:

a. Substitute the first point into the following general quadratic equation: $ax^2 + bx + c = y$

b. Now substitute the 2nd point into the same general quadratic equation: $ax^2 + bx + c = y$

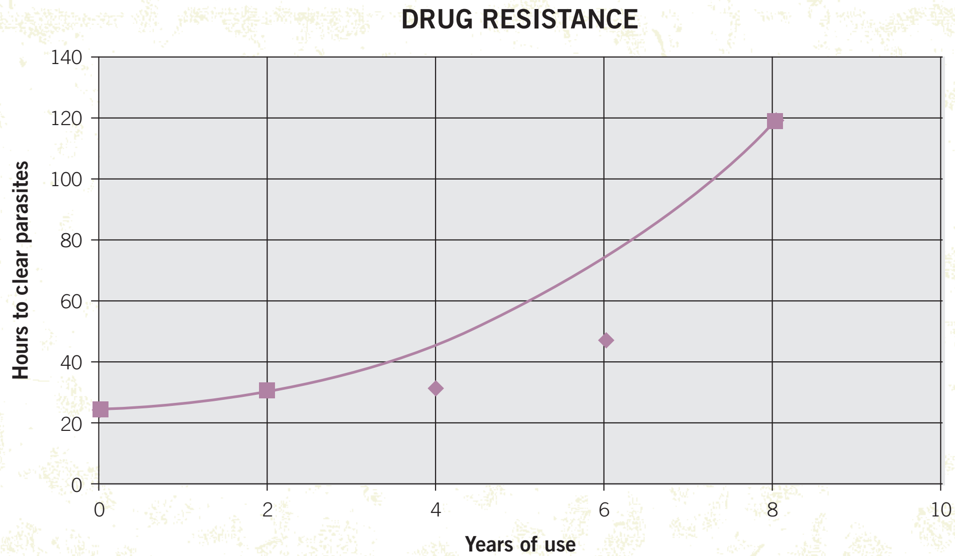
c. Now substitute the last point into the same general quadratic equation: $ax^2 + bx + c = y$

d. Fill in the following matrix using the three equations you created above:

$$\begin{bmatrix} \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ \end{bmatrix} \cdot \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} \_\_\_ \\ \_\_\_ \\ \_\_\_ \end{bmatrix}$$

e. Solve your matrix with your calculator using the “rref” feature of your calculator (or another method from your instructor). Write the specific quadratic equation that goes through the three data points.

f. If you were to plot the function it would look like this:



g. In the 10th year, how many hours does this **quadratic** equation predict that it will take a patient to clear the parasite from the bloodstream?

4. Finding a **cubic function (3rd degree)** that approximates the 5 points:

a. Substitute the first point into the following general cubic equation: $ax^3 + bx^2 + cx + d = y$

b. Now substitute the 2nd point into the same general cubic equation: $ax^3 + bx^2 + cx + d = y$

c. Now substitute the 3rd point into the same general cubic equation: $ax^3 + bx^2 + cx + d = y$

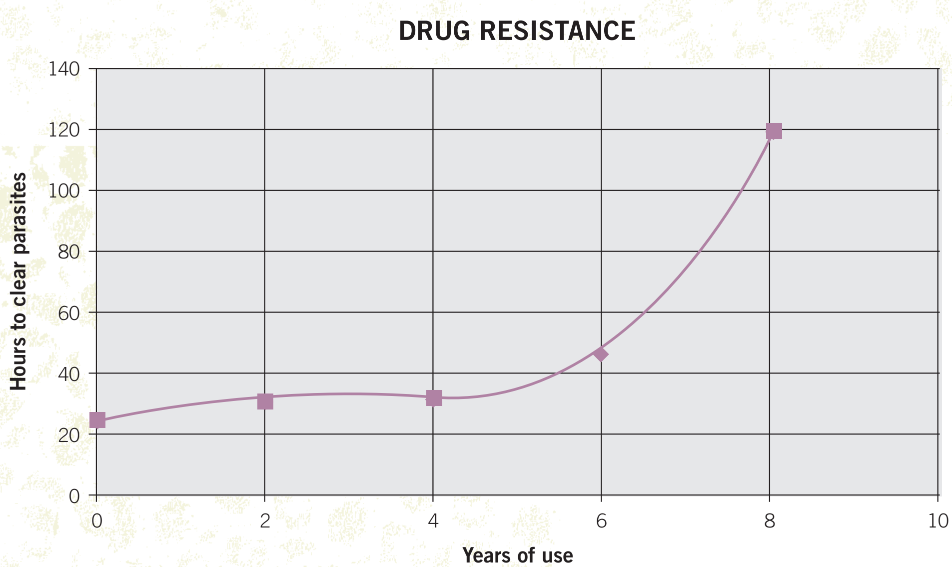
d. Now substitute the last point into the same general cubic equation: $ax^3 + bx^2 + cx + d = y$

e. Fill in the following matrix using the four equations you created above:

$$\begin{bmatrix} \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \end{bmatrix} \cdot \begin{bmatrix} \mathbf{a} \\ \mathbf{b} \\ \mathbf{c} \\ \mathbf{d} \end{bmatrix} = \begin{bmatrix} \_\_\_ \\ \_\_\_ \\ \_\_\_ \\ \_\_\_ \end{bmatrix}$$

f. Solve your matrix with your calculator using the "rref" feature of your calculator (or another method from your instructor). Write the specific cubic equation that goes through the four data points.

g. If you were to plot the function it would look like this:



h. In the 10th year, how many hours does this **cubic** equation predict that it will take a patient to clear the parasite from the bloodstream?

5. Finding a **quartic function (4th degree)** that passes through all 5 points:

a. Substitute the first point into the following general quartic equation: $ax^4 + bx^3 + cx^2 + dx + e = y$

b. Now substitute the 2nd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

c. Now substitute the 3rd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

d. Now substitute the 4thd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

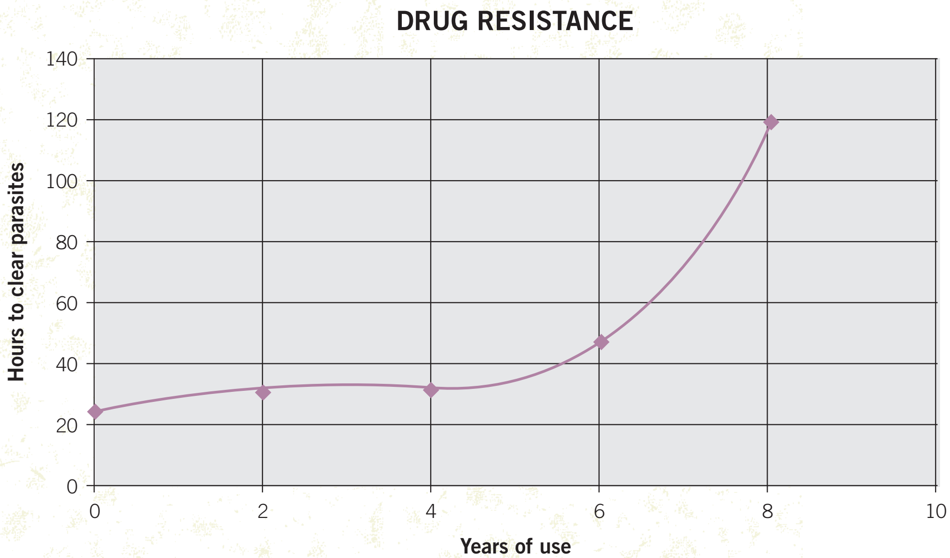
e. Now substitute the last point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

f. Fill in the following matrix using the five equations you created above:

$$\begin{bmatrix} \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \\ \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ & \_\_\_ \end{bmatrix} \cdot \begin{bmatrix} a \\ b \\ c \\ d \\ e \end{bmatrix} = \begin{bmatrix} \_\_\_ \\ \_\_\_ \\ \_\_\_ \\ \_\_\_ \\ \_\_\_ \end{bmatrix}$$

g. Solve your matrix with your calculator using the "rref" feature of your calculator (or another method from your instructor). Write the specific quartic equation that goes through the five data points.

h. If you were to plot the function it would look like this:



i. In the 10th year, how many hours does this **quartic** equation predict that it will take a patient to clear the parasite from the bloodstream?

6. Let's summarize all the work you have done up to this point. Fill out the table below:

Type of Polynomial	Specific Equation	Number of data points equation passes through	10th year prediction for # of hours for parasite to clear the bloodstream
Linear			
Quadratic			
Cubic			
Quartic			

7. **Reflection on Bumba's Situation:** Bumba needs to write to the Congolese Health Minister to request the purchase of new drugs ($3 per day) that are more effective than his current drugs ($0.40 per day). He was hoping to wait 2 more years to request the money. Using your findings above, what should he do?

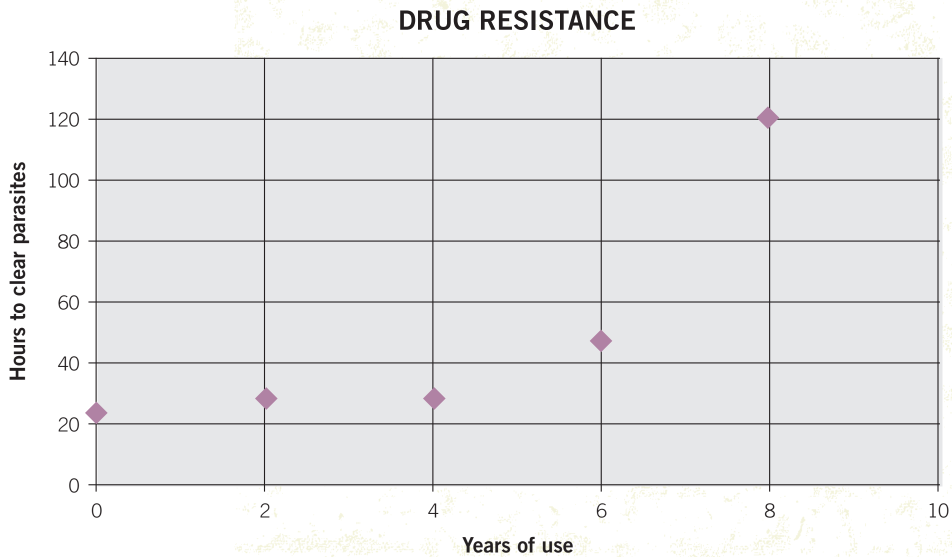
8. **Advanced:** Write two or three sentences arguing against your decision above, based on the same data analysis.

9. **Reflection on Global Health:** From what you have learned about the parasites' ability to become drug resistant, what needs to be done for communities to combat the effects of malaria?

10. **Reflection on the Math:** If you have 100 data points (instead of just 5 like in Bumba's example), what degree equation would you need to pass through all 100 points exactly? What size matrix would you need?

Bumba's Dilemma

1. On the graph below, plot the points from the table on the previous page.



The following tasks show some different ways Bumba could look at his data.

2. Finding a **linear function (first degree)** that approximates the 5 points:

a. Substitute the first point into the following general linear equation: ax + b = y

$a(0) + b = 24$

b. Now substitute the last point into the same general linear equation: ax + b = y

$a(8) + b = 120$

c. Fill in the following matrix using the two equations you created above:

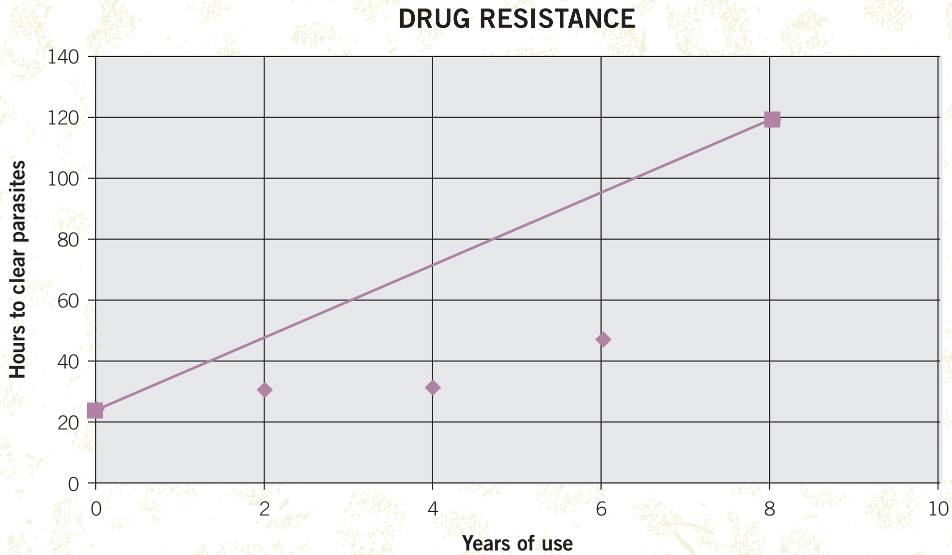
$$\begin{bmatrix} 0 & 1 \\ 8 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 24 \\ 120 \end{bmatrix}$$

KEY

d. Solve your matrix with your calculator using the “rref” feature of your calculator (or another method from your instructor). Write the specific linear equation that goes through the two data points.

$a = 12$
$b = 24$
$y = 12x + 24$

e. If you were to plot the function it would look like this:



f. In the 10th year, how many hours does this **linear** equation predict that it will take a patient to clear the parasite from the bloodstream?

$y = 12(10) + 24$
$y = 144$ hours

3. Finding a **quadratic function (2nd degree)** that approximates the 5 points:

a. Substitute the first point into the following general quadratic equation: $ax^2 + bx + c = y$

$a(0)^2 + b(0) + c = 24$
$0a + 0b + 1c = 24$

b. Now substitute the 2nd point into the same general quadratic equation: $ax^2 + bx + c = y$

$a(2)^2 + b(2) + c = 30$
$4a + 2b + 1c = 30$

c. Now substitute the last point into the same general quadratic equation: $ax^2 + bx + c = y$

$a(8)^2 + b(8) + c = 120$
$64a + 16b + 1c = 120$

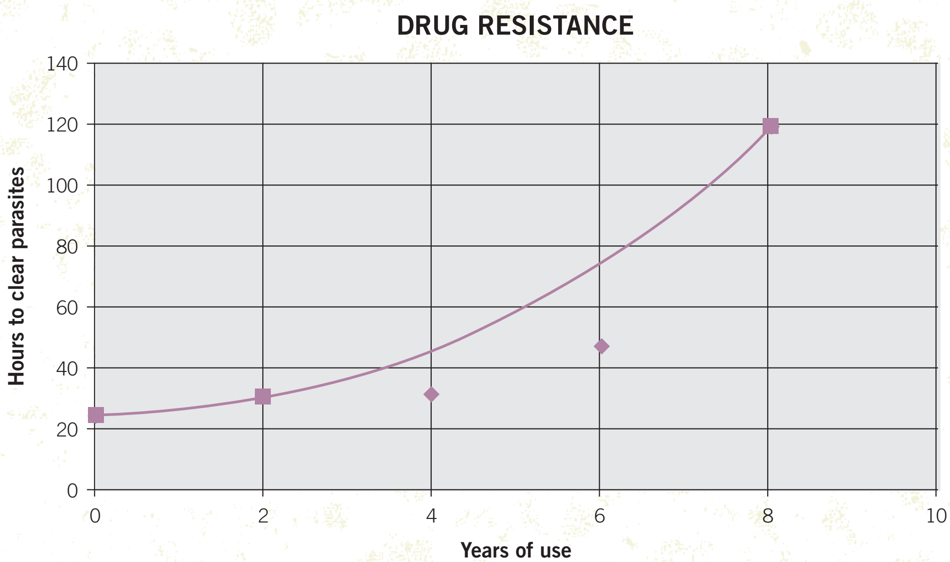
d. Fill in the following matrix using the three equations you created above:

$$\begin{bmatrix} 0 & 0 & 1 \\ 4 & 2 & 1 \\ 64 & 16 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 24 \\ 30 \\ 120 \end{bmatrix}$$

e. Solve your matrix with your calculator using the "rref" feature of your calculator (or another method from your instructor). Write the specific quadratic equation that goes through the three data points.

$a = 1.5$
$b = 0$
$c = 24$
$y = 1.5x^2 + 24$

f. If you were to plot the function it would look like this:



g. In the 10th year, how many hours does this **quadratic** equation predict that it will take a patient to clear the parasite from the bloodstream?

$y = 1.5(10)^2 + 24$
$y = 174$ hours

4. Finding a **cubic function (3rd degree)** that approximates the 5 points:

a. Substitute the first point into the following general cubic equation: $ax^3 + bx^2 + cx + d = y$

$a(0)^3 + b(0)^2 + c(0) + d = 24$

b. Now substitute the 2nd point into the same general cubic equation: ax3 + bx2 + cx + d = y

$a(2)^3 + b(2)^2 + c(2) + d = 30$
$8a + 4b + 2c + 1d = 30$

c. Now substitute the 3rd point into the same general cubic equation: ax3 + bx2 + cx + d = y

$a(4)^3 + b(4)^2 + c(4) + d = 30$
$64a + 16b + 4c + 1d = 30$

d. Now substitute the last point into the same general cubic equation: ax3 + bx2 + cx + d = y

$a(8)^3 + b(8)^2 + c(8) + d = 120$
$512a + 64b + 8c + 1d = 120$

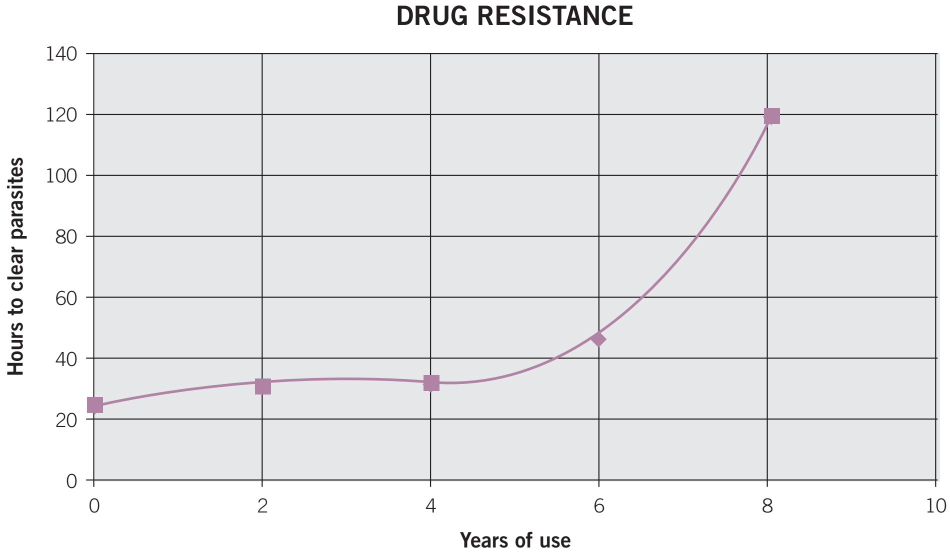
e. Fill in the following matrix using the four equations you created above:

$$\begin{bmatrix} 0 & 0 & 0 & 1 \\ 8 & 4 & 2 & 1 \\ 64 & 16 & 4 & 1 \\ 512 & 64 & 8 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} 24 \\ 30 \\ 30 \\ 120 \end{bmatrix}$$

f. Solve your matrix with your calculator using the "rref" feature of your calculator (or another method from your instructor). Write the specific cubic equation that goes through the four data points.

$a = 0.562$
$b = -4.125$
$c = 9$
$d = 24$
$y = 0.5625x^3 - 4.125x^2 + 9x + 24$

g. If you were to plot the function it would look like this:



h. In the 10th year, how many hours does this **cubic** equation predict that it will take a patient to clear the parasite from the bloodstream?

$y = 0.5625(10)^3 - 4.125(10)^2 + 9(10) + 24$
$y = 264$ hours

5. Finding a **quartic function (4th degree)** that passes through all 5 points:

a. Substitute the first point into the following general quartic equation: $ax^4 + bx^3 + cx^2 + dx + e = y$

$a(0)^4 + b(0)^3 + c(0)^2 + d(0) + e = 24$

b. Now substitute the 2nd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

$a(2)^4 + b(2)^3 + c(2)^2 + d(2) + e = 24$
$16a + 8b + 4c + 2d + 1e = 30$

c. Now substitute the 3rd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

$a(4)^4 + b(4)^3 + c(4)^2 + d(4) + e = 30$
$256a + 64b + 16c + 4d + 1e = 30$

d. Now substitute the 4thd point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

$a(6)^4 + b(6)^3 + c(6)^2 + d(6) + e = 48$
$1296a + 216b + 36c + 6d + 1e = 48$

e. Now substitute the last point into the same general quartic equation:
$ax^4 + bx^3 + cx^2 + dx + e = y$

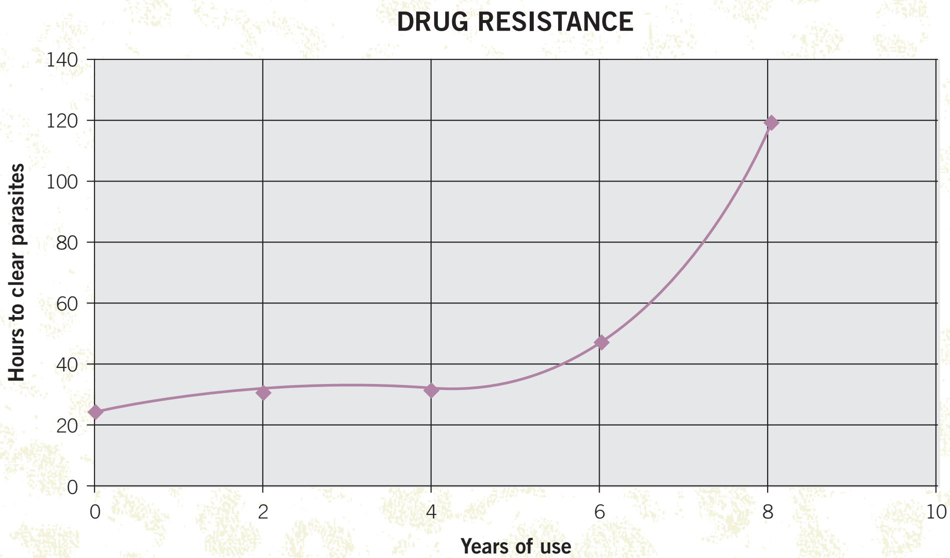
$a(8)^4 + b(8)^3 + c(8)^2 + d(8) + e = 120$
$4096a + 512b + 64c + 8d + 1e = 120$

f. Fill in the following matrix using the five equations you created above:

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 16 & 8 & 4 & 2 & 1 \\ 256 & 64 & 16 & 4 & 1 \\ 1296 & 216 & 36 & 6 & 1 \\ 4096 & 512 & 64 & 8 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ b \\ c \\ d \\ e \end{bmatrix} = \begin{bmatrix} 24 \\ 30 \\ 30 \\ 48 \\ 120 \end{bmatrix}$$

g. Solve your matrix with your calculator using the "rref" feature of your calculator (or another method from your instructor). Write the specific quartic equation that goes through the five data points.
$a = 0.03125$
$b = -0.125$
$c = -2.375$
$d = 7$
$e = 24$
$y = 0.03125x^4 + 0.125x^3 - 2.375x^2 + 7x + 24$

h. If you were to plot the function it would look like this:



i. In the 10th year, how many hours does this **quartic** equation predict that it will take a patient to clear the parasite from the bloodstream?
$y = 0.03125(10)^4 + 0.125(10)^3 - 2.375(10)^2 + 7(10) + 24$
$y = 294$ hours

6. Let's summarize all the work you have done up to this point. Fill out the table below:

Type of Polynomial	Specific Equation	Number of data points equation passes through	10th year prediction for # of hours for parasite to clear the bloodstream
Linear	$y = 12x + 24$	2	144
Quadratic	$y = 1.5x^2 + 24$	3	174
Cubic	$y = 0.5625x^3 - 4.125x^2 + 9x + 24$	4	264
Quartic	$y = 0.03125x^4 + 0.125x^3 - 2.375x^2 + 7x + 24$	5	294

7. Reflection on Bumba's Situation: Bumba needs to write to the Congolese Health Minister to request the purchase of new drugs ($3 per day) that are more effective than his current drugs ($0.40 per day). He was hoping to wait 2 more years to request the money. Using your findings above, what should he do?

Possible response: The most accurate equation is the quartic which predicts 294 hours (12.25 days) for the parasite to clear the bloodstream. Bumba should request the money now. Prescribing drugs for 12.25 days will likely be more expensive in the long run than buying a more expensive but more effective drug. Also the additional number of days of recovery means less productive days for individuals to provide for their families.

8. Advanced: Write two or three sentences arguing against your decision above, based on the same data analysis.

Answers will vary.

9. Reflection on Global Health: From what you have learned about the parasites' ability to become drug resistant, what needs to be done for communities to combat the effects of malaria?

Possible response: Money and resources must be directed to find solutions (vaccines, anti-malarials, etc.) now to replace outdated and soon ineffective treatments.

10. Reflection on the Math: If you have 100 data points (instead of just 5 like in Bumba's example), what degree equation would you need to pass through all 100 points exactly? What size matrix would you need?

99th degree equation. 99 x 100 matrix.

LESSON 3: Bed Nets

& Rewriting Irrational Expressions

Activity Time: 55 minutes

In this lesson, students investigate the long-term effectiveness of bed nets treated with two different types of insecticide. Students evaluate an expression, and in doing so, they must simplify radical expressions.

This lesson fits well within an irrational functions unit and provides students with practice in rewriting irrational expressions.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Irrational Expressions:** Irrational expressions can be used to model the amount of insecticide present in an insecticide-treated bed net over time.

Essential Question:

- How do bed nets help reduce the number of deaths related to malaria?

Learning Objectives:

Students will know…

- Bed nets are a part of the solution to lowering malaria deaths.
- The amount of insecticide in an insecticide-treated bed net diminishes over time.

Students will be able to…

- Simplify radical expressions.

Vocabulary:

- Deltamethrin
- Fractional exponent
- Insecticide
- Irrational
- Malaria
- Permethrin
- Radical
- Simple radical form

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.2.C** Add, subtract, multiply, divide, and simplify rational and more general algebraic expressions.

Common Student Preconceptions:

- There is nothing that I can do to help combat the effects of malaria.
- Bed nets are just used for decoration.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *Mosquitoes Bed Nets* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Preview the videos.
- Work through the Student Handout. Decide what form you want the students to use for their answers.
- Make copies of the Student Handout.

PROCEDURE

Hook:

1. Show the Malaria No More video and the Nothing But Nets video.

   David Beckham Commercial: Fight Malaria
   Malaria No More, 31 seconds
   http://www.youtube.com/watch?v=Va-PGV9RM4c

   Malaria Kills; Bed Nets Save Lives
   Nothing But Nets, 2:29 minutes
   http://www.youtube.com/watch?v=dyBWjN1e31A

Preconceptions:

2. Pass out copies of the *Mosquito Bed Nets* Handout, one per student.
3. Ask students one or both of the following questions; students will answer the question(s) on their handout.
   - What do you think can be done to help prevent malaria in developing countries?
   - Can malaria be eradicated?
4. After writing down their thoughts, lead a brief class discussion about students' preconceptions about malaria and bed nets.

Activity:

5. Review the handout with students. Depending on the students' level of understanding, it may be advisable to go through the example problems as a class.
6. The remainder of the handout may be completed in groups, individually, or as a homework assignment.

Wrap-up:

7. After students have completed the handout, ask the preconception questions again to see if their understanding of malaria and bed nets has changed.

STUDENT ASSESSMENT

Assessment Opportunities:

- The Student Handout can be collected and graded using the provided Teacher Answer Key.

Student Metacognition:

- Students will record their preconceptions about malaria and bed nets.
- Students will reflect on how their thinking has changed as a result of the lesson.

Scoring:

- A Teacher Answer Key is provided to help score the Student Handout.

EXTENSION ACTIVITIES

Extension Activities:

- Students could graph the equations.
- An amount of insecticide (in mg/m^2) could be given and students could solve for the time.
- Share the computer modeling interactive feature from the Koshland Science Museum. Show the class the data and graphs demonstrating the effectiveness of bed nets and other strategies for fighting malaria.

  Malaria Interactive Computer Model: Namawala, Tanzania
  Marian Koshland Science Museum
  http://www.koshland-science-museum.org/exhib_infectious/malaria_interactive.jsp

Adaptations:

- Break students into groups with students of high and low ability. Students can work together to complete the handout.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section below.

Resources:

David Beckham Commercial: Fight Malaria
Malaria No More, 31 seconds
http://www.youtube.com/watch?v=Va-PGV9RM4c

Malaria Kills; Bed Nets Save Lives
Nothing but Nets, 2:29 minutes
http://www.youtube.com/watch?v=dyBWjN1e31A

Malaria Interactive Computer Model: Namawala, Tanzania
Marian Koshland Science Museum
http://www.koshland-science-museum.org/exhib_infectious/malaria_interactive.jsp

FAQs about Refugees, Bed Nets, and Malaria
Nothing But Nets
http://www.nothingbutnets.net/about-the-campaign/faq-refugees-bed-nets-and-malaria.html#%E2%80%9D2%E2%80%9D

Nothing But Nets
http://www.nothingbutnets.net/

Malaria No More
http://www.malarianomore.org/

CDC: Vector Control—Malaria
http://www.cdc.gov/malaria/control_prevention/vector_control.htm

Name:______________________________ Date:___________ Period:________

Mosquito Bed Nets

HANDOUT

Your teacher will provide a question (or two) for you to think about before you begin the lesson. Write your response here about your preconceptions about malaria and bed nets:

Background Information:

In the poorest parts of the world, where effective window screens are lacking, insecticide-treated bed nets are arguably the most cost-effective way to prevent malaria transmission. One bed net costs just $10 to buy and deliver to individuals in need. One bed net can safely last a family for about four years, thanks to a long-lasting insecticide woven into the net fabric.

Studies show that use of insecticide-treated bed nets can reduce transmission as much as 90% in areas with high coverage rates. Bed nets prevent malaria transmission by creating a protective barrier against mosquitoes at night, when the vast majority of transmissions occur. The African malaria mosquitoes generally bite late at night or early morning, between 10:00 p.m. and 4:00 a.m. A bed net is usually hung above the center of a bed or sleeping space so that it completely covers the sleeping person. A net treated with insecticide offers about twice the protection of an untreated net and can reduce the number of mosquitoes that enter the house and the overall number of mosquitoes in the area.

Credit: Nothing But Nets, http://www.nothingbutnets.net.

Left: Mosquito net distribution

Right: Children sitting under mosquito net

Source: PATH

NOW LET'S DO SOME MATH

Permethrin is a common insecticide that is present in a standard bed net, which can be purchased for less than \$5. Let's assume the following equation describes how much permethrin (in mg/m^2) is present in a standard bed net over time (in years).

$$P = \frac{500}{3^t}$$

1. Practice your skills of rewriting radical expressions below for each time increment of 0.5 years. An example has been done for you:

Time (years)	Written with Fractional (or whole number) exponent	Written with a Radical in the Denominator	Written with a Simple Radical Form	Written as a Decimal
0		n/a	n/a	
0.5				
1.0		n/a	n/a	
1.5				
2.0		n/a	n/a	
2.5				
3.0		n/a	n/a	
3.5 (example)	$\frac{500}{3^{7/2}}$	$\frac{500}{(3^7)^{1/2}}$ $\frac{500}{2187^{1/2}} = \frac{500}{\sqrt{2178}} = \frac{500}{27\sqrt{3}}$	$\frac{500}{27\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{500\sqrt{3}}{81}$	10.69

2. How much permethrin is present in a mosquito net when it is first taken out of its package?

3. Let's assume a standard bed net needs to be retreated with insecticide if it falls below 290 mg/m^2. About when should a standard net be retreated with insecticide?

A more effective but twice as expensive (about $10 per net) long-lasting mosquito net contains deltamethrin as its insecticide. Let's assume the following equation describes how much deltamethrin (in mg/m^2) is present in a long-lasting bed net over time (in years).

$$D = \frac{24}{2^t}$$

4. Practice your skills of rewriting radical expressions below for each time increment of 0.5 years. An example has been done for you:

Time (years)	Written with Fractional (or whole number) exponent	Written with a Radical in the Denominator	Written with a Simple Radical Form	Written as a Decimal
0		n/a	n/a	
0.5				
1.0		n/a	n/a	
1.5				
2.0		n/a	n/a	
2.5				
3.0		n/a	n/a	
3.5 (example)	$\frac{24}{2^{7/2}}$	$\frac{24}{(2^7)^{1/2}}$ $\frac{24}{128^{1/2}} = \frac{24}{\sqrt{128}} = \frac{24}{8\sqrt{2}} = \frac{3}{\sqrt{2}}$	$\frac{3}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = 1.5\sqrt{2}$	2.12

5. How much deltamethrin is present in a mosquito net when it is first taken out of its package?

6. Let's assume that a long-lasting net needs to be retreated with insecticide if it falls below 2 mg/m^2. About when should a long-lasting net be retreated?

7. What are some challenges that an African might face when deciding what type of bed net to purchase for their family?

8. How have your preconceptions about malaria and bed nets changed as a result of this lesson?

Mosquito Bed Nets

KEY

NOW LET'S DO SOME MATH

Permethrin is a common insecticide that is present in a standard bed net, which can be purchased for less than $5. Let's assume the following equation describes how much permethrin (in mg/m^2) is present in a standard bed net over time (in years).

$$P = \frac{500}{3^t}$$

1. Practice your skills of rewriting radical expressions below for each time increment of 0.5 years. An example has been done for you:

Time (years)	Written with Fractional (or whole number) exponent	Written with a Radical in the Denominator	Written with a Simple Radical Form	Written as a Decimal
0	$\frac{500}{3^0}$	n/a	n/a	500
0.5	$\frac{500}{3^{1/2}}$	$\frac{500}{\sqrt{3}}$	$\frac{500\sqrt{3}}{3}$	288.68
1.0	$\frac{500}{3^1}$	n/a	n/a	166.67
1.5	$\frac{500}{3^{3/2}}$	$\frac{500}{3\sqrt{3}}$	$\frac{500\sqrt{3}}{9}$	96.23
2.0	$\frac{500}{3^2}$	n/a	n/a	55.56
2.5	$\frac{500}{3^{5/2}}$	$\frac{500}{9\sqrt{3}}$	$\frac{500\sqrt{3}}{27}$	32.08
3.0	$\frac{500}{3^3}$	n/a	n/a	18.52
3.5 (example)	$\frac{500}{3^{7/2}}$	$\frac{500}{(3^7)^{1/2}}\ \frac{500}{2187^{1/2}} = \frac{500}{\sqrt{2178}} = \frac{500}{27\sqrt{3}}$	$\frac{500}{27\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{500\sqrt{3}}{81}$	10.69

2. How much permethrin is present in a mosquito net when it is first taken out of its package?

500 mg/m^2

3. Let's assume a standard bed net needs to be retreated with insecticide if it falls below 290 mg/m^2. About when should a standard net be retreated with insecticide?

About 6 Months (0.5 year)

A more effective but twice as expensive (about $10 per net) long-lasting mosquito net contains deltamethrin as its insecticide. Let's assume the following equation describes how much deltamethrin (in mg/m^2) is present in a long-lasting bed net over time (in years).

$$D = \frac{24}{2^t}$$

4. Practice your skills of rewriting radical expressions below for each time increment of 0.5 years. An example has been done for you:

Time (years)	Written with Fractional (or whole number) exponent	Written with a Radical in the Denominator	Written with a Simple Radical Form	Written as a Decimal
0	$\frac{24}{2^0}$	n/a	n/a	24
0.5	$\frac{24}{2^{1/2}}$	$\frac{24}{\sqrt{2}}$	$12\sqrt{2}$	16.97
1.0	$\frac{24}{2^1}$	n/a	n/a	12
1.5	$\frac{24}{2^{3/2}}$	$\frac{12}{\sqrt{2}}$	$6\sqrt{2}$	8.49
2.0	$\frac{24}{2^2}$	n/a	n/a	6
2.5	$\frac{24}{2^{1/2}}$	$\frac{6}{\sqrt{2}}$	$3\sqrt{2}$	4.24
3.0	$\frac{24}{2^3}$	n/a	n/a	3
3.5 (example)	$\frac{24}{2^{7/2}}$	$\frac{24}{(2^7)^{1/2}}$ $\frac{24}{128^{1/2}} = \frac{24}{\sqrt{128}} = \frac{24}{8\sqrt{2}} = \frac{3}{\sqrt{2}}$	$\frac{3}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = 1.5\sqrt{2}$	2.12

5. How much deltamethrin is present in a mosquito net when it is first taken out of its package?

24 mg/m^2

6. Let's assume that a long-lasting net needs to be retreated with insecticide if it falls below 2 mg/m^2. About when should a long-lasting net be retreated?

About 3.5 – 4 years

7. What are some challenges that an African might face when deciding what type of bed net to purchase for their family?

Initial cost of the bed net.
Cost to retreat bed net.
Life of the fabric.
Training on how to use the bed net.

8. How have your preconceptions about malaria and bed nets changed as a result of this lesson?

Answers will vary.

LESSON 1: Stopping the Runs with Folk Medicine:

An Exploration of Intermolecular Forces and Solubility

Activity Time: 50 minutes

In this lesson, students will explore the connection between molecular structure, intermolecular forces, and solubility by examining how guava leaf is used in folk medicine to treat diarrhea, a symptom of malaria. This lesson may stand-alone, or may be used as background and preparation for the *Column Chromatography of Plant-Leaf Extract Wet Lab*.

Before delivering this lesson students should have been introduced to ionic and covalent bonding, and should understand that the difference in electronegativity between the atoms in a bond creates a bond dipole. Students should also know how to draw and interpret Lewis Dot Structures, and have a basic understating of VSEPR theory and molecular dipoles. It is probably best to wait until after solutions and the notion of solubility are introduced as well, although with proper scaffolding, this activity could be introduced immediately after the introduction of intermolecular forces.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Properties of Molecules:** Macroscopic properties of materials are determined by microscopic properties of molecules.

Essential Question:

- People in developing nations use a water-based extraction of guava leaves to treat diarrhea, which complicates the treatment of malaria. How does extraction of compounds in plant leaves work on the molecular level?
- What structural differences cause the differences in solubility of the compounds in *P. guajava* and other water-soluble and insoluble compounds?

Learning Objectives:

Students will know…

- The different types of intermolecular forces (IMFs).
- How IMFs determine relative solubility of compounds.
- Diarrhea is caused by malaria and complicates the effectiveness of anti-malarial drugs.

Students will be able to…

- Classify compounds as hydrophilic (water-soluble) and hydrophobic (not water-soluble).

Vocabulary:

- Aqueous
- Dipole-dipole forces
- Dispersion forces
- Dissolution
- Extraction
- Hydrogen-bonding
- Hydrophobic/Hydrophilic
- Instantaneous vs. permanent molecular dipole
- Intermolecular force
- Solubility

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 INQA** Scientists generate and evaluate questions to investigate the natural world.
- **9-12 INQC** Conclusions must be logical, based on evidence, and consistent with prior established knowledge.
- **9-12 INQF** Science is a human endeavor that involves logical reasoning and creativity and entails the testing, revision, and occasional discarding of theories as new evidence comes to light.
- **9-12 APPF** It is important for all citizens to apply science and technology to critical issues that influence society.
- **9-11 PS2B** Atoms of the same element have the same number of protons. The number and arrangement of electrons determines how the atom interacts with other atoms to form molecules and iconic arrays.
- **9-11 PS2C** When elements are listed in order according to the number of protons, repeating patterns of physical and chemical properties identify families of elements with similar properties.

Common Student Preconceptions:

- Everything dissolves in water.
- There is no connection between molecular structure and macroscopic properties of substances (or at least, the connection is very unclear).
- Folk medicine and home remedies aren't as effective as store-bought medicines.

TEACHER PREPARATION

Materials:

- Document camera or computer with projector
- *Stopping the Runs* Handout (1 per student)
- *Intermolecular Forces Lecture Notes*
- Teacher Answer Key for Student Handout
- A few examples of common western treatments for diarrhea: Pepto Bismol, Milk of Magnesia, Imodium AD, etc.
- Guava-leaf tea bags (available online or at natural food stores for around $4 per 20 bags)
- Hot water for making guava-leaf tea
- A clear glass container for the "demo" tea
- Optional: Small paper cups for passing out tea samples to the class.

Preparation:

- Make copies of Student Handout.
- Create a PowerPoint presentation using the IMF Lecture Notes, or else set-up a document camera to project the slides onto a screen. Another option is to make copies of the Lecture Notes and distribute to students
- Cut open a couple of the guava-leaf tea bags and allow the loose leaves to steep in hot water in a clear glass container. You may choose to use enough water to give the whole class a taste of the tea. *Have this set-up hidden from view while the students perform their initial group-work (see #7 in "Preconceptions").*

PROCEDURE

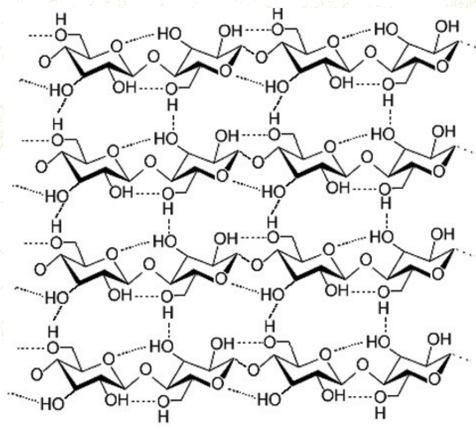
Hook:

1. Ask the class if any of them have ever had diarrhea. Most of them will probably not raise their hands. Then, ask students if they know anyone who has ever had diarrhea. Ask students to call out the common symptoms of this illness as you write them on the board.
2. Show the students the common western treatments for diarrhea, and ask if they have ever used them (or have a friend who has used them). Ask students to consider what they or their friend would have done had they not been able to locate or afford these medications.
3. Mention that this is the situation most of the world's population of developing countries find themselves in…they can't find or afford western treatments. However, diarrhea is older than Pepto Bismol, so indigenous people had to develop their own treatment regimens that many still use today because they are culturally accepted, easily accessible, and inexpensive.
4. Explain that a traditional diarrheal remedy common to southern Africa involves the leaves of a particular type of guava plant called *Psidium guajava*.
5. Organize a quick Pair-Share where partners talk for a few minutes about the best way to prepare an effective medicinal treatment from *P. guajava* leaves. Ask students to think about the equipment and materials available to indigenous peoples for use in this endeavor.

Preconceptions:

6. Have the pairs share their methods with the rest of the class and write them on the board.
   - Some of the approaches will involve crushing the fresh leaves with stones and soaking them in water, which is then ingested.
   - Some groups may suggest drying the leaves and then reconstituting them in hot water, like a tea.
   - Some groups may even suggest boiling down the dried-leaf extract to drive off even more water, thereby concentrating the effective ingredients, and reducing the amount of liquid that must be ingested.
7. At this point, show the class the steeped guava-leaf tea. Ask students where they think the anti-diarrheal components are: in the water or in the leaves that are still on the bottom of the container? The answer should be obvious ("the water, of course…"), especially since you have as a class just gone over the folk medicine approach, which involves boiling the leaves in water.
8. Next, ask students why the leaves do not completely dissolve in the water. What is the difference between the components that enter the water (the aqueous phase) versus those that stay in the leaves?
   - NOTE: The main component of the leaves that does not dissolve is cellulose, which is a massive polysaccharide composed of glucose monomers. Of course, glucose has –OH groups which should mean that cellulose is water-soluble. But as it turns out, these –OH groups are actually hydrogen-bonded to other glucose monomers in the cellulose macromolecule, leading to a structure that is essentially insoluble in water in the short term. If left in water for a long enough period of time (on the order of days or weeks), leaves will dissolve somewhat, or if you place them in acid of pH ~ 1. If the students ask about this seeming inconsistency involving cellulose, you can point out

that most of the cellulose they eat (in salads, fruits, vegetables, etc.) actually comes out the other end largely intact on the molecular level, even though their stomach contents are quite acidic, pH ~ 2-3. The cellulose gives us dietary fiber, the broom of the digestive system, as it were. Here is a picture of cellulose:



Source: http://commons.wikimedia.org/wiki/File:Cellulose_straSorcend.jpg

9. Ask the students to think about why some of the *P. guajava* leaf components are water-soluble while others are not. Ask students for some other examples of compounds that are water-soluble (salt, sugar, etc.) and examples that are not water-soluble (oil, gasoline, etc.). Write these on the board.
10. Introduce the essential question for this lesson: what structural differences cause the differences in solubility of the compounds in *P. guajava* and the compounds on the board?

Scheduling Notes:

11. Depending on where in the curriculum this lesson is employed, it could be used as a motivator for introducing intermolecular forces (IMFs), in which case you may lecture on IMFs here for the first time (refer to the IMF Lecture Notes). The Handout could then be assigned for homework, since there would may not be time to do the Hook, Pre-conceptions, IMF lecture and the Handout all in one class period.
12. If the students have already studied IMFs, then you could skip the IMF lecture or just do a quick review and then move right on to the Handout.

Activity:

13. Break students up into groups of 2-3 students, or ask them to meet with their lab partners.
14. Pass out copies of the *Stopping the Runs* Handout, one per student.
15. Review the handout, which challenges students to apply IMF concepts to progressively more difficult problems. The end of the handout asks students to determine which of the compounds from the guava leaf extract they believe contribute most strongly to its anti-diarrheal properties. Hopefully, they will zero-in on those compounds that have significant polarity (*refer to the Teacher Answer Key*). Students may have to defend their conclusions to the other members of their group, since some the compounds may be ambiguous (in that they contain both hydrophobic and hydrophilic areas). Encourage the students to consider the relative amounts of polar and non-polar regions as they work together. ***Make sure to stress the idea that "like dissolves like."*** If a compound is polar, it will not dissolve in a non-polar solvent and vice versa.
16. Allow time for students to work in their groups to complete the handout.

Wrap-Up:

17. The Wrap-Up may occur at the end of the class period, or the next class day if the worksheet is assigned as homework.
18. Ask the class to discuss the conclusions they drew when working on the handout. The focus should be on applying the general rules of solubility and polarity ("like dissolves like"), but keeping in mind that sometimes – especially in the case of larger, more complicated molecules – more information is needed to draw a correct conclusion. An experiment is one way to gather more information about complicated molecules.
19. If you plan to teach the *Column Chromatography of Plant-Leaf Extract Wet Lab* following this lesson, then this discussion will serve as the "Hook" and "Preconceptions" discussions for the experiment, since the chlorophyll molecule – which has polar C=O bonds and therefore might have slight dipole-dipole interactions with water – is actually far more soluble in petroleum ether (a hydrophobic solvent) than in water.

STUDENT ASSESSMENT

Assessment Opportunities:

- Participation points can be awarded for brainstorming group work on preparing the most effective medicinal treatment from *P. guajava* leaves.
- The discussion of the Student Handout regarding the compounds found in guava leaf extract can be assessed for participation and the quality of the discussion.
- The Student Handout can be graded.

Student Metacognition:

- There are several opportunities for students to share their ideas and conclusions with their classmates and receive feedback.

Scoring:

- The Student Handout can be scored using the provided Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- This lesson could very easily be extended into a study of organic functional groups if the class has time to look at organics at the end of the year.
- There are also some parallels between this lesson and the DDT lessons, in that they both explore the idea of polar vs. non-polar compounds, and how polarity governs molecular properties. A connection could be drawn between this content when the DDT lessons are explored.
- This lesson and the accompanying wet lab could also be used in teaching about diarrhea caused by cholera.
- If time and space is available, these ideas can be explored in real life using the lesson plan *Column Chromatography of Plant-Leaf Extract Wet Lab*.

Adaptations:

- Depending on where in the curriculum this lesson is employed, it could be used as a motivator for introducing intermolecular forces (IMFs), in which case you may want to devote a class period to a lecture on IMFs, and then either assign the handout as homework, or use the subsequent class period for the handout.
- This activity could easily appear after the unit on solutions and solubility, with a brief review of IMFs taking the place of the lecture.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

For some background on diarrhea and its global health impact, refer to the World Health Organization website below.

Resources:

WHO Malaria
http://www.who.int/topics/malaria/en/

The Malaria Site
http://www.malariasite.com/malaria/WhatIsMalaria.htm

WHO Diarrhea Websites
http://www.who.int/topics/diarrhoea/en/
http://www.who.int/child_adolescent_health/documents/diarrhoea/en/

Guava Information
http://www.hort.purdue.edu/newcrop/morton/guava.html

Images of Guava Plants
http://www.hear.org/starr/plants/images/species/?q=psidium+guajava

Column Chromatography
http://en.wikipedia.org/wiki/Column_chromatography

Credit:

Forest & Kim Starr. Guava images.
Available from: http://www.hear.org/starr/plants/images/.

Kimbrough, D. R. (1992). *J. Chem. Educ.*, 69, 987.

Lewin, R. (2001). *Perspectives in Biology and Medicine*, 44, 594.

Lin, J. et al. (2002). *Journal of Ethnopharmicology*, 79, 53.

Mayo Clinic. *Loperadmide (Oral Route).*
Available from: http://www.mayoclinic.com/health/drug-information/DR600859.

Ojewole, J.A.O. et al. (2008). *Journal of Smooth Muscle Research*, 44, 195.

Sodeinde, O. et al. (1996). *Journal of Diarrheal Disease Research*, 14, 269.

World Health Organization. (2006). *Guidelines for the Treatment of Malaria.*
Available from: http://apps.who.int/malaria/docs/TreatmentGuidelines2006.pdf.

World Health Organization. *Water-Related Diseases.*
Available from: http://www.who.int/water_sanitation_health/diseases/diarrhoea/en/.

Name:_________________________ Date:__________ Period:_______

HANDOUT

Stopping the Runs with Folk Medicine

An Exploration of Intermolecular Forces and Solubility

Diarrhea is no joke. Although it's kind of gross to talk about, diarrhea can and does kill millions of people every year, mostly children in developing nations. Diarrhea is typically caused by some kind of bacterial infection in the gastrointestinal tract, such as *E. coli*, cholera, or dysentery. The symptoms of diarrhea include the frequent passage of very loose or watery stools, accompanied by sometimes very severe intestinal contractions. In the case of dysentery, the stools may also contain blood.[1]

There is also some indication that diarrhea is a symptom of malaria, although this hasn't been clinically proven.[2] At the very least, the co-occurrence of diarrhea makes the treatment of malaria very difficult. This is because the transit time through the intestinal tract is much faster than normal, meaning that the body is unable to effectively absorb malarial drugs that are delivered by mouth.[3]

Photos of *P. guajava*

Credit: Forest & Kim Starr (http://www.hear.org/starr/plants/images/).

Typically, treatments for diarrhea address either the bacterial infection or the intestinal contractions, or both.[4] For example, a standard anti-diarrheal medication available in western countries, loperamide, relieves symptoms by slowing down the intestinal movements.[5] However, in developing countries, loperamide or related types of western medicines may not be available, or if they are, they may be far too expensive for most of the native population to afford.

There are a number of traditional folk remedies that have been used to treat diarrhea for hundreds, if not thousands, of years. This only makes sense, since diarrhea is older than Pepto Bismol. For example, German soldiers in North Africa during World War II were advised by the Bedouins that the "…consumption of fresh, warm camel feces…" was an excellent treatment for bacterial dysentery, the efficacy of which is probably due to an antibiotic produced by a bacteria native to the camel's gut.[6]

A far less disgusting treatment involves a water-based extraction of the leaves from the guava plant, in particular the species *Psidium guajava*. This method is very common in southern Africa and southeast Asia, and the anti-diarrheal properties of *P. guajava* have recently been scientifically proven.[4,7] *P. guajava* is a small tree that produces a round fruit with a green-yellow rind and pale pink flesh. The leaves are relatively large and oval in shape, and are dark green in color. The traditional recipe involves chopping up the fresh leaves and boiling them in hot water, like making a tea. Certain compounds from the leaves dissolve in the water, and the resulting extract is drunk.

Why do certain compounds from the guava leaves dissolve in water while others do not? It actually depends on the molecular structure of the compounds in question. The purpose of this activity is to use the microscopic properties of molecules to predict the relative water solubility of the molecules, which is a macroscopic property.

[1] World Health Organization: http://www.who.int/water_sanitation_health/diseases/diarrhoea/en/
[2] Sodeinde, O. et al. *Journal of Diarrheal Disease Research*, 1996, 14, 269.
[3] "Guidelines for the Treatment of Malaria," World Health Organization, 2006.
[4] Ojewole, J.A.O. et al. *Journal of Smooth Muscle Research*, 2008, 44, 195.
[5] http://www.mayoclinic.com/health/drug-information/DR600859
[6] Lewin, R. *Perspectives in Biology and Medicine*, 2001, 44, 594.
[7] Lin, J. et al. *Journal of Ethnopharmicology*, 2002, 79, 53.

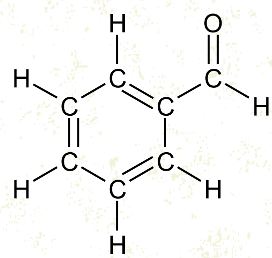
INTERMOLECULAR FORCES AND SOLUBILITY WORKSHEET

1. In the following pairs, list the intermolecular forces that each species exhibits, and circle the structure that will exhibit the strongest intermolecular forces.

a. C_3H_8 **and** C_8H_{18}

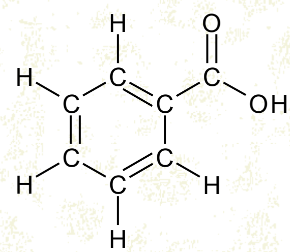
b. $F-C\equiv C-F$ **and** $F-C\equiv C-CH_3$

c.



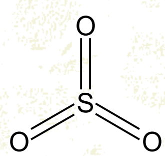
benzaldenhyde

and



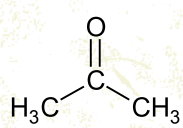
benzoic acid

d.



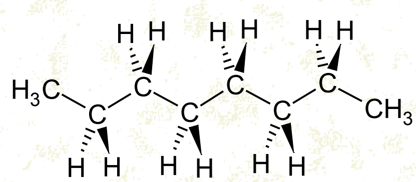
sulfur trioxide

and



acetone

2. Which of the compounds shown in #1 would you expect to be soluble in water? Which would expect to be soluble in octane?

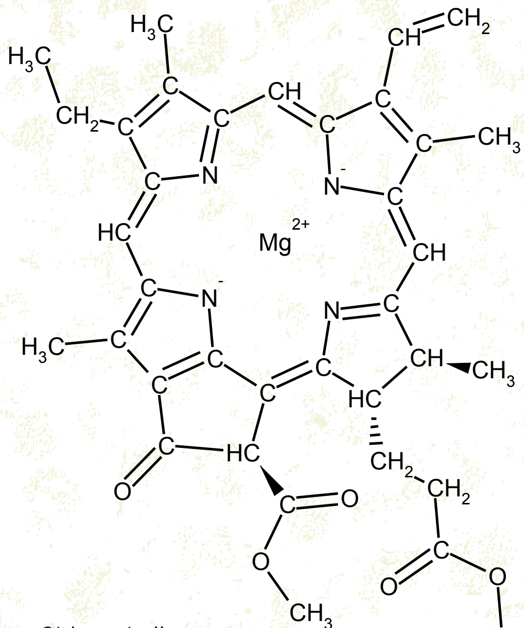


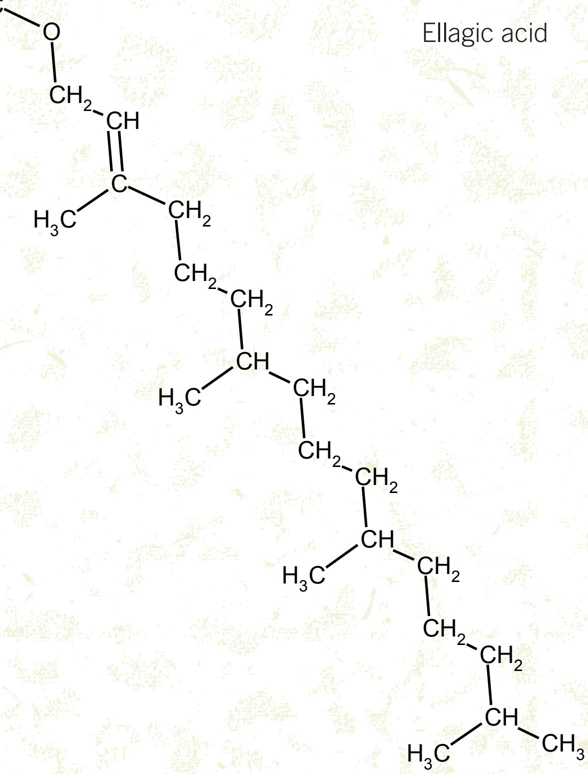
octane

3. What is the term for a molecule that is soluble in water? What is the term for a molecule that is not soluble in water?

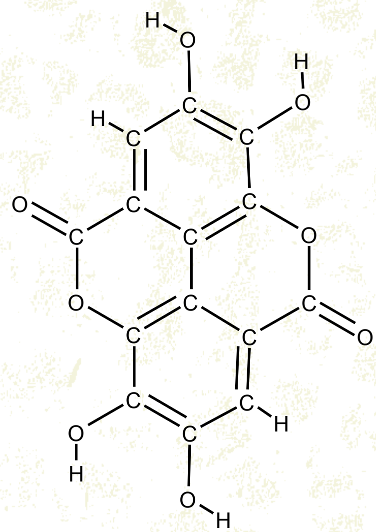
4. Can water interact with other molecules only through hydrogen bonding? Why or why not?

5. The remaining pages of this worksheet contain structures of some of the compounds that are found in guava-leaf extract. Examine these structures with your group mates. Which of these compounds do you think contributes most strongly to the anti-diarrheal properties of *P. guajava* extract? Do you think more than one may contribute? Why or why not?

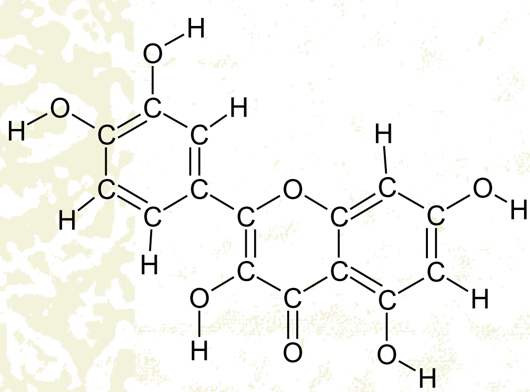




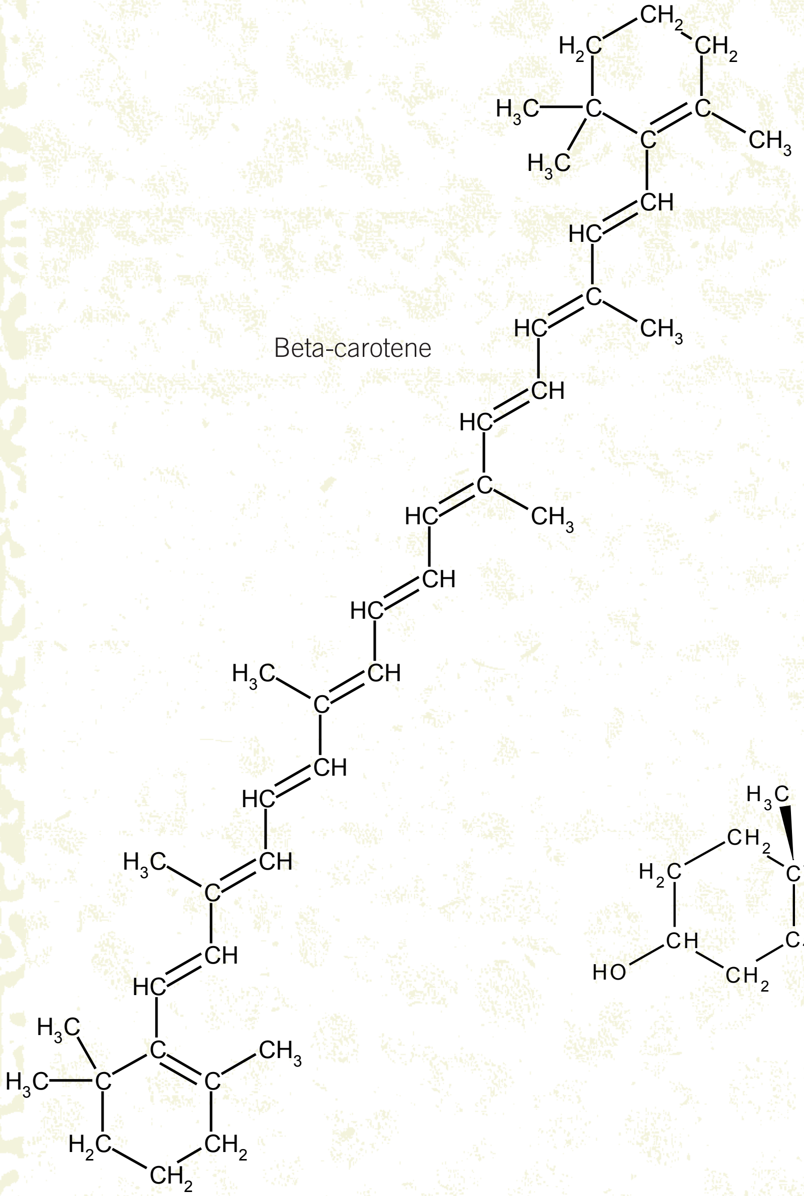
Chlorophyll a



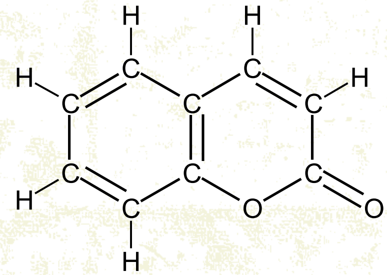
Ellagic acid



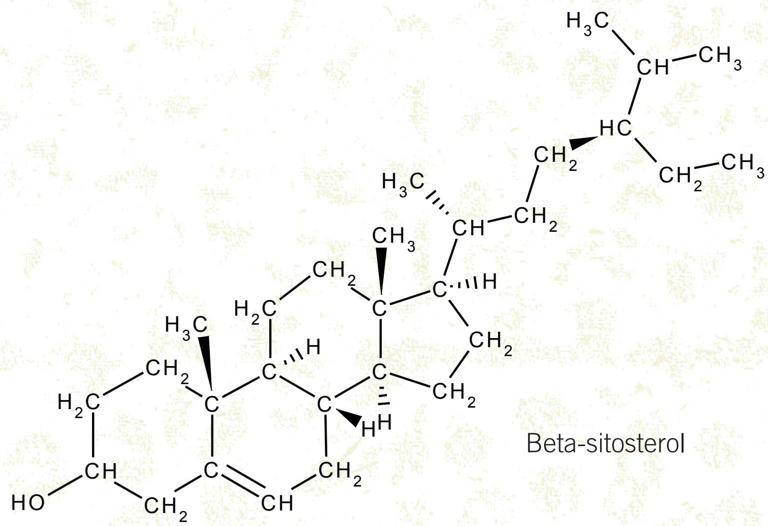
Quercetin



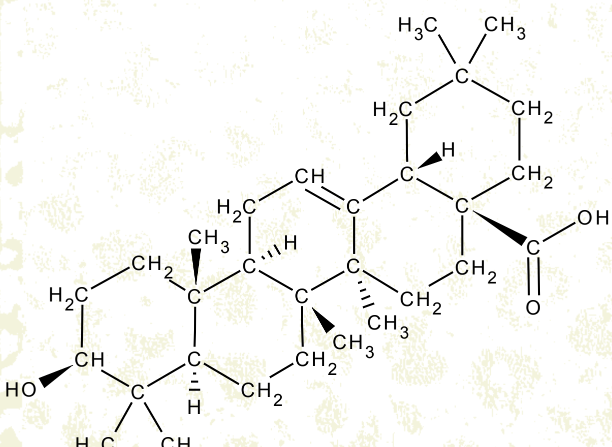
Beta-carotene



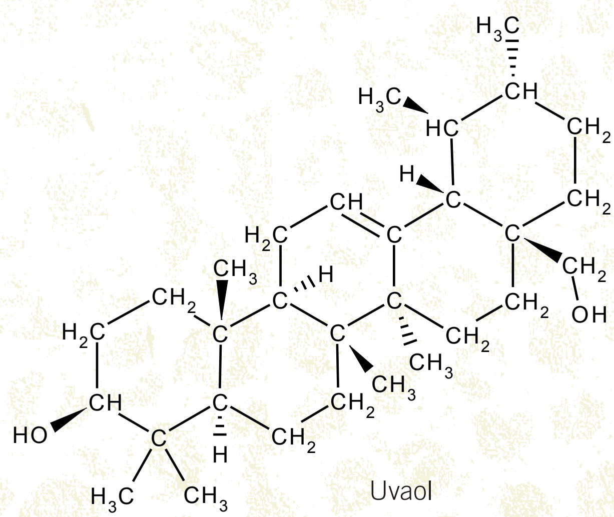
Coumarin



Beta-sitosterol



Oleanic acid



Uvaol

Name:___________________________ Date:__________ Period:________

Intermolecular Forces Lecture Notes

INTERMOLECULAR ATTRACTIONS

Intermolecular attractions are what make liquids liquid and solids solid. Intermolecular attractions also determine what kinds of solutes will dissolve in what kinds of solvents.

What ARE these intermolecular attractions anyway?

In essence, all intermolecular attractions are the result of attractions between different electrical charges on molecules. The strength and origin of these charges depends on the structure of the molecule.

ELECTRONEGATIVITY AND MOLECULAR DIPOLES

Recall that in **polar covalent bonds**, there is an unequal sharing of electrons due to the difference in **electronegativity** between the two atoms. In this type of bond, there is a partial negative charge on the more-electronegative atom, and a partial positive charge on the less-electronegative atom. The presence of these two different regions of charge in the bond is called a **bond dipole**. Depending on the shape, a molecule with bond dipoles may also have an overall **molecular dipole**.

DIPOLE-DIPOLE INTERACTIONS

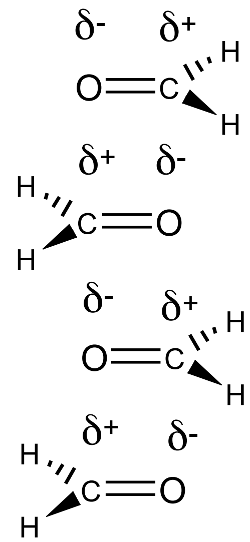
Partial positive charge of one permanent dipole is attracted to partial negative charge on another permanent dipole, resulting in a **dipole-dipole interaction**.

$$\overset{\delta+}{H}\text{—}\overset{\delta-}{Cl}\text{- - - -}\overset{\delta+}{H}\text{—}\overset{\delta-}{Cl}$$

Dipole-dipole forces are much weaker than covalent bonds.

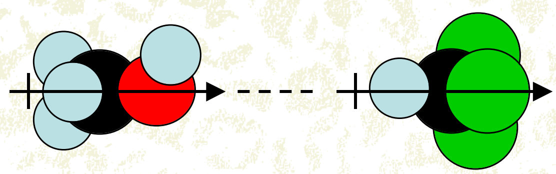
DIPOLE-DIPOLE INTERACTIONS

Molecules with a dipole moment will tend to "line up" in a condensed phase.



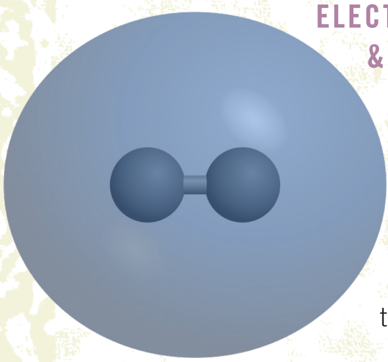
CH_2O, formaldehyde

Dipoles on different molecules will also interact.



CH_3OH methanol

$CHCl_3$ trichloromethane



ELECTRON DENSITY & DISPERSION FORCES

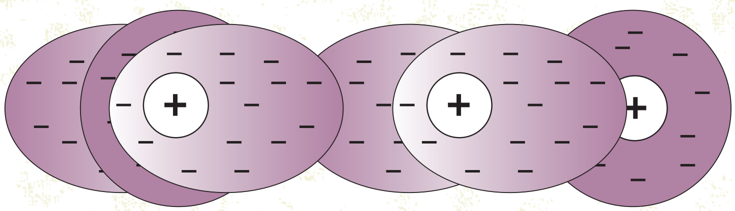
The electron cloud of an atom or molecule is not rigid...it is mushy. It can be pushed around, or **polarized**. This polarization results in **instantaneous dipoles**. The more electrons an atom/molecule. has, the more polarized it can become.

DISPERSION FORCES

Electron density "sloshes" around the atom or molecule in response to nearby electric charges, resulting in an **instantaneous dipole**, a short-lived separation of positive and negative charges. The attraction between instantaneous dipoles is called the **dispersion force**.

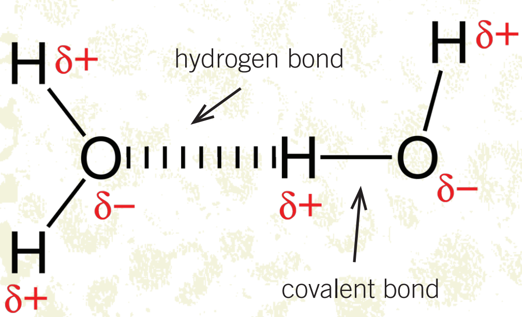
Dispersion forces depend on atomic/molecular mass:

> The larger the atom or the number of atoms → the more electrons available to polarize → the stronger the dispersion forces.



HYDROGEN BONDING

Partial positive charge on H is attracted to partial negative charge on a more electronegative atom (O, N, or F) resulting in a hydrogen bond, a particularly strong type of dipole-dipole interaction.



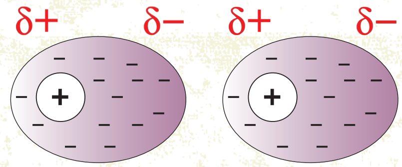
H–bonds are **intermolecular** forces. Covalent bonds are **intramolecular** forces.

Hydrogen bonds are stronger than dipole-dipole forces, but they are still weaker than covalent bonds.

INTERMOLC. FORCES SUMMARY

London Dispersion

Interaction between **instantaneous dipoles** in neighboring atoms/molecules.



Strength: WEAKEST.

Generally depends on atomic/molecular mass… the more electrons, the more polarization, the stronger the instantaneous dipole.

Dipole-Dipole Interactions

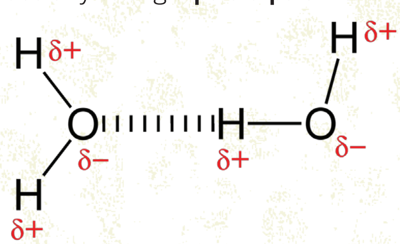
Interaction between **permanent dipoles** in neighboring molecules.

Strength: IN THE MIDDLE.

Depends on relative ENs of atoms in a bond…the larger EN, the stronger the dipole. Also depends on molecular shape…if one "side" has more EN atoms than another, the molecule has a permanent dipole.

Hydrogen Bonds

A particularly strong **dipole-dipole interaction**.

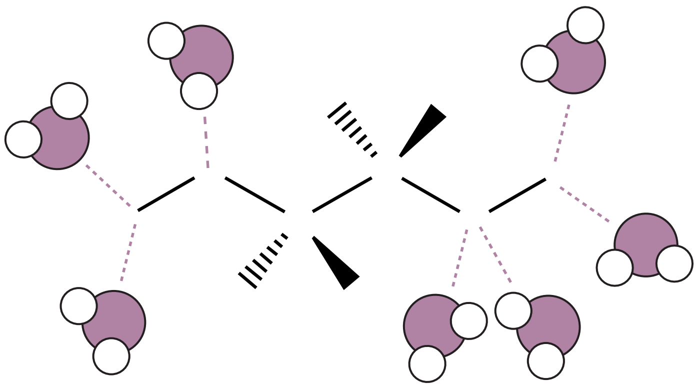


Strength: STRONGEST.

H-bonds occur between N,O,F and an H covalently bonded to N,O,F.

ANTI-FREEZE IS SOLUBLE IN WATER.

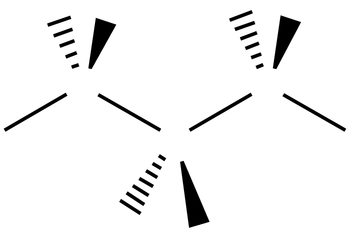
The main component of anti-freeze is ethylene glycol, which has two polar O-H bonds that attract water molecules. It is **hydrophilic** ('water-loving')



H-bond interactions means ethylene glycol is soluble in polar solvents like water.

MOTOR OIL IS NOT SOLUBLE IN WATER.

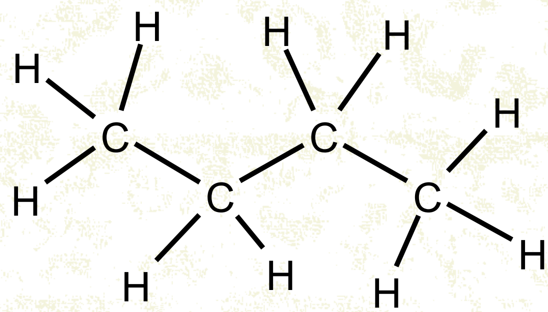
Motor oil is composed of hydrocarbons, compounds that contain only C and H atoms. The C-H bond is relatively non-polar, meaning it cannot attract water molecules. It is **hydrophobic** ('water-fearing').



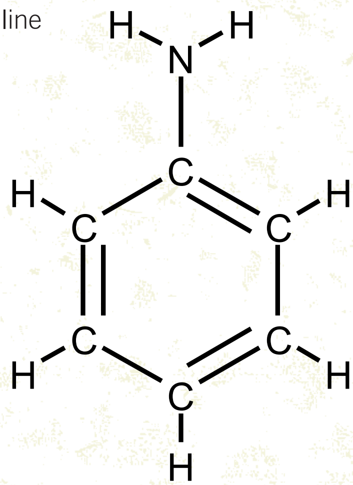
In general…like dissolves like.

Consider the following molecules:

1. Butane



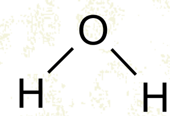
2. Aniline



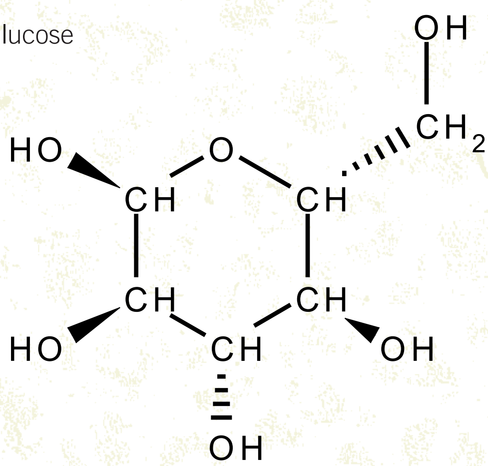
3. Hydrogen cyanide

4. Carbon dioxide

5. Water



6. Glucose



Identify the intermolecular forces each species is expected to exhibit.

dispersion **dipole-dipole** **H-bonding**

Stopping the Runs with Folk Medicine

An Exploration of Intermolecular Forces and Solubility

INTERMOLECULAR FORCES AND SOLUBILITY WORKSHEET

KEY

1. In the following pairs, list the intermolecular forces that each species exhibits, and circle the structure that will exhibit the strongest intermolecular forces.

a. C_3H_8 **and** C_8H_{18}

C_3H_8: **dispersion forces only**

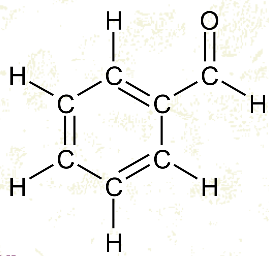
C_8H_{18}: **dispersion forces only, but greater molar mass than C_3H_8**

b. F—C≡C—F **and** F—C≡C—CH_3

F—C≡C—F: **dispersion forces only (C-F bond dipoles cancel)**

F—C≡C—CH_3: **dispersion forces dipole/dipole interaction**

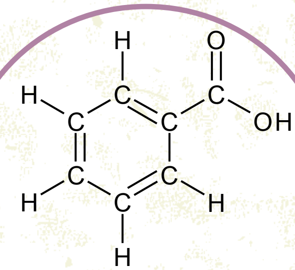
c.



benzaldenhyde

dispersion forces dipole/dipole interaction

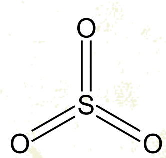
and



benzoic acid

dispersion forces dipole/dipole interaction hydrogen-bonding

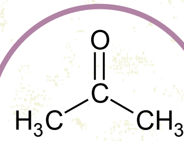
d.



sulfur trioxide

dispersion forces only (S=O bond dipoles cancel)

and



acetone

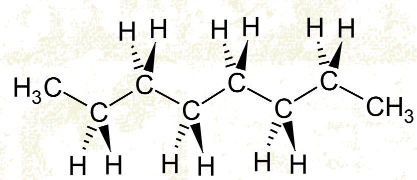
dispersion forces dipole/dipole interaction

2. Which of the compounds shown in #1 would you expect to be soluble in water? Which would expect to be soluble in octane?

Soluble in H_2O: F—C≡C—CH_3, benzaldehyde, benzoic acid*, acetone

Soluble in octane: C_3H_8, C_8H_{18}, F—C≡C—F, sulfur trioxide

* **NOTE: Students will probably list benzaldehyde and benzoic acid as soluble in water, because of the polar –C=O group and H-bonding –OH group in benzoic acid. However, they both also contain a considerable hydrocarbon skeleton, meaning that they will actually be more soluble in a non-polar solvent like octane than a polar solvent like water.**



octane

3. What is the term for a molecule that is soluble in water? What is the term for a molecule that is not soluble in water?

A substance that is soluble in water is hydrophilic ("water loving").

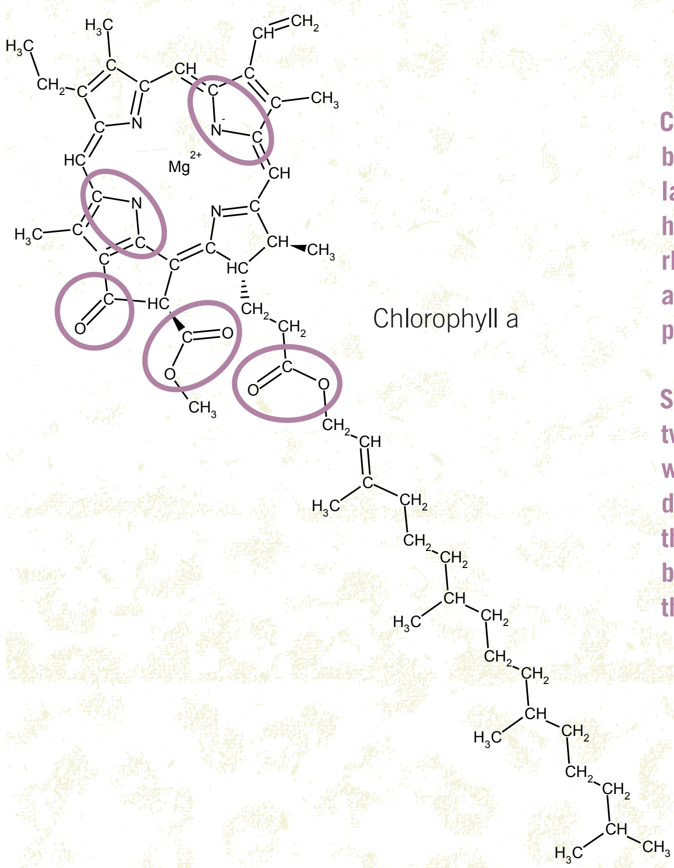
A substance that is not soluble in water is hydrophobic ("water fearing").

4. Can water interact with other molecules only through hydrogen bonding? Why or why not?

No, water does not only interact through H-bonding. Water can also interact through dipole/dipole forces and dispersion forces (anything that has electrons can exhibit dispersion forces). H-bonding is just the strongest IMF that water can exhibit.

5. The remaining pages of this worksheet contain structures of some of the compounds that are found in guava-leaf extract. Examine these structures with your group mates. Which of these compounds do you think contributes most strongly to the anti-diarrheal properties of *P. guajava* extract? Do you think more than one may contribute? Why or why not?

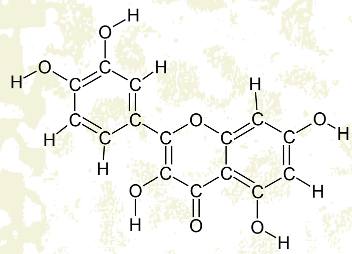
The key here is that students must recognize that only hydrophilic compounds could possibly account for the anti-diarrheal properties of the guava leaf extract, since the leaves are boiled in water to produce the folk medicine. Then, the students must collaborate with their group mates to decide which of the compounds are the most hydrophilic, and therefore the most likely to end up in the aqueous extract of the guava leaf. There are only three compounds for which the solubility is completely obvious: b-carotene, quercetin, and ellagic acid. All the others should elicit some discussion and argument because they contain polar groups on much larger non-polar regions. Students will need to defend their conclusions based on reason and available evidence. Instructor should let the students struggle with the ambiguous nature of this question for awhile.



Chlorophyll a

Chlorophyll a and b both have a number of polar covalent bonds (circled), but the hydrocarbon skeleton is so much larger that this structure is effectively non-polar, and therefore hydrophobic, and not expected to contribute to the anti-diarrheal properties of guava leaf extract. Indeed, chlorophyll is among the first compounds to elute with the non-polar solvent petroleum ether in the column chromatography experiment.

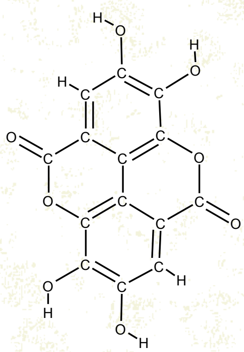
Students may also note the ionic bonds between Mg2^{+} and two N^{-} ions, and may suggest that this will make chlorophyll water-soluble, like NaCl is. If this comes up, you can tell students that not all ionic bonds break when placed in water, and this is one that does not break. The reasons why some ionic bonds break and others do not are fairly complex and beyond the scope of a high-school chemistry class.



Quercetin

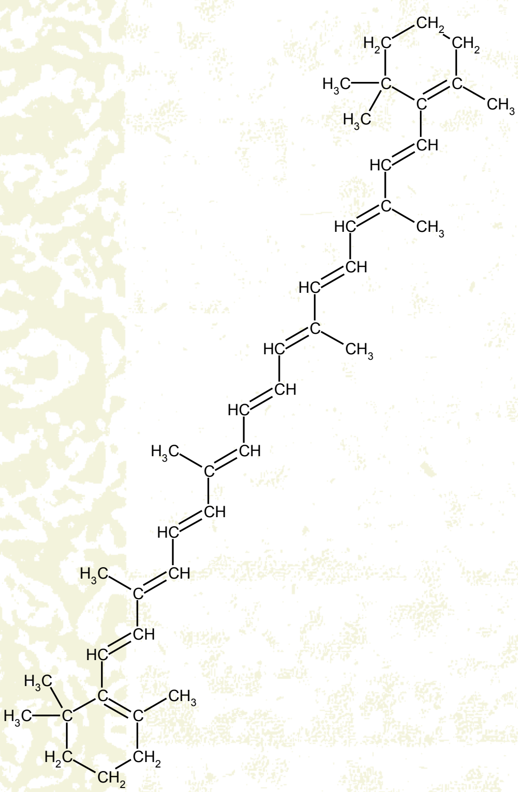
Quercetin is bristling with polar –OH groups that are capable of hydrogen-bonding, so this structure is expected to by highly soluble in water and therefore would be expected to contribute to the anti-diarrheal properties of guava leaf extract.

Indeed, Ojewole et al. cite quercetin as a major contributor to the anti-diarrheal properties of guava leaf extract.



Ellagic acid

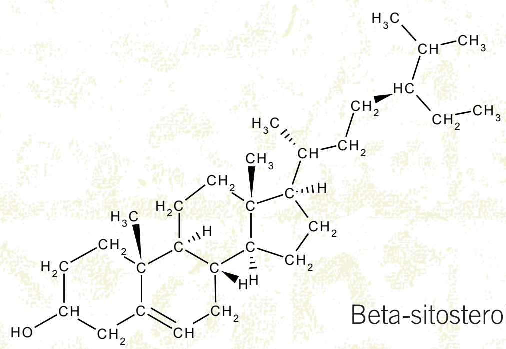
Similar to quercetin, ellagic acid contains several polar –OH groups that are capable of hydrogen-bonding, so this structure is expected to be highly soluble in water and therefore would be expected to contribute to the anti-diarrheal properties of guava leaf extract



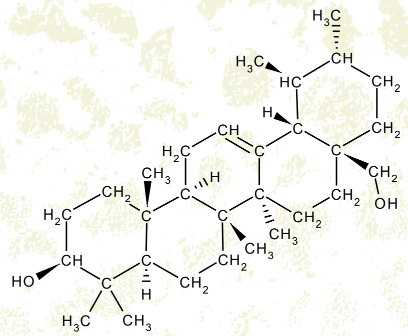
Beta-carotene

This structure has only relatively non-polar C-H bonds, and so beta-carotene is expected to be hydrophobic, and therefore is not expected to contribute to the anti-diarrheal properties of guava leaf extract.

Beta-sitosterol has just one polar –OH group on a very large non-polar hydrocarbon…this structure is not expected to exhibit hydrophilicity, and therefore is not expected to contribute to the anti-diarrheal properties of guava leaf extract.

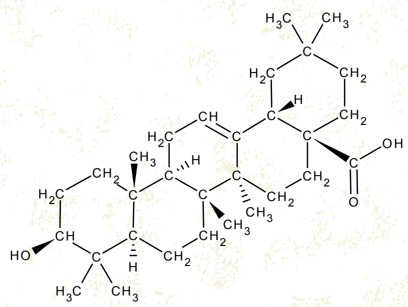


Beta-sitosterol



Uvaol

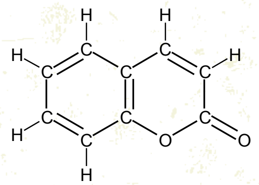
Uvaol has two polar –OH groups, so it probably is slightly more soluble in water than beta-sitosterol, but since it also has a very large non-polar hydrocarbon skeleton, it is not expected to contribute to the anti-diarrheal properties of guava leaf extract.



Oleanic acid

Oleanolic acid has two polar –OH groups and a polar –C=O group, so it is probably more soluble in water than either beta-sitosterol or uvaol. However, it also has a very large non-polar hydrocarbon, so we might not expect it to contribute very much to the anti-diarrheal properties of guava leaf extract.

However, oleanolic acid is an example of a pentacyclic triterpenoid, which Ojewole et al. cite as probable contributors to the anti-diarrheal properties of guava leaf extract. This suggests that there might be a concentration argument to be made for some of these compounds in addition to a straight solubility argument.



Coumarin

Coumarin is relatively small, so even though it has a larger non-polar region than polar region, the polar region account for a larger percentage of the molecule than in something like, say, chlorophyll. So, we might expect this compound to be slightly soluble in water. In fact, Ojewole et al. cite courmarins as probable contributors to the anti-diarrheal properties of guava leaf extract. Similar to oleanolic acid, this suggests that there might be a concentration argument to be made for some of these compounds in addition to a straight solubility argument. One might only need a small amount of coumarin or oleanolic acid to calm down one's bowels.

Here is a section from the conclusion to the Ojewole, et al. article to help guide the discussion:

"Although the exact mechanism of the antidiarrhoeal action of PGE could not be established in this study, a number of investigators have shown that tannins and other polyphenolic compounds (e.g., coumarins), flavonoids, triterpenoids, saponins, and a host of other plant secondary metabolites possess antidiarrhoeal properties in various experimental animal models (Dicarlo et al., 1994; Abdullahi et al., 2001; Aniagu et al., 2005; Agunu et al., 2005; Akindele and Adeyemi, 2006; Suleiman et al., 2008; and Mbagwu and Adeyemi, 2008). Since Psidium guajava is known to contain beta-sitosterol, uvaol, numerous tannins, polyphenolic compounds, pentacyclic triterpenoids (including guajanoic acid, oleanolic and ursolic acids), ellagic acid, guiajaverin, quercetin and other flavonoids (Watt and Breyer-Brandwijk, 1962; Dicarlo et al.,1994; Van Wyk et al., 2002; Van Wyk, and Wink, 2004), it is not unreasonable to speculate that some of these chemical compounds, especially the flavonoids, coumarins and pentacyclic triterpenoids, could have contributed to the observed antidiarrhoeal effect of the plant's leaf aqueous extract. Quercetin, a prominent constituent of Psidium guajava leaf, has been shown to inhibit spasmogenic effects of various agonists (acetylcholine, carbachol, potassium chloride, etc) on guinea-pig isolated ileum (Galvez et al., 1996). The flavonoid has also been shown to inhibit gastrointestinal release of acetylcholine ((Lutterodt, 1989). Furthermore, it has been suggested that quercetin exerts its spasmolytic (i.e., antispasmodic) effect via calcium antagonism (Morales et al., 1994). Taken together, we speculate that PGE probably produces antidiarrhoeal activity through a combination of its antibacterial (antimicrobial) property and its ability to inhibit gastrointestinal acetylcholine release. However, further studies are required to clarify this speculation."

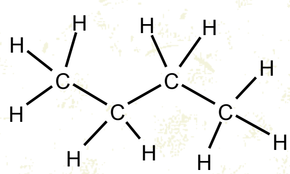
PGE = *P. guajava* extract

Ojewole, J.A.O.; Awe, E.O.; Chiwororo, D.H. (2008). *Journal of Smooth Muscle Research*, 44 (6): 195-207.

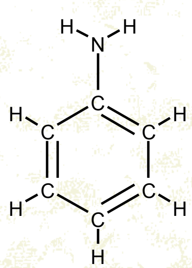
INTERMOLECULAR FORCES LECTURE NOTES

Consider the Following molecules:

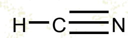
1. Butane



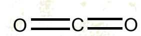
2. Aniline



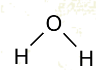
3. Hydrogen cyanide



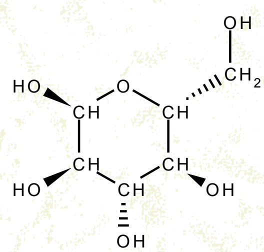
4. Carbon dioxide



5. Water



6. Glucose



Identify the intermolecular forces each species is expected to exhibit.

dispersion	**dipole-dipole**	**H-bonding**
All exhibit dispersion forces	2, 3, 5, 6	2, 5, 6

LESSON

LESSON 2:

Column Chromatography of Plant-Leaf Extract Wet Lab

Activity Time: 120 minutes

This experiment is intended to reinforce the lesson *Stopping the Runs with Folk Medicine: An Exploration of Intermolecular Forces and Solubility*, in which the properties of intermolecular attraction are explored. In this experiment, an acetone extraction of plant leaves is performed, and the various components in the extract are separated using column chromatography. All of the required materials are relatively inexpensive, and can be purchased at grocery, drug, or hardware stores.

The experimental set-up and procedure will take considerably longer than a typical class period, and so this activity is recommended only in the case where a longer lab period can be scheduled. This lesson should be delivered immediately following the lesson *Stopping the Runs with Folk Medicine: An Exploration of Intermolecular Forces and Solubility*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Properties of Molecules:** Macroscopic properties of materials are determined by microscopic properties of molecules.

Essential Question:

- People in developing nations use a water-based extraction of guava leaves to treat diarrhea, which complicates the treatment of malaria. How does extraction of compounds in plant leaves work on the molecular level?

Learning Objectives:

Students will know…

- Diarrhea is caused by malaria and complicates the effectiveness of anti-malarial drugs.

Students will be able to…

- Conduct a column chromatography using a plant-leaf extract.
- Write a lab report summarizing the experiment.
- Follow lab safety procedures.

Vocabulary:

- Column chromatography
- Elute/elution
- Extraction
- Fraction
- Mobile phase
- Stationary phase

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 INQD** The methods and procedures that scientists use to obtain evidence must be clearly reported to enhance opportunities for further investigation.
- **9-11 PS2E** Molecular compounds are composed of two or more elements bonded together in a fixed proportion by sharing electrons between atoms, forming covalent bonds. Such compounds consist of well-defined molecules. Formulas of covalent compounds represent the types and number of atoms of each element in each molecule.
- **9-11 PS2H** Solutions are mixtures in which particles of one substance are evenly distributed through another substance. Liquids are limited in the amount of dissolved solid or gas that they can contain. Aqueous solutions can be described by relative quantities of the dissolved substances and acidity or alkalinity (pH).

Common Student Preconceptions:

- Everything dissolves in water.
- There is no connection between molecular structure and macroscopic properties of substances (or at least, the connection is very unclear).
- Folk medicine and home remedies aren't as effective as store-bought medicines.

TEACHER PREPARATION

Materials:

- *Column Chromatography of Plant-Leaf Extract Wet Lab* Handout (1 per lab station)
- Teacher Answer Key for Student Handout
- Chromatography column (1 per lab station). A plastic syringe barrel is a good substitute if a chromatography column or buret is not available. Note that a syringe won't have a way to stop the flow of solvent, so a waste receptacle will be needed, or a small length of tubing could be fastened to the bottom and held closed with a binder clip when not in use.
- Mortar and pestle (1 per lab station). This is for smashing up the leaf with the solvent to make the extract. A regular bowl and fork work just as well as an actual mortar and pestle.
- 1 Tsp Sodium bicarbonate (baking soda) (1 per lab station). This will be the stationary phase of the column.
- Solvents (10 mL of each solvent per lab station). All the solvents are available at drug or grocery stores, except petroleum ether, which can be found at a hardware store.

  CAUTION: Petroleum ether, acetone, and alcohol are all highly flammable, and should be disposed of properly in waste solvent cans.

  > Petroleum ether (mineral spirits or paint thinner).

  > Acetone (unscented, uncolored nail polish remover).

  > Isopropyl alcohol/water, 70/30 v/v (rubbing alcohol).

  > Saturated aqueous sodium bicarbonate solution (make this yourself with baking soda and water)
- Small beakers (6 per lab station). For collecting fractions or waste solvents and measuring. Baby food jars or glass votive candle holders will also work.
- Leaves (1 handful per lab station). Spinach, red leaf lettuce, houseplants with pigmented leaves, etc.
- Cotton balls
- Medicine droppers or pipettes (3 per lab station)
- Small spatula (1 per lab station)
- Ring clamp or some other support for the column (1 per lab station)
- Nitrile gloves for handling solvents (1 pair per student)

Preparation:

- Make copies of Student Handout.
- Gather all the necessary materials. Prepare saturated aqueous sodium bicarbonate solution (make this yourself with baking soda and water).
- Set up each lab station. See the Teacher Answer Key for an example experimental set-up.

PROCEDURE

Activity:

1. The lesson *Stopping the Runs with Folk Medicine* can be used to introduce this activity. In particular, the Wrap-Up section of the *Stopping the Runs* lesson can serve as the "Hook" and "Preconceptions" for the experiment, since the chlorophyll molecule – which has polar C=O bonds and therefore might have slight dipole-dipole interactions with water – is actually far more soluble in petroleum ether (a hydrophobic solvent) than in water.
2. Students need to work with their lab partners on this experiment. Pass out copies of the *Column Chromatography of Plant-Leaf Extract Wet Lab* Handout, one per lab station. Ask students to work through the steps listed on the handout.
3. See the Teacher Answer Key for tips, time-saving hints, and photos of each stage of the experiment.
4. When students have completed the experiment, ask them to write up a lab report, using the format regularly employed in your classroom.

Wrap-Up:

5. Hand out Exit Tickets with the following questions:
   - If the solvents were delivered in the opposite order, would you be able to pull out your extracts in the opposite order? Why or why not?
   - Consider the structure of the solvents used in this experiment. Rank them in terms of increasing polarity and write down all the IMFs you expect each to exhibit. Now rank the polar solvents in terms of increasing IMF strength.
   - Why does sodium bicarbonate dissolve in water but not in the petroleum ether?

STUDENT ASSESSMENT

Assessment Opportunities:

- Students' lab technique can be assessed during the wet-lab activity.
- Students' lab reports can be assessed for content and format.
- The Exit Ticket questions provide an opportunity to assess student learning.

Student Metacognition:

- There are several opportunities for students to share their ideas and conclusions with their classmates and receive feedback.

Scoring:

- The lab report can be graded based on content, format, and inclusion of sufficient physical observations.

EXTENSION ACTIVITIES

Extension Activities:

- This lesson could very easily be extended into a study of organic functional groups if the class has time to look at organics at the end of the year.

Adaptations:

- Suggestions are provided in the Materials section on how to substitute lab equipment with materials easily found at the grocery, drug, or hardware store.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Column Chromatography
http://en.wikipedia.org/wiki/Column_chromatography

Petroleum Ether MSDS
http://www.jtbaker.com/msds/englishhtml/p1696.htm

Acetone MSDS
http://www.jtbaker.com/msds/englishhtml/A0446.htm

Isopropyl Alcohol MSDS
http://www.jtbaker.com/msds/englishhtml/i8840.htm

Sodium Bicarbonate MSDS
http://www.jtbaker.com/msds/englishhtml/s2954.htm

Credit:

Kimbrough, D. R. (1992). Supermarket column chromatography of leaf pigments. *J. Chem. Educ.*, 69, 987.

Name:__________________________ Date:__________ Period:_______

HANDOUT

Column Chromatography of Plant-Leaf Extract Wet Lab

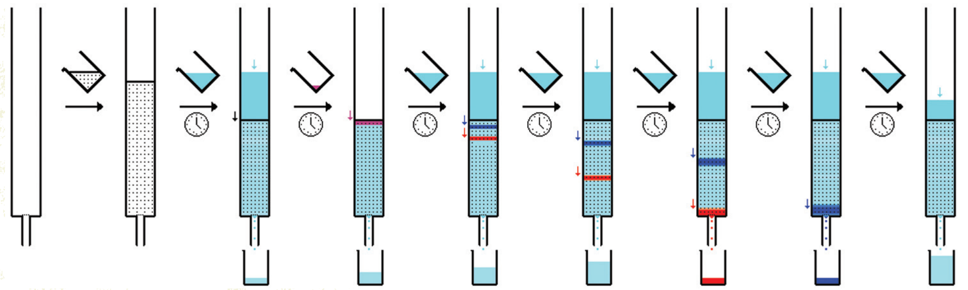
Experimental Overview:

In this experiment, an acetone **extraction** of plant leaves is performed, and the various components in the extract are separated using **column chromatography**.

Chromatography is a way to separate compounds in a mixture by exploiting differences in molecular properties – such as polarity – among the dissolved components. In this experiment, a column is constructed with a polar solid phase (baking soda) suspended in a non-polar solvent (petroleum ether). Plant leaf acetone extract is then delivered to the column. The extract contains components of varying polarity. The more-polar components will be more attracted to the polar **stationary phase**, and the less-polar components will be more attracted to the non-polar **mobile phase** (the solvent). As petroleum ether is delivered to the column, it will wash out the non-polar components of the leaf extract, while the more-polar components will remain adsorbed onto the stationary phase. As the non-polar solvent **elutes** (moves down the column), a band of non-polar compounds will move with it (see figure). The solvent is changed to more polar solvents, acetone, then alcohol, then aqueous bicarbonate, and each solvent will elute a component of the leaf extract of increasing polarity. As each of the **fractions** of the original extract move out of the column, they are collected in small beakers or other receptacles.

Figure

Source: http://en.wikipedia.org/wiki/File:Column_chromatography_sequence.png



Vocabulary:

- Column chromatography
- Elute/elution
- Mobile phase and stationary phase
- Extraction
- Fraction

Materials:

- Chromatography column, buret, or plastic syringe barrel (1)
- Mortar and pestle (1)
- 1 Tsp sodium bicarbonate (baking soda)
- Solvents (10 mL of each solvent)
  CAUTION: Petroleum ether, acetone, and alcohol are all highly flammable, and should be disposed of properly in waste solvent cans.
  > Petroleum ether (mineral spirits or paint thinner).
  > Acetone (unscented, uncolored nail polish remover).
  > Isopropyl alcohol/water, 70/30 v/v (rubbing alcohol).
  > Saturated aqueous sodium bicarbonate solution (baking soda and water)
- Small beakers (6) for collecting fractions or waste solvents.
- Leaves
- Cotton
- Medicine droppers or pipettes (3)
- Small spatula (1)
- Ring clamp or other support for the column
- Nitrile gloves (2 pairs) for handling solvents

Experimental Set-up:

Your teacher will provide instructions on how to set-up your lab station.

Procedure:

NOTE: The term "column" refers to the stationary phase inside the syringe.

1. Prepare the plant extract by using the mortar and pestle to grind up the leaf with ~2 mL of acetone.
2. Place approximately 1 Tsp of baking soda in a small beaker and add a few mL of petroleum ether (PE) to make the stationary phase slurry for the column. The solid should be well-saturated with solvent, and there should be some extra solvent in the beaker.
3. Place a small plug of cotton in the bottom of the buret/syringe, and then use the spatula to scoop the slurry into the buret/syringe barrel. The slurry should be about 3-4 cm high. If slurry sticks to the sides, you can wash it down with a little PE.
4. Place the buret/syringe in its support. Place a waste container below the buret/syringe to catch excess solvent as it flows off the column.
5. There should be excess PE above the level of the solid; allow the excess solvent to flow out of the column. Once the level of the PE reaches the top of the solid, carefully deliver ~0.5 mL of the plant extract (just the liquid!) to the top of the column. Try to evenly distribute the extract on the solid, and try not to disturb the packing material, otherwise as the bands form they will not be flat and concentrated, and they will be very difficult to see as they move down the column.
6. The next step is to add more PE to cause the first band to elute from the extract. However, you must wait until the extract has completely entered the column BEFORE adding more PE. **This is very important!!** The polar components must be allowed enough time to adsorb onto the stationary phase. Failure to wait will cause more than one component to elute at the same time…basically, you won't be able to separate your components.

7. Keep adding PE in ~0.5 mL increments as the first fraction (a large green band) elutes. The first fraction will probably not travel as a discrete band…more likely the whole column will appear green.

8. Once the green band reaches the bottom of the column, use a clean receptacle to collect the fraction. This fraction contains mostly cholorphyll a and b, and carotenoid pigments. As you continue to add more and more PE, it will eventually appear less green as this first set of components elutes.

   Try not to let the column become dry…there should always be some solvent above the top of the solid.

9. When the first fraction is complete (all the green is gone), add about 1 mL of acetone to the top of the column (it actually can be added before the last of the PE reaches the top of the column). Depending on the leaf, this will elute a pale-green or yellowish band which is most likely composed of phytochrome pigments. It will be much smaller and much more difficult to see than the first band.

   Again, keep adding ~0.5 mL increments of acetone until the fraction is complete. Once this band reaches the bottom of the column, collect it in a clean container.

10. When the acetone fraction is complete, add ~1 mL of alcohol to the column. This will elute another small and difficult-to-see band, which will be yellowish-brown. As before, keep adding alcohol to the column until the fraction is complete.

11. Finally, add ~1 mL of the saturated bicarbonate, and keep adding until the last fraction comes off the column. The color of this band will depend on the leaf species.

12. Write up a lab report for this experiment.

Column Chromatography of Plant-Leaf Extract Wet Lab

Note: Students should work in pairs.

Experimental Set-up:

Your teacher will provide instructions on how to set-up your lab station.

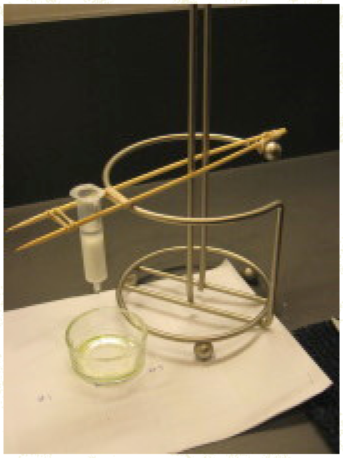


Figure 1: Experimental set-up

NOTE: The term "column" refers to the stationary phase inside the syringe.

1. Prepare the plant extract by using the mortar and pestle to grind up the leaf with ~2 mL of acetone.

Figure 2: Plant extract of red leaf lettuce and acetone

2. Place approximately 1 Tsp of baking soda in a small beaker and add a few mL of petroleum ether (PE) to make the stationary phase slurry for the column. The solid should be well-saturated with solvent, and there should be some extra solvent in the beaker.
3. Place a small plug of cotton in the bottom of the buret/syringe, and then use the spatula to scoop the slurry into the buret/syringe barrel. The slurry should be about 3-4 cm high. If slurry sticks to the sides, you can wash it down with a little PE.

Note: The experiment will go a little faster with a shorter column, but it may be more difficult to observe the separate bands.

4. Place the buret/syringe in its support. Place a waste container below the buret/syringe to catch excess solvent as it flows off the column.
5. There should be excess PE above the level of the solid; allow the excess solvent to flow out of the column. Once the level of the PE reaches the top of the solid, carefully deliver ~0.5 mL of the plant extract (just the liquid!) to the top of the column. Try to evenly distribute the extract on the solid, and try not to disturb the packing material, otherwise as the bands form they will not be flat and concentrated, and they will be very difficult to see as they move down the column.

KEY

6. The next step is to add more PE to cause the first band to elute from the extract. However, you must wait until the extract has completely entered the column BEFORE adding more PE. **This is very important!!** The polar components must be allowed enough time to adsorb onto the stationary phase. Failure to wait will cause more than one component to elute at the same time…basically, you won't be able to separate your components.

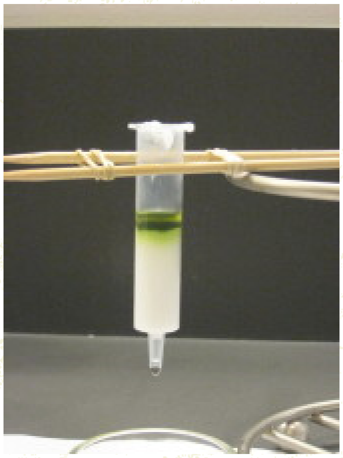


Figure 3: The column immediately after the addition of the extract.

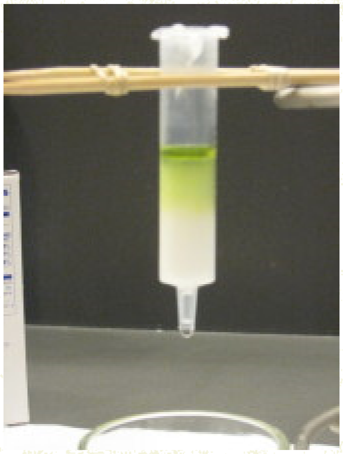


Figure 4: The column after the extract has been allowed to enter the stationary phase.

7. Keep adding PE in ~0.5 mL increments as the first fraction (a large green band) elutes. The first fraction will probably not travel as a discrete band…more likely the whole column will appear green.

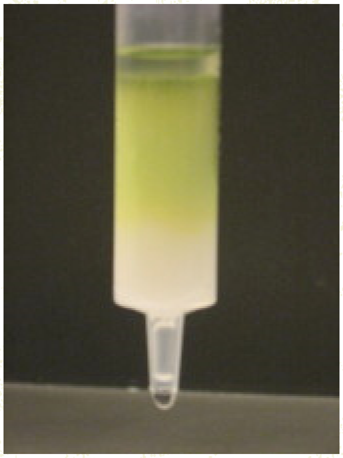


Figure 5: The first fraction with PE.

8. Once the green band reaches the bottom of the column, use a clean receptacle to collect the fraction. This fraction contains mostly cholorphyll a and b, and carotenoid pigments. As you continue to add more and more PE, it will eventually appear less green as this first set of components elutes.

   Try not to let the column become dry…there should always be some solvent above the top of the solid.

Note: Pilot tests of this experiment using spinach and red-leaf lettuce leafs determined that this stage of the experiment takes around 20 minutes.

9. When the first fraction is complete (all the green is gone), add about 1 mL of acetone to the top of the column (it actually can be added before the last of the PE reaches the top of the column). Depending on the leaf, this will elute a pale-green or yellowish band which is most likely composed of phytochrome pigments. It will be much smaller and much more difficult to see than the first band.

   Again, keep adding ~0.5 mL increments of acetone until the fraction is complete.

Once this band reaches the bottom of the column, collect it in a clean container.

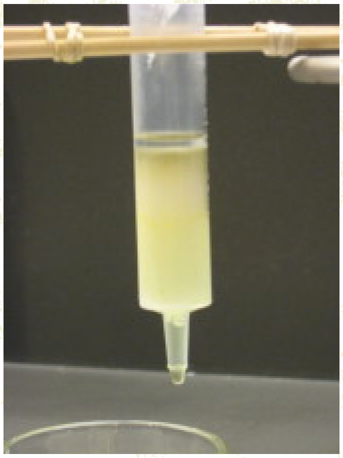


Figure 6: The second fraction with acetone.

Note: In pilot tests of this experiment, the acetone extraction of spinach leaves took well in excess of 40 minutes. Some component of the acetone eluted in spinach just kept getting hung up in the stationary phase. The process can be sped up a little by using the syringe plunger to push the solvent through… *this time-saving ability strongly recommends the use of syringes for chromatography columns in this experiment.* In the red-leaf lettuce experiment, however, the acetone eluted very quickly, on a similar time scale to the PE fraction.

10. When the acetone fraction is complete, add ~1 mL of alcohol to the column. This will elute another small and difficult-to-see band, which will be yellowish-brown. As before, keep adding alcohol to the column until the fraction is complete.

11. Finally, add ~1 mL of the saturated bicarbonate, and keep adding until the last fraction comes off the column. The color of this band will depend on the leaf species.

Note: In pilot testing, a spinach experiment produced a final band that was a very pale yellow while a red-leaf experiment produced a final band that was brown.

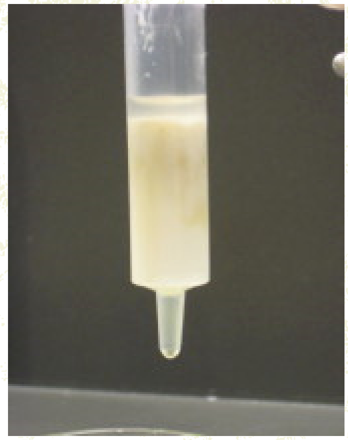


Figure 7: Fourth fraction with saturated bicarbonate.

Note: The article that this experiment is adapted from claims that the alcohol and bicarbonate solvents will elute two or three different bands, which contain yellow, brown, or reddish pigments. In pilot testing, three bands were not observed from these two solvents; only one band per each new solvent added was observed.

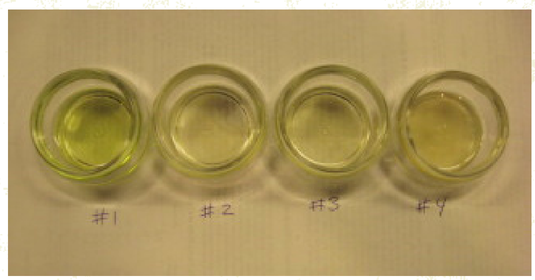


Figure 8: Fractions obtained from red leaf lettuce experiment.

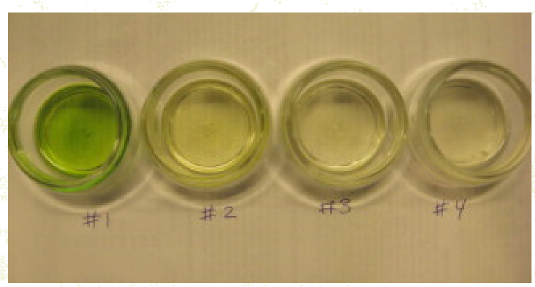


Figure 9: Fractions obtained from spinach experiment.

TIME SAVERS

This can be a long experiment, so here are some ideas for speeding things up:

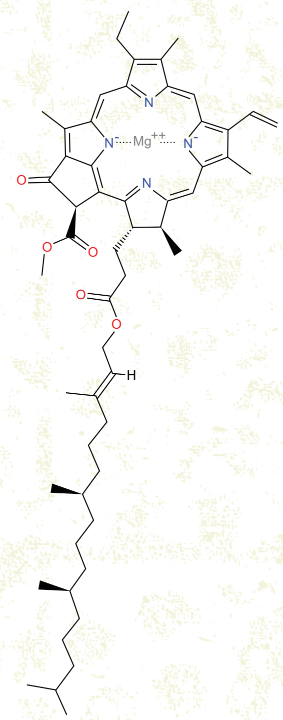
- Rather than having the students set up their columns, you can construct them ahead of time.
- Perform only two fractions, one with the non-polar PE and the second with the polar alcohol or aqueous baking soda solution.
- If elution is especially slow, you can use the syringe plunger to carefully apply pressure to the top of the column, which will force the elution to occur more quickly. However, care must be taken during the subsequent removal of the plunger from the syringe barrel, as this will cause the contents of the barrel to rise up with the plunger. There is the possibility that some of the stationary phase will sneak past the cotton plug and thereby end up in your fractions. This won't adversely affect results other than making the fractions a bit cloudy (indeed, in the pictures above, it may be apparent that the last couple of fractions in each case are a little cloudy from a small amount of baking soda).

FRACTION #1 – Petroleum Ether

A mixture of different non-polar hydrocarbons – dispersion forces only

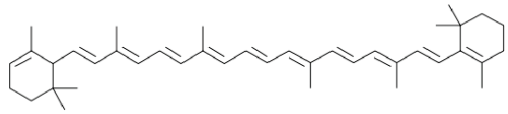
CHLOROPHYLL-a, $C_{55}H_{72}O_5N_4Mg$

(http://en.wikipedia.org/wiki/Chlorophyll)

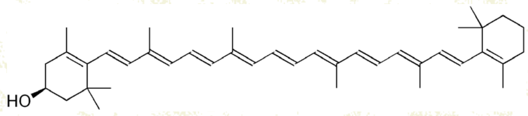


CAROTENOIDS

Carotene
(http://en.wikipedia.org/wiki/Carotenes)

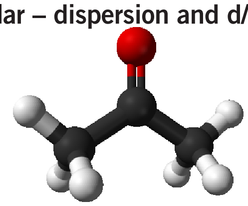


Xanthophyll
(http://en.wikipedia.org/wiki/Xanthophylls)

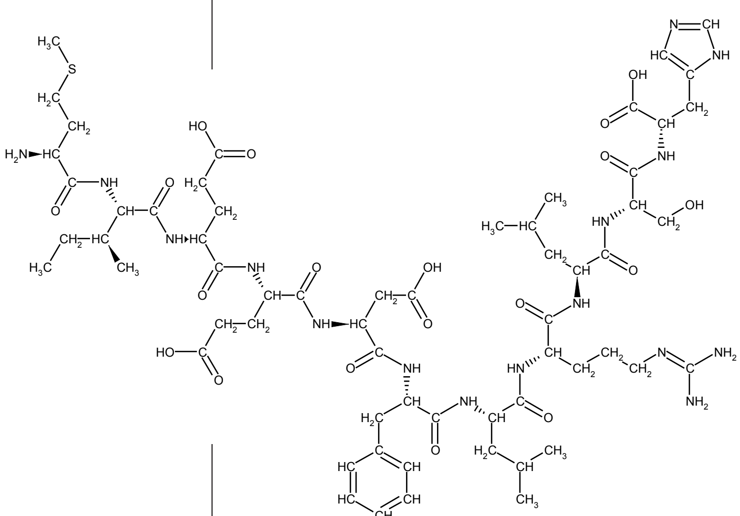


FRACTION #2 – Acetone

Slightly polar – dispersion and d/d forces

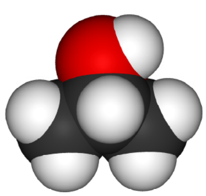


PHYTOCHROMES. Although this molecule has several carboxylic acid (-COOH) groups, ketones (-C=O), and N-H groups, its massive hydrocarbon backbone works to make it only slightly polar, but not non-polar enough to elute with the petroleum ether.



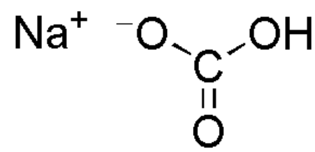
FRACTION #3 – Isopropyl alcohol

Polar – dispersion, d/d, and hydrogen-bonding



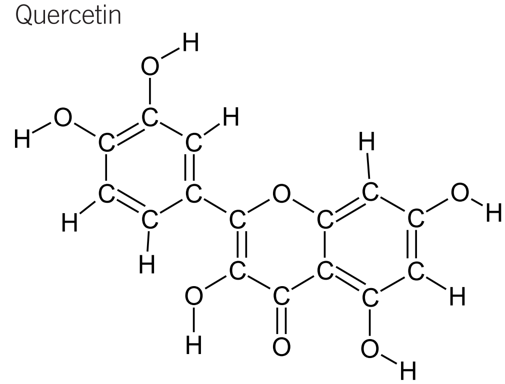
FRACTION #4 – Saturated Sodium Bicarbonate solution

Polar, ionic – dispersion, d/d, hydrogen-bonding, and ionic attraction

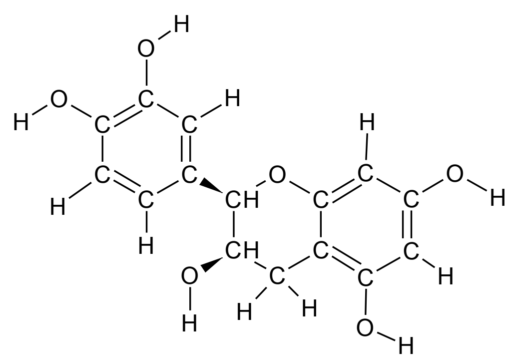


WATER-SOLUBLE FLAVONOIDS

Quercetin



Epicatechin



Quercetin is cited as a likely contributor to the anti-diarrheal properties of guava leaf extract, largely because it appears to inhibit the contraction of the smooth muscle of the small intestine.

LESSON 3: Structure of DDT – Part I

Activity Time: 100 minutes

In this lesson, students will discuss the big idea of "science and technology in society" and then watch a segment of the *Malaria: Fever Wars* video. Students will learn about DDT as a way to prevent malaria. Students will categorize different molecules into polar/non-polar functional groups, including the DDT molecule.

This chemistry lesson is intended to be taught towards the end of the course as a way to introduce the functional groups in organic chemistry. This lesson should be delivered so that it precedes the lesson *Structure of DDT—Part II*.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Science & Technology in Society:** Chemistry can be used to develop technologies that reduce the spread of infectious diseases like malaria, but the technology must be evaluated in terms of risks and benefits before introducing it into society.

Essential Question:

- What factors need to be considered when making decisions about the introduction of a new technology into society?
- How has chemistry been used to develop technologies to reduce the spread of malaria?
- How does the structure of the DDT molecule influence its function?

Learning Objectives:

Students will know…

- Chemistry has been used to develop technologies to fight malaria.
- New scientific technologies come with both risks and benefits.
- Functional groups are responsible for a molecule's function.

Students will be able to…

- Identify the different kinds of functional groups in organic chemistry.
- Understand how each functional group contributes to a molecule's solubility.

Vocabulary:

- Alcohol
- Aldehyde
- Amine
- Benzene ring
- Carboxylic acid
- DDT
- Electronegativity
- Ester
- Halide
- Ketone
- Malaria
- Methyl group
- Non-polar
- Organic chemistry
- Polar

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 APPA** It is important for all citizens to apply science and technology to critical issues that influence society.
- **9-12 APPF** Perfect solutions do not exist. All technological solutions involve trade-offs in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended, others not.

Common Student Preconceptions:

- DDT is a bad chemical that killed lots of birds.
- Malaria doesn't happen in the United States.

TEACHER PREPARATION

Materials:

- DVD player and TV/projector
- Science journals, lab notebooks, or blank paper
- Classroom chemistry text (organic chemistry section)
- Poster paper (for capturing students' preconceptions of malaria)
- *Malaria: Fever Wars* DVD
- *Organic Molecules* Handout (1 per student)
- *Polar vs Non-Polar Molecules* Handout (1 per student)
- *Can a Maligned Pesticide Save Lives?* Handout (1 per student)
- *Identify that Functional Group* Handout (1 per pair of students)
- Teacher Answer Key for Student Handout

Preparation:

- Make copies of the Student Handouts.
- Preview the video, determining which clip you wish to show to students.

PROCEDURE

DAY ONE

Hook:

1. Science and technology are often used to solve local, national, and global challenges. However, science courses often don't challenge students to use a socially-conscious lens to evaluate the complexities of science and technology in society. The following journal prompt encourages students to consider the complexities involved in making decisions about science and technology.
2. Ask students to respond to the following journal prompt either in their science journals, lab notebooks, or on a piece of blank paper:

   Suppose you discovered a new chemical technology that could drastically reduce one of the world's most deadly diseases… yet, the risks of this new technology aren't fully known. Some research has reported that the technology could have huge benefits, including reducing the human death-rate from the disease by ten-fold. Other research has reported that the new technology might have serious risks, including harming birds, bats, and fish.

   What questions would you want answered about the technology's potential benefits and risks? Would you use the technology, or would you hold back from using it? What are the risks associated with your position? Explain.
3. Ask students to each find a partner. Challenge students to Pair-Share with a partner, discussing what they wrote in response to the journal prompt. Ask students to add to their written response any new ideas that are gleaned from their partner.
4. Save students' written responses to use later.
5. Lead a whole class discussion about the students' responses to the journal prompt. Connect the discussion to the topic of malaria and technologies used to reduce the spread of malaria. Tell students that the deadly disease referenced in the journal prompt is malaria, and the new chemical technology is a chemical pesticide called DDT. Introduce students to the Big Idea and Enduring Understanding for this lesson, and explain how it will tie into the other malaria chemistry lessons that will be presented.

Preconceptions:

6. Explain that you want to hear what students already know and think about malaria. Use the chart paper to begin a chart that is titled "Preconceptions about Malaria."
7. Begin a class share-out where students toss out their thoughts on: what they already know about malaria vs. what they suppose is the truth about malaria (based of what they know from the media). Write down the students' responses on the chart.
8. Explain that this list will be referenced throughout the malaria lessons to either confirm or bust their preconceptions about malaria.

Activity:

9. Show the *Malaria: Fever Wars* DVD. Depending on how much time you have, you may choose to show a particular segment of the video, or to show the entire video (60 minutes). Alternatively, you may choose to show the Deadly Messengers segment of the *Rx for Survival* DVD. The video segment is intended to introduce students to malaria, its causes, treatments, and preventive measures.

10. Pass out copies of the *Organic Molecules* Handout, one per student

11. Explain to students that the molecule on the left is exactly like the 'new technology' they wrote about in their journals at the beginning of the malaria unit.

12. Read the following quote aloud:

    "If molecules can be said to go in and out of fashion, then in the developed world DDT is definitely unfashionable—even the name seems to have an ominous ring. Although it is now outlawed in many countries, this insecticide is estimated to have saved fifty million human lives. The threat of death from malaria has largely gone from developed countries—a direct and huge benefit from a much-maligned molecule—but for millions who still live in malarial regions of the world it remains." (Napoleon's Buttons, pg. 345).

13. Ask students to pull out their science journals, lab notebooks, or blank paper and to respond to the following questions:
    - What looks familiar about this molecule?
    - What do you think a molecule like this does?
    - Chemistry can be used to develop technologies that reduce the spread of infectious diseases like malaria, but the technology must be evaluated in terms of risks and benefits before introducing it into society. What could have made DDT go out of fashion?

14. Discuss students' conceptions about the molecule. Add students' ideas to the "Preconceptions about Malaria" chart.

Wrap-Up:

15. Provide students with an Exit Ticket question:
    - Look at our list of "Preconceptions about Malaria." Describe one preconception that was either supported or busted today by watching the documentary. Provide support from the video.

DAY TWO

Hook:

16. Pass out copies of the *Can a Maligned Pesticide Save Lives?* Handout, one per student. Ask students to read the article. Students should annotate the text and/or use Cornell Notes in their journals, depending on what method is familiar to them.

17. Lead a brief discussion of the reading. Begin the discussion by asking the same question that students responded to in their journals: What made DDT go out of fashion?

Functional Groups:

18. Introduce the activity by explaining that in order to understand what made DDT go out of fashion, and what is making people to argue for it to be returned to use to fight malaria, students will be examining the functional structure of DDT. Students will be examining what is it about DDT that makes it able to effectively kill mosquitoes and what is it about DDT that negatively affected the environment when it was initially used.

19. Show the images of commonly used organic molecules from the *Organic Molecules* Handout. The final image compares cholesterol with DDT. Ask students to draw both of these molecules in their journals and to write down three similarities and three differences. Discuss.

20. Introduce the field of organic chemistry to the students as the field that is responsible for the synthesis and identification of these complex molecules. Introduce the purpose, which is learning how a molecule's structure denotes its function (hence the name—functional groups).

21. Introduce functional groups to the students using your classroom chemistry text (usually the chapter on organic chemistry) or the Organic Functional Groups website listed in the Resources section of this lesson plan. Project each functional group onto the screen for the students to see. Ask students to draw each structure and take notes as you describe the characteristics of each group.
22. After going through all the groups, pass out the *Identify that Functional Group* Handout, one per pair of students. Ask students to work in pairs, practicing how to identify the functional groups. Students can use the notes they took in their journals.

Polar vs. Non-Polar Covalent Bonds:

23. Using your classroom chemistry textbook, review polar covalent bonds and non-polar covalent bonds. Use a periodic table with the electronegativities listed to discuss what causes a polar covalent bond vs. a non-polar covalent bond.
24. Pass out copies of the *Polar vs Non-Polar Molecules* Handout, one per student. As a class, discuss each molecule and determine if it is polar or non-polar. Explain why it is categorized as such. The correct categorization is provided below:
    - Polar Molecules: Water, Hydrogen chloride, Carbon monoxide, Ammonia, Ozone.
    - Non-polar Molecules: Methane, Carbon dioxide.
    - Other Molecule Types: Carboxylic acid (depends on the R group), Triglyceride.
25. After this practice, have students make two lists in their journals: Polar Functional Groups and Non-Polar Functional Groups. Challenge students to work in pairs to complete these lists by categorizing the organic functional groups from the *Identify that Functional Group* Handout.

Wrap-Up:

26. Use the following two Exit Ticket questions to assess student learning.
    - Question #1: What determines whether or not whether a small molecule like HCl or O_2 is polar or non-polar?
    - Question #2: Do you think DDT is mainly polar or non-polar? Write 4 – 5 sentences explaining your answer. Use your knowledge of functional groups and electronegativities to justify your claim.

STUDENT ASSESSMENT

Assessment Opportunities:

- The journal response, student handout, and Exit Ticket can all be used to assess student understanding.
- The class discussion provides an opportunity to hear students' thoughts on the journal prompts and research article.
- Students' notes from the article can be used to assess reading comprehension.
- The Exit Ticket provides an opportunity to assess students' learning from the activity.

Student Metacognition:

- The journal prompt asks students to reflect on their learning.
- The pair work time provides an opportunity for students to reflect and discuss their thinking.
- Students will keep their response in their journals and be able to reference it later to see how their thinking has changed.
- Students will be able to reference the "Preconceptions about Malaria" class list, which will be posted in the room. Each time a preconception is confirmed or busted, it will be noted accordingly on the list.

Scoring:

- The journal response and Exit Ticket can be used to assign participation points.
- Participation points can also be assigned for making contributions to the class discussion.
- The Student Handout can be scored using the provided Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- This activity could be extended by watching a longer segment of the *Fever Wars* DVD or by also watching the Deadly Messengers segment of the *Rx for Survival* DVD.
- Use more examples of organic molecules for identifying the functional groups
- Use more examples of molecules for identifying polar vs. non-polar covalent bonds.
- Have students conduct an Article Review of the *Discover Magazine* article.

Adaptations:

- Have students keep a vocabulary list in the back of their journals to track all the new words learned during class.
- To help low-level readers, pre-read the journal prompt and article and circle words whose definitions are not necessarily known by students. Provide students with definitions before assigning the journal prompt.
- Make flashcards with all of the functional groups. Challenge students to compete to see who can memorize the cards the fastest.
- This lesson could be broken into two class periods by focusing on DDT and functional groups during the first class, and polar/non-polar covalent bonds during the second class.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

In order to teach this lesson, you will need a basic understanding of the following topics:

- DDT
- Organic functional groups
- Polar and non-polar covalent bonds

A good resource for learning about DDT is included in the Resources section. It may be helpful to read this information yourself or you may also want to use it with students.

Resources:

Malaria: Fever Wars DVD
PBS, 2006, 120 minutes

Rx for Survival: A Global Health Challenge DVD
WGBH, 2005, 336 minutes total running time

Polar vs. Nonpolar Notes
http://iweb.tntech.edu/snorthrup/chem111/polar.html

Electronegativity: Classifying Bond Types
http://www.chemteam.info/Bonding/Electroneg-Bond-Polarity.html

Organic Functional Groups
http://www.chemistry-drills.com/functional-groups.php?q=simple

DDT: An Introduction
Choose the "DDT: An Introduction" link at the bottom of the page
Cruising Chemistry, University of California, San Diego
http://www.chem.duke.edu/~jds/cruise_chem/pest/pestindex.html

The Why Files: Mosquito Bytes
http://whyfiles.org/016skeeter/3.html#

Slide Set of Mosquito Taking Its Meal
http://www.cdc.gov/malaria/ppt/freeborni_sequence.pps

Credit:

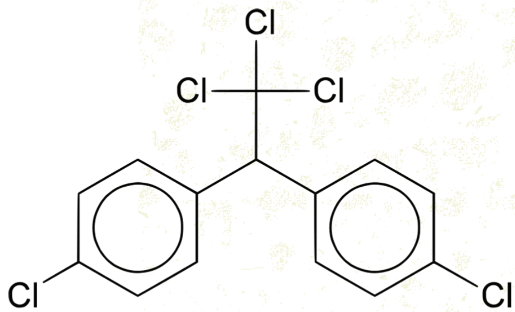
Glausiusz, J. (2007). Can a maligned pesticide save lives? *Discover Magazine*, 11/20/07. Available from: http://discovermagazine.com/2007/nov/can-a-maligned-pesticide-save-lives.

LeCouteur, P. (2003). "Molecules versus malaria." *Napoleon's Buttons: How 17 Molecules Changed History*. Tarcher Publishing.

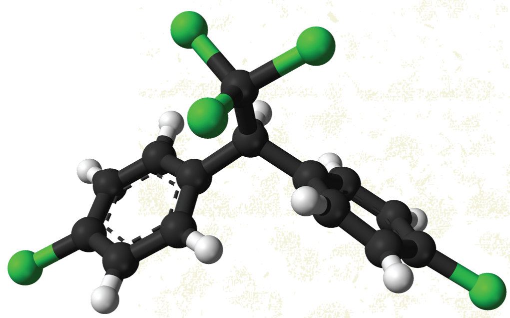
Name:______________________________ Date:__________ Period:________

Organic Molecules

A Molecule to Help Fight Malaria



Credit: Lukas Mizoch, 2006.



Credit: Ben Mills, 2009.

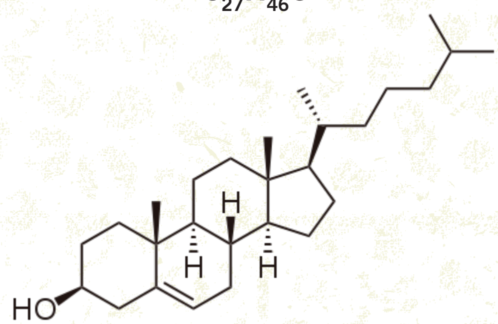
Chemical Name: 1,1,1-trichloro-2,2-bis-(p-chlorophenyl) ethane.

Common Name: DDT (dichloro-diphenyl-trichloroethane)

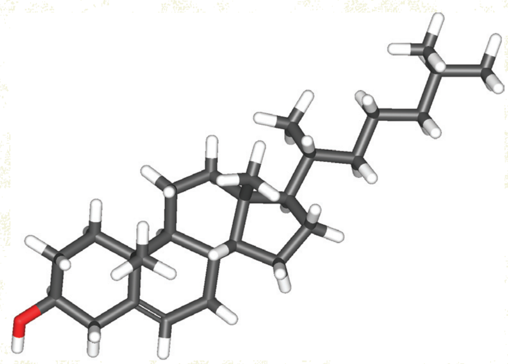
Molecular Formula: $C_{14}H_9Cl_5$

Pure Form: White, crystalline powder. Low odor.

Cholesterol Molecule
$C_{27}H_{46}O$

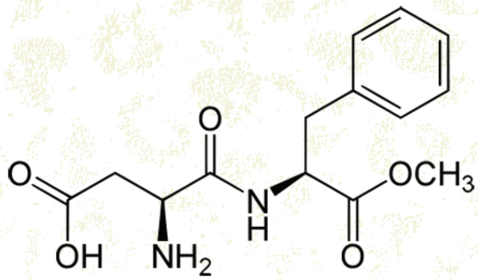


Credit: BorisTM

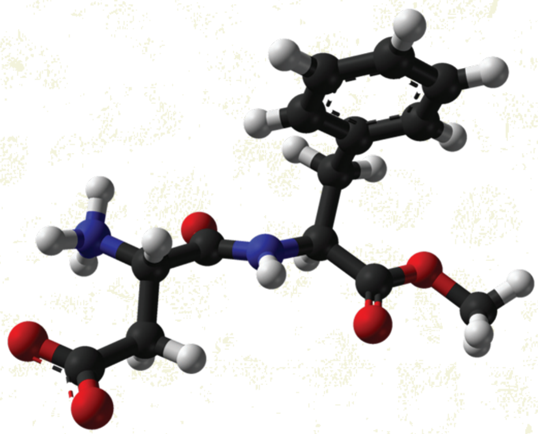


Credit: Sbrools, 2007

Aspartame Molecule
$C_{14}H_{18}N_2O_5$
artificial sweetener

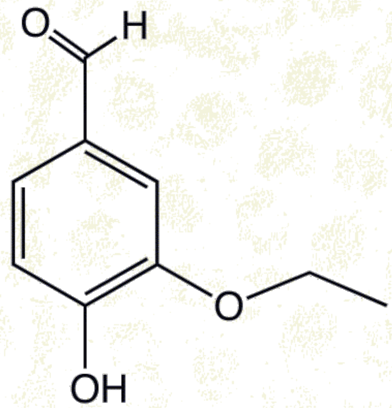


Credit: Yikrazuul, 2008



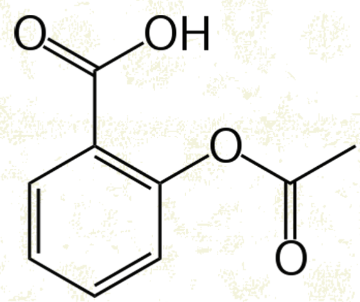
Credit: Ben Mills, 2009

Ethylvanillin Molecule
$(C_2H_5O)(HO)C_6H_3CHO$
artificial vanilla flavoring

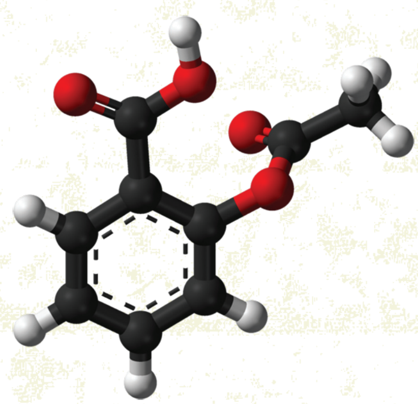


Credit: Smokefoot, 2008

Acetylsalicylic Acid Molecule
$C_9H_8O_4$
aspirin

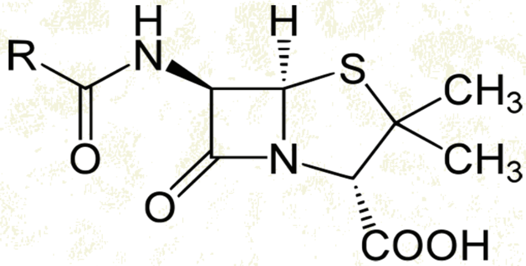


Credit: Benjah-bmm27, 2006



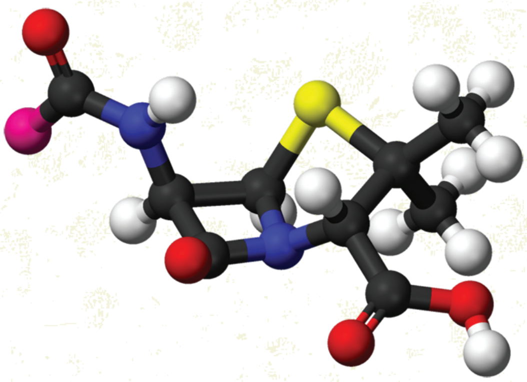
Credit: Ben Mills, 2008

Penicillin Molecule
$C_9H_{11}N_2O_4S$
antibiotic



Penicillin core structure.
"R" is a variable group.

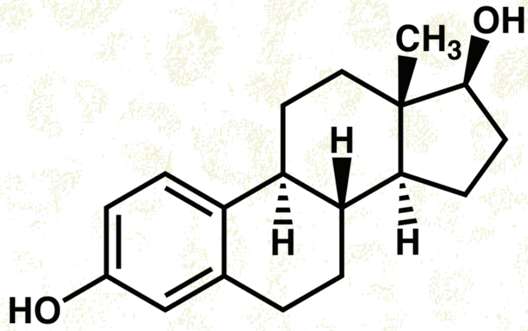
Credit: Yikrazuul, 2009



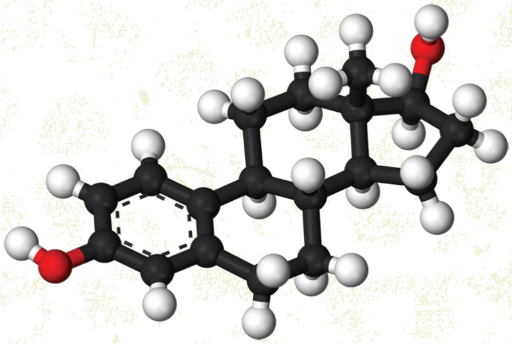
Penicillin core structure.
Purple is a variable group.

Credit: Benjah-bmm27

Estradiol
$C_{18}H_{24}O_2$
an estrogen used in birth control pills

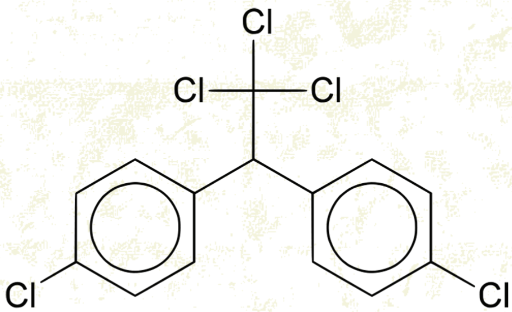


Credit: Boghog2, 2007

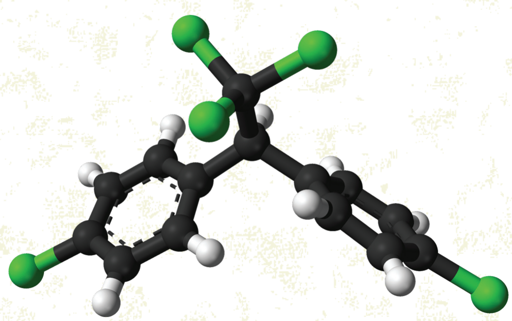


Credit: Benjah-bmm27, 2006

DDT Molecule
$C_{14}H_9Cl_5$



Credit: Lukas Mizoch, 2006.



Credit: Ben Mills, 2009.

Chemical Name: 1,1,1-trichloro-2,2-bis-(p-chlorophenyl) ethane

Common Name: DDT (dichloro-diphenyl-trichloroethane)

Molecular Formula: $C_{14}H_9Cl_5$

Molar Mass: 354.49 g/mol

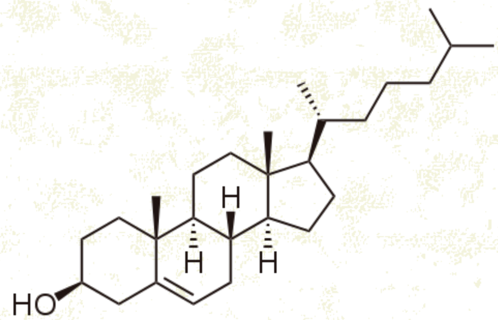
Melting Point: 109 °C

Boiling Point: 260 °C (decomposes)

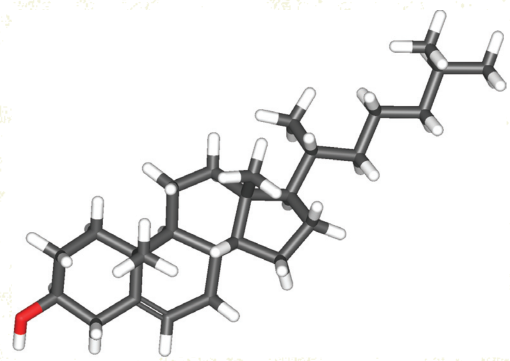
Solubility in Water: <1 mg/L (20 °C)

Pure Form Appearance: White crystalline powder

Cholesterol Molecule
$C_{27}H_{46}O$



Credit: BorisTM



Credit: Sbrools, 2007

Chemical Name: 1,1,1-trichloro-2,2-bis-(p-chlorophenyl) ethane

Common Name: Cholesterol

Molecular Formula: $C_{27}H4_{6}O$

Molar Mass: 386.65 g/mol

Melting Point: 148-150 °C

Boiling Point: 360 °C (decomposes)

Solubility in Water: 0.095 mg/L (30° C)

Pure Form Appearance: White crystalline powder

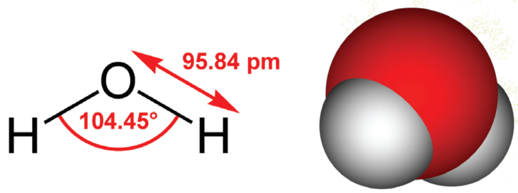
Name:______________________ Date:__________ Period:________

HANDOUT

Polar vs. Non-Polar Molecules

H_2O Molecule

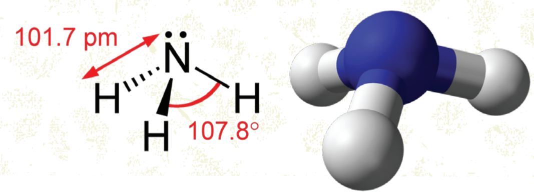
Water



Credit: Benjah-bmm27, 2006 and Dbc334, 2006

NH_3 Molecule

Ammonia



Credit: Ben Mills, 2009 and Ben Mills, 2008

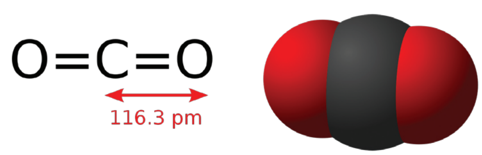
CH_4 Molecule

Methane

Credit: Benjah-bmm27, 2009 and Dbc334, 2006

CO_2 Molecule

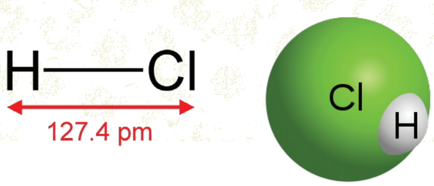
Carbon dioxide



Credit: Alessio Damato, 2007 and Jacek FH, 2007

HCl Molecule

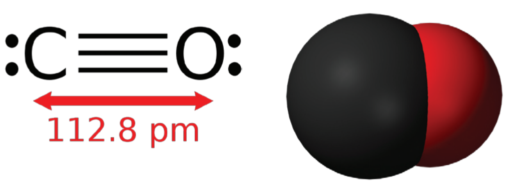
Hydrogen chloride



Credit: Benjah-bmm27, 2006 and Bobarino, 2006

CO Molecule

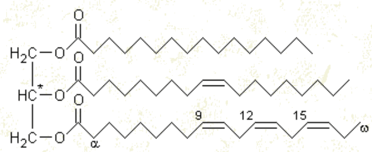
Carbon monoxide



Credit: ItIsMeHere, 2008 and Benjah-bmm27, 2006

$C_{55}H_{98}O_6$ Molecule

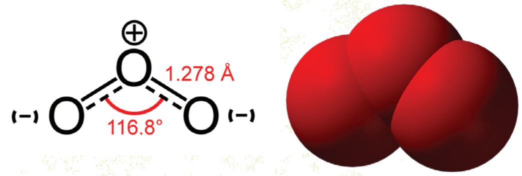
Fat Triglyceride
(component of animal and vegetable oils)



Source: Wolfgang Schaefer, 2005

O_3 Molecule

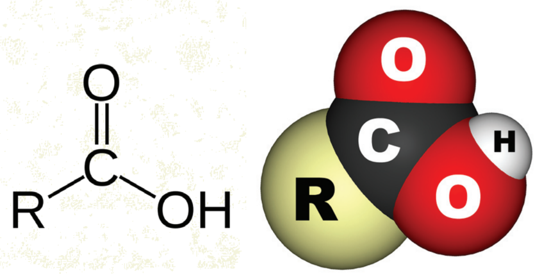
Ozone



Credit: Benjah-bmm72, 2006 and Ben Mills, 2009

-COOH Molecule

Carboxylic acid



Credit: De.Nobelium, 2007 and Benjah-bmm27, 2006

Name:__________________________ Date:__________ Period:________

HANDOUT

Can a Maligned Pesticide Save Lives

DDT may be a useful public-health tool—until its effect wears off...
by Josie Glausiusz

DDT, formerly one of the most common industrial chemicals, was banned in the United States three decades ago, in no small part due to the work of one woman: Rachel Carson.

Born a century ago this year, Carson published *Silent Spring*, a haunting book that has been credited with helping to found the modern environmental movement in 1962. In her landmark book, she documented a litany of evils observed after DDT and other organochlorine insecticides were sprayed on landscapes, rivers, and lawns: dead birds and paralyzed birds, pigeons dropping from the sky, bird nests without eggs and eggs that did not hatch, dead fish and fish swimming in circles, cancers in humans, and a buildup of DDT in the fat of animals and people.

But in more recent years, a conglomeration of critics from organizations as diverse as the conservative American Enterprise Institute and the civil rights group Congress of Racial Equality have charged that Carson overstated the dangers of DDT, that it is not a carcinogen, and that at moderate doses, it is not even harmful to birds. Above all, her opponents argue that the reduction in DDT use has led to a dramatic rise in mosquito-borne malaria cases in Africa and South America. Bring back DDT, they demand, and let it be sprayed on the inner walls of houses, where it would kill vectors of malaria and other insect-borne diseases like dengue and typhus.

It's clear that eliminating DDT as a common agricultural pesticide has had marked environmental benefits, according to Chandler Robbins, an 89-year-old wildlife biologist at the U.S. Geological Survey's Patuxent Wildlife Research Center in Laurel, Maryland, who worked directly with Carson in the 1940s. (Carson herself died of cancer in 1964.) Following the publication of *Silent Spring*, Robbins helped develop the Breeding Bird Survey, a continent-wide census of birds designed to track changes in populations. "Rachel was right about the drastic effect DDT was having on populations of birds, fish, and other wildlife," Robbins says. "The peregrine falcon and the brown pelican, in particular, were rapidly heading for extinction, and hundreds of other species were showing drastic declines."

Rachel Carson

Source: U.S. Fish and Wildlife Service

In fact, Carson may have underestimated the impact of DDT on birds, says Michael Fry, an avian toxicologist and director of the American Bird Conservancy's pesticides and birds program. She was not aware that DDT—or rather its metabolite, DDE—causes eggshell thinning because the data were not published until the late 1960s and early 1970s. It was eggshell thinning that devastated fish-eating birds and birds of prey, says Fry, and this effect is well documented in a report on DDT published in 2002 by the Department of Health and Human Services'

Agency for Toxic Substances and Disease Registry (ATSDR). The report, which cites over 1,000 references, also describes how DDT and its breakdown products accumulate in the tissues of animals high up on terrestrial and aquatic food chains—a process that induced reproductive and neurological defects in birds and fish.

On the subject of cancer, however, the evidence is more equivocal. Although the EPA has classified DDT and its metabolites, DDE and DDD, as "probable human carcinogens," and although mice exposed to DDT for more than a year did develop liver tumors, a detailed analysis of multiple studies of breast, pancreatic, prostate, testicular, and other forms of cancer in people led the authors of the ATSDR report to conclude that "there is no clear evidence that exposure to DDT/DDE causes cancer in humans."

So is it safe to apply DDT to combat malaria? One advocate for its use is Donald Roberts, a medical zoologist recently retired from the Uniformed Services University of the Health Sciences in Bethesda, Maryland, and a member of the board of Africa Fighting Malaria, which collaborates with conservative think tanks. "The reason that I promote the use of DDT is because, number one, it's very cheap," he says. "Number two, it's long lasting. And number three, as a repellent it keeps mosquitoes from entering the houses to a greater degree than any other chemical that we know of." Roberts has studied malaria transmission in Central and South America for three decades and claims that spraying DDT inside houses—while avoiding its use in agriculture—has already produced "spectacular declines" in malaria rates in those regions.

But elsewhere, the picture is murkier. According to the World Health Organization (WHO), over 500 million cases of malaria occur each year, resulting in an estimated 1 million deaths. Most of these cases of illness and mortality occur in sub-Saharan Africa. But no one can say whether malaria rates have increased or declined in Africa as a whole in recent decades because of difficulties in collecting data, says Valentina Buj, public-health officer for the WHO's Global Malaria Programme in Geneva. Some countries do not track whether DDT has been used to combat malaria. "Given the wide variation in the transmission of the disease—endemic areas, areas of low endemicity, hyperendemic areas, and sometimes these strata all occurring in the same country—we prefer to look at each country separately without aggregates over the entire continent," Buj says.

The confusion is also reflected by the fact that in the past year officials at the WHO have issued contradictory directives on the use of DDT to fight malaria. On September 15, 2006, Arata Kochi, the head of the Global Malaria Programme, announced at a news conference in Washington, D.C., that DDT posed no health risk when sprayed in small quantities on the inside walls of houses, and he called for an expansion of its use to combat the mosquito-borne disease. Then on May 3, 2007, Maria Neira, director of the WHO's public-health and environment department, said at a Dakar, Senegal, meeting of the ratifiers of the Stockholm Convention—an international treaty that went into effect in 2004 that controls the use of persistent organic pollutants like DDT—that the WHO's goal was to reduce the use of DDT and eventually eliminate it.

Lost in all the hullabaloo is the fact that DDT has never been completely banned for use in public-health measures. The Stockholm Convention defines disease control as an " acceptable use" for DDT, and 13 countries in Africa and Asia have registered their intention to use it as such. Among them is South Africa, which claims significant success in controlling malaria since DDT was reintroduced to that country in 2000. According to South Africa's department of health, the number of malaria cases in the country dropped by 65 percent between 2005 and 2007, and deaths from the disease fell by 73 percent. The agency attributes the decline to an increase in indoor spraying with DDT, but also to earlier surveillance and detection of the illness in malaria-prone regions and the use of a drug, artemisinin, to treat multidrug-resistant strains of the malaria parasite.

Given the fact that DDT does appear to be effective at fending off malaria mosquitoes in some places, its use would seem logical—but if applications do become more widespread, users may encounter a problem that Carson herself highlighted in *Silent Spring*: resistance to the insecticide by the Anopheles mosquitoes that transmit malaria, says Michael Fry. Since *Silent Spring's* publication, hundreds of mosquito species have become resistant to DDT, and although the rise of resistance has slowed since the ban on the agricultural use of DDT, many mosquito populations are already immune to its effects, says Pierre Guillet, of vector control and prevention at the WHO's Global Malaria Programme. While the main malaria vector in South Africa, Anopheles funestus, is susceptible to DDT, a secondary vector, A. arabiensis, has developed resistance to DDT and other insecticides. Elsewhere in Africa, mosquito resistance to DDT is already common. "DDT resistance in Africa as well as several other parts of the world has been acquired because of massive use of these insecticides for crop protection," Guillet says.

That's why Fry and others believe that a broader and better solution is one that would help humans while minimizing the impact on wildlife and the environment. That solution is a suite of techniques called integrated vector management: draining mosquito-breeding pools, spraying safer, less persistent pesticides known as permeth-rins, and plastering homes with mosquito-repelling lime. This last approach has been applied successfully in Mexico, which no longer uses DDT for vector control. "No single pesticide will ever solve the problem," Fry says. "What you need to do is use a variety of different pesticides in different years to minimize the insect resistance problem. You want to use other techniques as well—wetlands management, netting, screens, repellent chemicals indoors. If you rely on a single chemical like DDT, you're going to fail."

Credit: Glausiusz, J. (2007). Can a maligned pesticide save lives? *Discover Magazine*, 11/20/07.
Available from: http://discovermagazine.com/2007/nov/can-a-maligned-pesticide-save-lives.

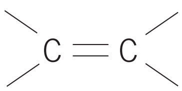
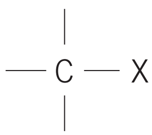
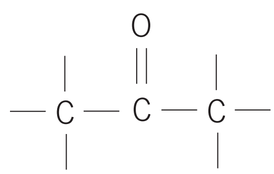
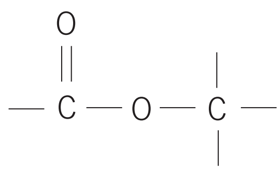
Name:____________________ Date:__________ Period:________

Identify that Functional Group

HANDOUT

Write the name of the functional group that describes each of the following organic compounds.

- Alkane
- Alkenes
- Alkyne
- Arene
- Haloalkane
- Alcohol
- Ether
- Amine
- Aldehyde
- Ketone
- Carboxylic Acid
- Ester
- Amide

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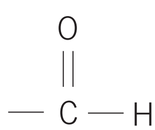
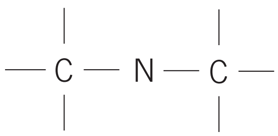

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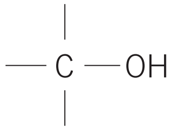
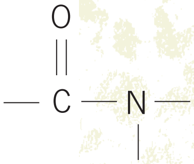
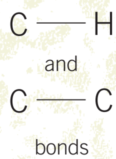

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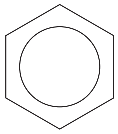
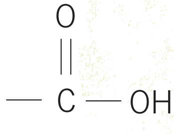
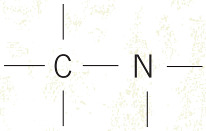




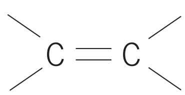
______________ ______________ ______________

Identify that Functional Group

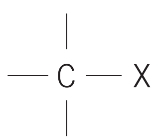
KEY

Write the name of the functional group that describes each of the following organic compounds.

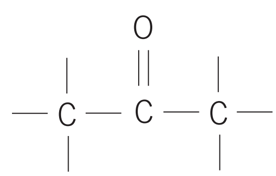
- Alkane
- Alkenes
- Alkyne
- Arene
- Haloalkane
- Alcohol
- Ether
- Amine
- Aldehyde
- Ketone
- Carboxylic Acid
- Ester
- Amide



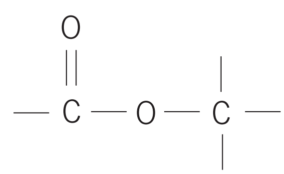
Alkenes



Haloalkane

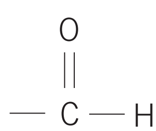


Ketone

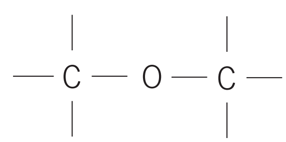


Ester

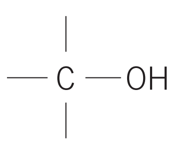
Alkyne



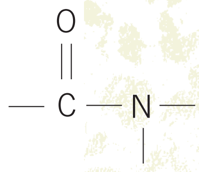
Aldehyde



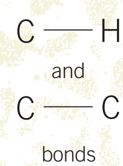
Ether



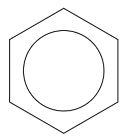
Alcohol



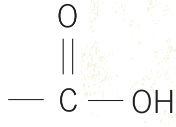
Amide



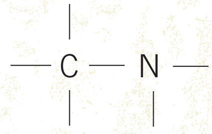
Alkane



Arene



Carboxylic Acid



Amine

LESSON

LESSON 4: Structure of DDT – Part II

Activity Time: 55 minutes

In this lesson, students discover the polar/non-polar qualities of DDT that make it interact with cell membranes, using soap for comparison. By examining DDT's functional group and structure, students will understand how it works as a pesticide.

This lesson should be delivered so that it follows the lesson *Structure of DDT—Part I*. Students should have already studied solubility and polar/non-polar covalent bonds before participating in this activity.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Science & Technology in Society:** Chemistry can be used to develop technologies that reduce the spread of infectious diseases like malaria, but the technology must be evaluated in terms of risks and benefits before introducing it into society.

Essential Question:

- How does the structure of the DDT molecule influence its function?

Learning Objectives:

Students will know…

- The polar/non-polar structure of DDT makes it lethal to mosquito nerve cells.
- DDT molecules, like soap molecules, are both polar and non-polar.
- DDT is soluble in lipids and concentrates in body fat.

Students will be able to…

- Articulate how soap chemistry works.
- Describe how polar/non-polar concepts play a large role in soap chemistry.
- Compare soap chemistry to the structure and function of DDT and its effects to animal cells.
- List the steps in the process of how DDT kills mosquitoes.

Vocabulary:

- DDT
- Emulsification
- Hydrophilic
- Hydrophobic
- Malaria
- Miscelle
- Non-polar
- Polar
- Saponification
- Sodium hydroxide
- Sodium stereate

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **9-12 APPA** It is important for all citizens to apply science and technology to critical issues that influence society.
- **9-12 APPF** Perfect solutions do not exist. All technological solutions involve trade-offs in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended, others not.

Common Student Preconceptions:

- Poisons and pesticides kill cells somehow.
- Chemicals can damage living cells somehow.
- DDT is a pesticide.
- DDT is a bad chemical that killed lots of birds.

TEACHER PREPARATION

Materials:

- Computer with projector or document camera
- DDT Cards (1 set of 10 cards for each group)
- *Going Batty Homework Assignment* Handout (1 per student)
- *Soap and Saponification* Handout (1 per student)
- *Lipid Bilayer and Cell Membrane* Handout (1 per student)
- "Preconceptions about Malaria" chart (from *Structure of DDT–Part I* lesson)
- Science journals, lab notebooks, or blank paper
- Classroom chemistry textbook
- Optional: *Fight Club* DVD
- Optional: Samples of different kinds of soap

Preparation:

- Make copies of Student Handouts.
- Copy and cut up the DDT Cards. Each student group will need one complete set of ten DDT Cards. Be sure to shuffle the cards before handing them out.
- Check out your chemistry textbook to review sections on soap chemistry.
- Optional: Queue the *Fight Club* DVD to the scene where Brad Pitt and Edward Norton break into the liposuction clinic.

PROCEDURE

Hook:

1. Write the following list on the board:
    - Milk
    - Butter
    - Mayonnaise
    - Salad dressing
    - Body lotion
    - Volcanic magma
    - Fire extinguisher foam
    - DDT pesticide
2. Ask students what the items on the list have in common. Listen to all ideas, but don't provide the answer. Tell students that you'll return to this list at the end of the class period.
3. Optional: Bring in several different types of soap—dish soap, bath soap, hand soap, etc.
4. Optional: Show scene from *Fight Club* where Brad Pitt and Edward Norton break into the liposuction clinic to steal human fat for making soap. Before showing, ask students to watch the video closely and make a list of what they think the ingredients are for making soap.

Preconceptions:

5. Ask students what they know about how soap works and list these ideas on the board. Return to this list as saponification is discussed.
6. Explain that the chemistry of how soap works depends on its structure. Point out that the chemistry of soap works very similar to the chemistry of DDT.

Saponification Chemistry:

7. Pass out copies of the *Soap and Saponification* Handout, one per student. Give a mini-lecture on soap and saponification using your classroom textbook and the resources provided with this lesson plan. Students need to take notes in their journals or the handout.
8. Show students the necessary ingredients for making soap, an example word equation for the soap-making process a chemical equation. Then, have students circle the functional groups in each molecule and identify each molecule as polar vs. non-polar.

9. Show the chemical structure of the final product in the soap-making process: sodium stearate ($C_{18}H_{35}NaO_2$). Ask students to identify the functional groups. Then have the class vote on whether or not it is polar vs. non-polar. Explain that the molecule is both polar and non-polar. Explain how this molecule works to emulsify non-polar chemicals (e.g. lipids) in polar solutions (e.g. aqueous solutions).

10. Show diagram of a micelle and explain how it works. Discuss how the structure of sodium stearate causes the micelle structure to occur.

11. Have students Think-Pair-Share with the following question. First have students "think" by writing in their journals. Then have students "pair" up and discuss their thinking. Then bring the class together as a whole group to discuss the question.
    - Think-Pair-Share Question: "Hard-water" isn't good for showering or taking baths because soap doesn't really work well in this kind of water. The reason the water is "hard" is because there is a high concentration of Ca++ ions dissociated throughout the water. If you put soap into this Ca++ rich water, how would the ability of the soap to form micelles be affected?

12. Show image of a micelle affected by Ca++ in hard water. Discuss what has happened to the micelle.

13. Challenge students to apply their new knowledge to answer the following question: How would the shape of the micelle be different in oil (instead of water)? Answer: A micelle that forms in oil would have the inverse shape, with the hydrophobic tails pointed outwards and the hydrophilic heads pointed inwards.

DDT Timeline:

14. After soap chemistry has been explained, ask students how this has anything to do with DDT. Explain that there is a link between soap chemistry and DDT because hydrophobic things attract other hydrophobic things, and hydrophilic things attract other hydrophilic things. Discuss the hydrophobic/hydrophilic properties of DDT and its similarities/differences with soap. DDT has low solubility in water, but it is soluble in lipids. Why is this important to know? Because DDT is chemically stable and soluble in fat, the chemical builds up in animals and is stored in fatty tissues. Because DDT has low solubility in water, it can accumulate in lakes and other waterways.

15. Reflecting back on the structure of a micelle, explain how a lipid bilayer forms in a cell membrane, with the hydrophilic polar heads pointed outward and the hydrophobic non-polar tails pointed inward.

16. Pass out copies of the *Lipid Bilayer and Cell Membrane* Handout, one per student. Show diagram of a cell membrane. With the students' input, circle and discuss the different functional groups in the cell membrane. Discuss the cell membrane's polar vs. non-polar parts.

17. Have students Think-Pair-Share with the following question.
    - Think-Pair-Share Question: How do you think a DDT molecule will interact with a cell membrane? (Hint: Consider what Ca++ did to the micelle and the similarities between DDT and Cholesterol).

18. Similar to how Ca^{++} disrupts the structure of a micelle, DDT causes changes in the lipid bilayer in the cell membrane. Explain that DDT acts like an uncontrolled channel in the cell membrane, allowing Na^{+} and K^{+} to leak out of the cell in an uncontrolled manner, which causes a cascade events that are detrimental to the cell.

19. Break students into small groups of 2 to 3 students. Pass out one set of DDT Cards to each group. Challenge students to use the cards to reconstruct how DDT chemically affects a cell, and in turn, harms an organism. Each step of this process is listed on one of the DDT Cards. Students need to arrange the cards in the proper order to receive credit for the activity.
20. After students have arranged the cards, ask them to copy the steps into their journal. This provides you with a record that can be used for scoring.
21. Ask students to answer the following questions in their own journals:
    - Is sodium stearate (soap) hydrophobic, hydrophilic, or both? Explain using functional groups in your answer.
    - Look at the structure of DDT. Is it more non-polar or polar? Explain using functional groups in your answer.
    - How are DDT and sodium stearate similar? How are they different? Be sure to discuss functional groups and polar/non-polar in your answer.

Wrap-Up:

22. Return to the list of items on the board. Ask students what the items on the list have in common. The correct answer is that each item is an example of an emulsion. Soap is an emulsifying agent. A liquid emulsion of DDT is often used to kill mosquitoes in aquatic environments.
23. Review the "Preconceptions about Malaria" chart. What can be added to the chart? What preconceptions have been busted with the new information students have acquired?
24. Use the following three Exit Ticket questions to assess student learning:
    - Question #1: How do soaps work?
    - Question #2: How is it different/similar to what you previously thought?
    - Question #3: Do you think DDT should be brought back into use to control malaria? Why or why not?

Homework Assignment:

25. Pass out copies of the *Going Batty Homework Assignment*, one per student. Collect the assignment the next day. Discuss students' responses.

STUDENT ASSESSMENT

Assessment Opportunities:

- The class discussion provides an opportunity to hear students' thinking, preconceptions, and misunderstandings.
- Students' notes from the lecture, journal responses, and Exit Tickets questions can all be used to assess student learning.
- The homework assignment provides an opportunity to see how students are able to apply their new knowledge to a different challenge.

Student Metacognition:

- The journal prompts ask students to reflect on their learning.
- The Think-Pair-Share time provides an opportunity for students to reflect and discuss their thinking.
- The Exit Ticket questions ask students to reflect on how their thinking about soap has changed.

Scoring:

- Participation points can be awarded for participating in class discussions and group work.
- The student's assembly of the DDT Cards can be graded.
- The *Going Batty Homework Assignment* can be graded.

The correct order for the DDT cards is as follows:

1. DDT enters the bloodstream.
2. DDT's polar chlorine groups allow it to stay aqueous in the bloodstream.
3. DDT's hydrophobic structure allows it to wedge into the lipid bi-layer of a nerve cell membrane.
4. The bulky size of the DDT molecule opens up the cell membrane.
5. Na^+ and K^+ ions begin to leak across the membrane.
6. The concentration of Na^+ and K^+ ions is disrupted.
7. The nerve cell can no longer fire correctly because of the lack of a concentration gradient across the cell membrane.
8. Nerve cell begins to fire spontaneously.
9. Organism begins to convulse rapidly, unable to control its muscular movements.
10. Organism eventually suffers paralysis, unable to execute any muscular function and dies from large organ failure.

EXTENSION ACTIVITIES

Extension Activities:

- The cholera chemistry lesson, *Soap Lab*, provides a detailed introduction to soap chemistry. In this lesson, students are challenged to make soap.

Adaptations:

- To help visual learners better understand the lipid bi-layer, show students the Sodium Potassium Pump Animation listed in the Resources section.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

In order to teach this lesson, you will need a basic understanding of the following topics:

- Saponification
- DDT
- Polar vs. non-polar covalent bonds
- Cell membrane and lipid bilayer

The Resources section provides some websites that can help you to understand these topics.

Resources:

Synthesis of Soap
http://homepages.ius.edu/DSPURLOC/c122/soap.htm

Lye Soap Chemistry
http://www.cavemanchemistry.com/oldcave/projects/soap/

Lipid Bilayer and Micelle Diagrams
BioTeach
http://www.bioteach.ubc.ca/Bio-industry/Inex/

Sodium Potassium Pump Animation
Human Anatomy, McGraw-Hill
http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_the_sodium_potassium_pump_works.html

Cell Membrane and Lipid Bilayer Animation
John Kyrk, Cell Biology Animation
http://www.johnkyrk.com/cellmembrane.html

Introduction to DDT
http://www.chem.duke.edu/~jds/cruise_chem/pest/ddtup.html

Effects of DDT (including bats)
http://www.chem.duke.edu/~jds/cruise_chem/pest/effects.html

Credit:

Synthesis of Soap website, http://homepages.ius.edu/DSPURLOC/c122/soap.htm

Name:________________________ Date:_________ Period:_______

DDT Cards

HANDOUT

DDT enters the bloodstream.	DDT's polar chlorine groups allow it to stay aqueous in the bloodstream.
DDT's hydrophobic structure allows it to wedge into the lipid bi-layer of a nerve cell membrane.	The bulky size of the DDT molecule opens up the cell membrane.
Na+ and K+ ions begin to leak across the opened cell membrane.	The concentration of Na+ and K+ ions is disrupted.
The nerve cell can no longer fire correctly because of the lack of a concentration gradient across the cell membrane.	Nerve cell begins to fire spontaneously.
Organism begins to convulse rapidly, unable to control its muscular movements.	Organism eventually suffers paralysis, unable to execute any muscular function and dies from large organ failure.

Name:____________________________ Date:___________ Period:________

Going Batty

Homework Assignment:

Bats are perhaps one of the populations of organisms that are most susceptible to DDT.

Bats, like many types of birds, migrate during certain parts of the year. In order to make a long migration, bats require a lot of stored energy, most of which comes from the fat stores in their body. So…where does DDT come in, and why does it harm migrating bats so much?

Write a 1-page paper that answers each of the following questions.

- Is DDT primarily polar or non-polar? How do you know?
- Is body fat primarily polar or non-polar? How do you know?
- In what part of a bat's body do you think DDT would be stored?
- What happens to fat as it is burned off?
- What would happen to the DDT molecules contained within fat once that fat is burned off?

Name:________________________ Date:__________ Period:________

Soap and Saponification

Basic Soap Recipe

Soap is essentially a salt (sodium or potassium) of long-chain carboxylic acids. The long-chain carboxylic acids are made by the hydrolysis of the long-chain esters found in animal and vegetable fats. The hydrolysis is carried out by combining the esters with an alkali such as sodium hydroxide. The method works well for different types of oil/fat and it might be worth investigating the quality of the soap produced from the different types of vegetable and/or animal fats.

Saponification is the reaction of a fat/oil with sodium or potassium hydroxide to create soap.

Word equation

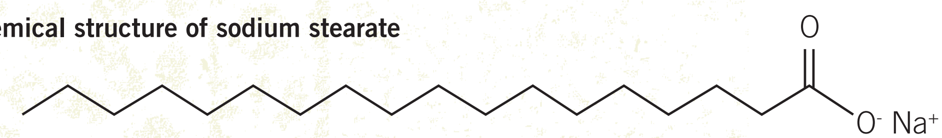
Fat/oil + sodium hydroxide $\longrightarrow$ soap + glycerol

Chemical equations

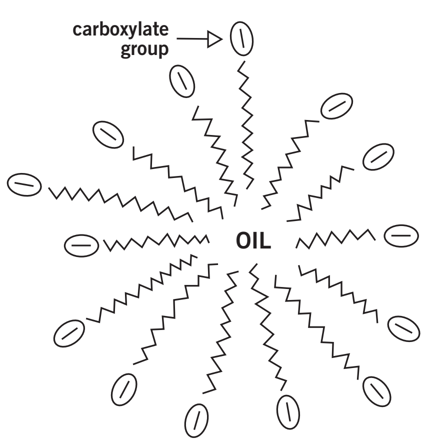
Glyceryl stearate + sodium hydroxide $\longrightarrow$ sodium stearate + glycerol

$$\left[\begin{array}{l} CH_2OOCC_{17}H_{35} \\ CHOOCC_{17}H_{35} \\ CH_2OOCC_{17}H_{35} \end{array}\right. + 3\ NaOH \rightarrow 3\ C_{17}H_{32}COONa + \left[\begin{array}{l} CH_2OH \\ CHOH \\ CH_2OH \end{array}\right.$$

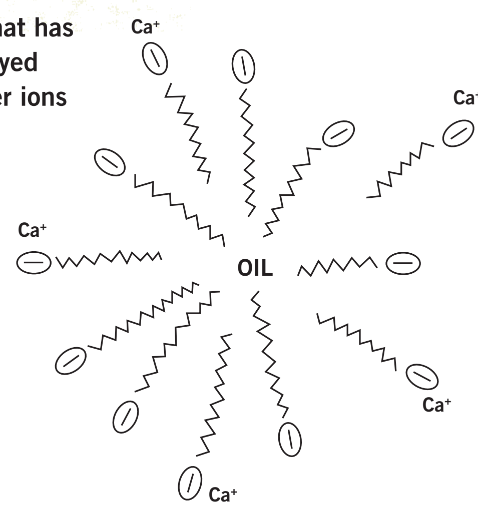
Chemical structure of sodium stearate



An example micelle



A micelle that has been destroyed by hardwater ions

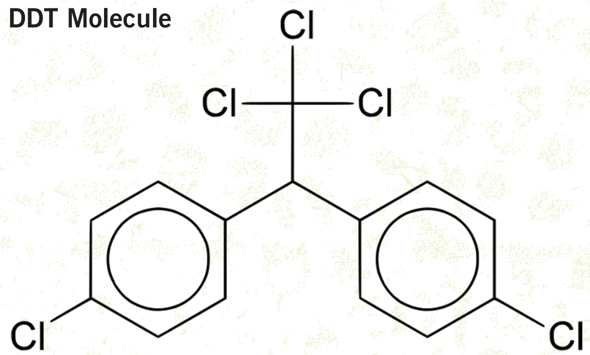


HANDOUT

Name:____________________________ Date:___________ Period:________

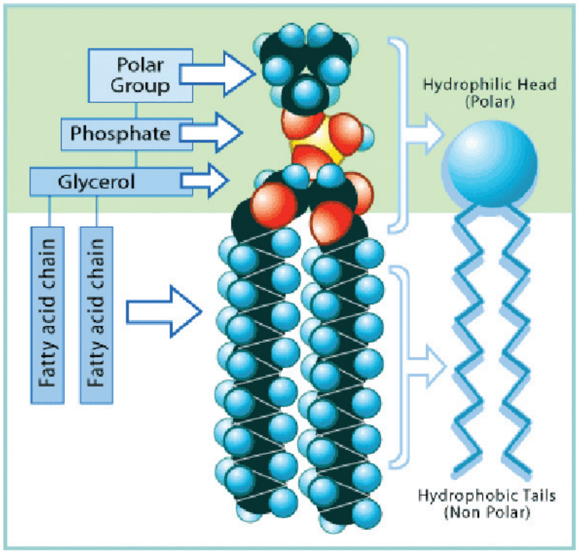
Lipid Bilayer and Cell Membrane

DDT Molecule



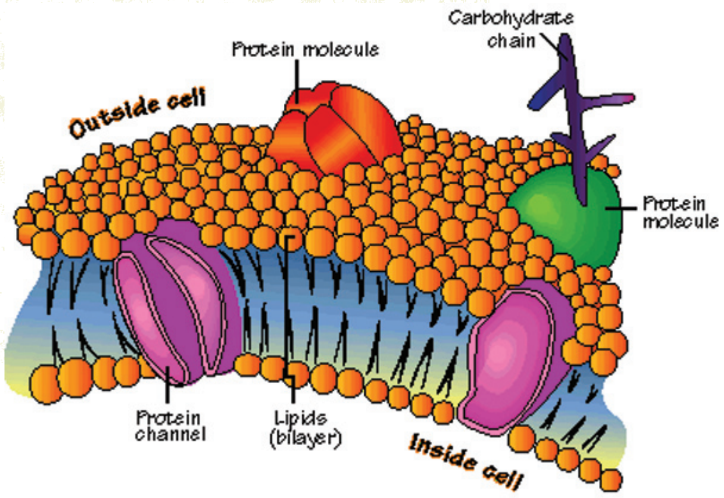
Credit: Lukas Mizoch, 2006.

Phosphlipid



Credit: BioTeach
http://www.bioteach.ubc.ca/Bio-industry/Inex/

Lipid Bilayer in Cell Membrane



Credit: http://library.thinkquest.org/C004535/media/cell_membrane.gif

LESSON 1: Malaria & African Slavery – Part I

Activity Time: 50 minutes

Students will investigate the pragmatic reasons that led to Africans being chosen as slaves. Students will read excerpts from *Medical Apartheid, Mosquito: The Story of Man's Deadliest Foe*, and *A People's History of the United States*. In addition, they will be asked to complete a question and inference chart. Students will then answer one of their own questions that has been selected by the teacher.

This lesson should be delivered so that it precedes the *Malaria & African Slavery—Part II* lesson.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **African Slavery:** There were pragmatic reasons that led to Africans being chosen as slaves.

Essential Question:

- Why were Africans chosen to be slaves in the New World?
- What series of unique circumstances and faulty science lead to 400 years of oppression of Africans?

Learning Objectives:

Students will know…

- There are many reasons—biological and psychological—for why Africans were selected to be slaves.

Students will be able to…

- Demonstrate knowledge of the pragmatic reasons why Africans were chosen to be slaves in the New World.

Vocabulary:

- Chattel
- Immune
- Malaria
- Pragmatic

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Economics 2.1** Understands that people have to make choices between wants and needs and evaluate the outcomes of those choices.
- **Geography 3.1** Understands the physical characteristics, cultural characteristics, and location of places, regions, and spatial patterns on the Earth's surface.
- **History 4.2** Understands and analyzes causal factors that have shaped major events in history.
- **History 4.3** Understands that there are multiple perspectives and interpretations of historical events.
- **History 4.4** Uses history to understand the present and plan for the future.

Common Student Preconceptions:

- Africans were selected for slavery solely because of European racism.
- Those people who were born in a malaria-endemic country such as Africa have some 'natural' immunity to malaria.

TEACHER PREPARATION

Materials:

- *Medical Apartheid* by H.A. Washington, H.A., 2006.
- *A People's History of the United States* by H. Zinn, 2003.
- *Mosquito* by A. Spielman and M. D'Antonio, M., 2002.
- Why Africans? *Question and Inference* Handout (1 per student)
- Envelopes (1 per group)

Preparation:

- Make copies of the Student Handouts.
- Make copies (1 per student) of the pages of the following books:

  Pages 27-30 of *Medical Apartheid*

  Pages 23-27 of *A People's History of the United States*

  Pages 61-64 of *Mosquito*
- Cut out small 2-3 word passages from one of the readings. Select ten passages and put them in the envelope. Repeat until you have an envelope for each student group.
- Become familiar with Higher Order Thinking Skills (H.O.T.S) and Art Costa's Three Levels of Questioning. Information about the levels is provided below:

  Level One: define, describe, identify, list, name, observe, recite, scan

  Level Two: analyze, compare, contrast, group, infer, sequence, synthesize

  Level Three: apply, evaluate, hypothesize, imagine, judge, predict, speculate

PROCEDURE

Hook:

1. Break the students into small groups of 2-3 students.
2. Do a "predict the passage" activity to spark students' interest in the readings. Hand out one envelope (filled with 10 passages) to each group.
3. Give the students five minutes to piece together the selection in order to have them guess what they will be reading about.
4. After five minutes, lead a report out session on what each group thought they were going to be reading about.

Preconceptions:

5. Share with students the essential questions that they will be exploring:
   - Why were Africans chosen to be slaves in the New World?
   - What series of unique circumstances and faulty science lead to 400 years of oppression of Africans?
6. Ask students to share their thoughts on these two questions. This can be done in Pair-Share fashion or through large group discussion.

Activity:

7. Pass out copies of the three readings and the *Question and Inference* Handout, one per student. Passing out the readings soon after completing the "predict the passage" activity will help keep students' interest engaged.
8. Explain that students will fill out the *Questions and Inference* Handout during and after they read the three passages.
9. Allow time for students to read the three passages, about 20-30 minutes.

Wrap-up:

10. When the students have completed their reading time, thank the class for their participation. Then, ask each student to circle the question about the text that they recorded on the *Questions and Inference* Handout that they found the most interesting. This question will be used during a Socratic Seminar the next day.
11. Tell students to hold onto their completed *Questions and Inference* Handout, as it will serve as an Entrance Ticket for tomorrow's class.

STUDENT ASSESSMENT

Assessment Opportunities:

- Student's preconceptions about the two essential questions can be evaluated for misconceptions and misunderstandings that may need to be confronted.
- The fact-based questions on the *Questions and Inferences* Handout provide an opportunity to assess student learning and reading comprehension.

Student Metacognition:

- Students are asked to detail their metacognitive thinking as they draw inferences and questions from the text. This process allows for students to "talk to the text." Talk to the text is a reading strategy where students are asked to think about any questions, confusions, predictions, or connections (to things they already know) they have with the text. Mark these right on the text itself, or on sticky notes if you're reading out of a book.

Scoring:

- The *Question and Inference* Handout can be scored according to the amount of questions and inference that the students were able to draw from the reading.
- The students will be allowed to demonstrate their understanding of the readings during the Socratic Seminar to be held the next day.
- Participation points can be assigned for making contributions to the class discussion.

EXTENSION ACTIVITIES

Extension Activities:

- Instead of offering a Socratic Seminar for students to extend their understanding, the sheet can be turned into the teacher. The teacher will then select one of the questions that the teacher posed and have the students write a short research essay.

Adaptations:

- For students with lower reading level, the reading activity could be set up as a jigsaw activity to help create mastery for small groups of students.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

Washington, H.A. (2006). *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present.* New York: Doubleday Broadway Publishing Group.

Zinn, H. (2003). *A People's History of the United States: 1492-Present.* New York: HarperCollins.

Spielman, A & D'Antionio, M. (2002). *Mosquito: The Story of Man's Deadliest Foe.* New York: Hyperion.

Credit:

Parker, W. (2002). *Teaching Democracy: Unity and Diversity in Public Life.* Teachers College Press.

Name:____________________________ Date:___________ Period:________

Why Africans? Questions and Inferences

READINGS

- *Medical Apartheid* by H.A. Washington (pages 27-30)
- *Mosquito* by A. Spielman and M. D'Antionio (pages 61-64)
- *A People's History of the United States* by H. Zinn (pages 23-27)

PRE-READING BACKGROUND

Try to picture the world as you know it today. Think of the entire globe and your community. What places are developed, modern, rich in technology? What places are not? How would you describe those differences? How might you explain those differences?

Now, think back to your earlier work in this U.S. History and prior World History courses. Why were Africans chosen by Europeans to be slaves in the New World?

WHAT TO WATCH FOR IN THE READINGS

As you read the three readings make notes on your questions and inferences chart on these:

- **Questions** authors raise.
- **Theories** Zinn, Washington, and D'Antonio & Spielman pose.
- **Evidence and Facts** that the authors offer in support of their theories.

Questions and Inferences Chart

Reading Notes (key words, quick thoughts) ***QUESTIONS / Theories / Evidence and Fact***	**Expanded Meaning / Inferences** (written soon after finishing the readings

POST-READING EXERCISE/ HOMEWORK

1. Expand on your notes in the right-hand column. Try to make the meaning from your preliminary jotted-down notes more meaningful. It is best to do this SOON after you finish reading.

2. Try to answer some of the specific fact-based questions below (You may not be able to answer all of them).

- According to Zinn, what philosophy lead Europeans to select Africans for slavery?

- Why were other groups not used, according to Zinn?

- According to Zinn, how were European servants different from African servants?

- How does Edmund Morgan detail the relationship between European settlers and Native Americans?

- How does Washington's theory of African enslavement differ from Zinn's?

- What evidence does Washington use to support her theory of African Immunity?

- Was the "fact" presented by planters scientifically sound? Why or why not?

- How does eighteenth century doctors' understanding of malaria differ from what we know today?

- Washington argues that Scientific Racism filled a critical political purpose. What was that purpose?

- According to D'Antonio & Spielman, how did malaria-carrying mosquitoes make their way to America?

- The two authors discuss how diseases were exchanged during the slave trade. What diseases were exchanged between the two cultures?

3. Respond to the following questions:

- What do you make of the theories presented by the authors? What weaknesses or strengths do you see in each theory?

- What is your immediate answer to the question, "Why were Africans chosen to be slaves in the new world?"

LESSON

LESSON 2
Malaria & African Slavery – Part II

Activity Time: 100 minutes

Students will use a Socratic Seminar to examine the three readings that were introduced in the *Malaria & African Slavery—Part I* lesson. Students will gain an deeper understanding the issues, ideas, and principles contained in these documents, and how it conflicts with different perspectives and the students' own ideas. Through the practices of Socratic Seminar, student will develop large-group discussion skills, by analyzing the article and using the multiple perspectives of one another as a resource. Using Socratic Seminars will help develop visual comprehension, analytical, and interpretation skills.

This lesson should be delivered so that it immediately follows the *Malaria & African Slavery—Part I* lesson.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **African Slavery:** Racism was not the only reason Africans were chosen to be slaves. There were many pragmatic reasons that Africans were selected.
- **Racism:** Racism is a theory based in the abject superiority of one race over another. Yet, if Europeans selected Africans because of the belief that they were immune to diseases such as malaria, is that not an acknowledgement of the superiority of Africans?

Essential Question:

- Why do you believe Africans were chosen by Europeans to be slaves in the New World?

Learning Objectives:

Students will know…

- History has a causation effect.
- Primary sources can be used to uncover biases and viewpoints.
- Sickle-cell anemia and malaria played a role in the enslavement of Africans.

Students will be able to…

- Identify the effects of stereotypes.
- Demonstrate an understanding of the multiple reasons for African enslavement.
- Cite evidence, from readings, of their position.

Vocabulary:

- Malaria

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Civics 1.2** Examine key ideals of United States democracy such as individual human dignity, liberty, justice, equality, and the rule of law.
- **Civics 4.1** Understand individual rights and their accompanying responsibilities including problem-solving and decision-making at the local, state, national, and international level.
- **History 1.2** Understand events, trends, individuals, and movements shaping United States, world, and Washington State history.
- **History 2.1** Compare and contrast ideas in different places, time periods, and cultures, and examine the interrelationships between ideas, change, and conflict.

Common Student Preconceptions:

Students will have their own ideas on what the reasons were behind slavery. The obvious answer is European racism. There is some truth behind this Red Herring. The problem with this line of thinking is that it allows students to eliminate the human element of history. If we are to face the future as analytical thinkers we must ask questions such as "How could humans do this to other humans?" Historians and students alike need to understand how this can happen if we are to face the issues of our current era. Much in the same way the students will ask how "good" people could allow this to happen, historians in the future will look at issues in our own era and ask how we allowed this to happen.

TEACHER PREPARATION

Materials:

- *Medical Apartheid* by H.A. Washington, H.A., 2006.
- *A People's History of the United States* by H. Zinn, 2003.
- *Mosquito* by A. Spielman and M. D'Antionio, M., 2002.
- *Question and Inference* Handout (completed by students in previous lesson)
- *Guidelines for Socratic Seminar* Handout (1 per student)
- White board

Preparation:

- Make copies of Student Handout.
- Students need to have already completed their *Question and Inference* Handout from the previous lesson, *Malaria & African Slavery—Part I*. The completed handouts should act as Entrance Tickets to the Socratic Seminar.

PROCEDURE

Hook:

1. Share with students the following statement:
   - Most Americans believe that slavery was the ugliest moment in American history, though, in some ways, this time period is no different that any other. Atrocities exist because those who know better failed to stand against them. It is no different today.
2. Ask students if they agree or disagree with this statement. Why?

Preconceptions:

3. Ask students if they can think of any horrible things going on around the world or in your neighborhood that exist because people are not doing enough to stop them? What about the spread of malaria in Africa today?

Activity:

4. Gather students for a Socratic Seminar to discuss the three readings from yesterday's lesson. Tell students to bring their completed *Question and Inference* Handout and their copies of the three readings from yesterday; the handout and readings will be their Entrance Ticket to participate in the seminar. Students also need to bring a pen and paper for taking notes.
5. Ask students to set up their chairs so that there are two circles: half the students will sit in an inner circle and half will sit in an outer circle.
6. Pass out copies of the *Guidelines for Socratic Seminars* Handout, one per student. Review the basic set-up, guidelines for participation, expectations, and grading sections of the handout.
7. Following the guidelines on the handout, lead the Socratic Seminar. Launch the seminar by asking the question:
   - Why do you believe Africans were chosen by Europeans to be slaves in the New World?
8. During the seminar, students need to use evidence from the three readings to backup their position.

Wrap-Up:

9. Students' participation in the seminar can be assessed through peer review. Ask students to swap their *Guidelines for Socratic Seminars* Handout with the person sitting on their right. Ask students to review their peer by writing a "yes" or "no" next to each of the questions in the Expectations section of the handout.
10. Ask students to complete a short reflective writing piece (in class if there is time, or as a homework assignment). The writing should respond to the following prompt:
    - How did the seminar change your thinking about why Africans were chosen by the Europeans to be slaves in the New World?

STUDENT ASSESSMENT

Assessment Opportunities:

- The quality and quantity of students' participation in the Socratic Seminar can be assessed, along with their level of preparedness.

Student Metacognition:

- Student will have a short reflective writing piece following the seminar that challenges them to consider how their thinking changed as a result of the Socratic Seminar.

Scoring:

- Students will conduct a peer-review for each other.
- A grade can be awarded for students' participation in the Socratic Seminar, with a score out of 50 points.
- A participation rubric for Socratic Seminars can be found at the following website:

  Socratic Seminars
  http://www.studyguide.org/socratic_seminar_student.htm

EXTENSION ACTIVITIES

Extension Activities:

- Challenge students to write a 1-page paper expressing their thoughts on the reasons why Africans were chosen for slavery.

Adaptations:

- There are many ways to facilitate a Socratic Seminar. One method is to have the seminar in small groups rather than a large group.
- More time could be provided for students to read the documents.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. Information on Socratic Seminars is provided in the Resources section below.

Resources:

Socratic Seminars
http://www.studyguide.org/socratic_seminar.htm

Socratic Seminars Scoring Rubric
http://www.studyguide.org/socratic_seminar_student.htm

Best Practices: Socratic Seminar
http://www.saskschools.ca/~bestpractice/socratic/index.html

Washington, H.A. (2006). *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present.* New York: Doubleday Broadway Publishing Group.

Zinn, H. (2003). *A People's History of the United States: 1492-Present.* New York: HarperCollins.

Spielman, A & D'Antionio, M. (2002). *Mosquito: The Story of Man's Deadliest Foe.* New York: Hyperion.

Credit:

StudyGuide.org. *Guidelines for Socratic Seminars.*
Available at: http://www.studyguide.org/socratic_seminar_student.htm.

Name:____________________________ Date:___________ Period:________

Guidelines for Socratic Seminars

HANDOUT

BE SURE TO KEEP THIS HANDOUT.

We will continue to do this activity throughout the year and these instructions are essential.

The Socratic method of teaching is based on Socrates' theory that it is more important to enable students to think for themselves than to merely fill their heads with "right" answers. Therefore, he regularly engaged his pupils in dialogues by responding to their questions with questions, instead of answers. This process encourages independent thinking and close analysis. This is the goal of our Socratic Seminars.

Basic Setup of the Socratic Seminar

- Half of the class will be in the inner circle and half the class will be in the outer circle.
- The inner circle will be given a specific amount of time to answer the first half of the questions. I will keep you informed about how much time you have left, but it is your responsibility to respectfully and equally discuss the questions with every member of your group. You need to make sure that you have enough time to get through all the questions and to provide the best answers possible. Every person in the group should speak.
- The outer circle will sit quietly and listen carefully to your conversation.
- All students should be taking notes on the answers and discussion related to the questions, regardless of whether they are in the inner or outer circle.
- Each member of the outer circle will write down a question that they will ask their group based of the first discussion. Then the outer circle and inner circle will switch places and roles. The new inner circle will cover the second half of the discussion questions.

Guidelines for Participating in a Socratic Seminar

- Refer to the text when needed during the discussion. A seminar is not a test of memory. You are not "learning a subject;" your goal is to understand the ideas, issues, and values reflected in the text.
- It's OK to "pass" when asked to contribute. But if you don't participate you will not receive credit for the activity.
- Do not participate if you are not prepared. A seminar should not be a bull session.
- Do not stay confused; ask for clarification.
- Stick to the point currently under discussion; make notes about ideas you want to come back to.
- Don't raise hands; take turns speaking.
- Listen carefully to each other and be incredibly respectful.
- Speak up so that all can hear you… including the people in the outer circle.

- Talk to each other, not just to the leader or teacher.
- Discuss ideas rather than each other's opinions.
- You are responsible for the seminar, even if you don't know it or admit it.

Expectations of Participants in a Socratic Seminar

When I evaluate your Socratic Seminar participation, I will ask myself the following questions.

Did you….

- Speak loudly and clearly?
- Cite reasons and evidence for your statements?
- Use the text to find support?
- Listen to others respectfully?
- Stick with the subject?
- Talk to each other, not just to the leader?
- Paraphrase accurately?
- Ask for help to clear up confusion?
- Support each other?
- Avoid hostile exchanges?
- Question others in a civil manner?
- Seem prepared?

Grading

You will receive a grade for your participation in Socratic Seminars. Each active participant will receive a grade with a score out of 50 points. Your active participation in these activities will be vital in this assignment. In addition, if your performance is very much above average, or very much below average, your grade will be adjusted accordingly on the 50 point scale.

Credit: StudyGuide.org. Guidelines for Socratic Seminars.
Available from: http://www.studyguide.org/socratic_seminar_student.htm.

LESSON 3
Eradicating Malaria

Activity Time: 150 minutes (three 50 minute periods)

In this lesson, students will conduct research on one of the seven methods used to control or eradicate malaria. After obtaining some mastery over their subject, the new "experts" will then teach the class their method through a presentation with a focus on how these methods balance the common good with the rights of the individual.

This lesson should be taught in an interdisciplinary fashion with a chemistry teacher so that students receive science content on malaria in the chemistry classroom. The malaria chemistry lesson plans (*Structure of DDT–Part I and II*) were specifically developed to be taught with the *Eradicating Malaria and DDT Debate* history lessons. This lesson should be immediately followed by the *DDT Debate* history lesson.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Malaria Eradication:** Malaria can be controlled and even stopped; it was eradicated in the U.S. in the 1940's and 1950's by implementing aggressive tactics, some of which are now outlawed.
- **Vaccines:** Some diseases can be stopped with vaccines. There is no vaccine yet for malaria, but there are groups in the trial phase of development.
- **Individual Rights vs. Common Good:** Proven methods for eradicating malaria can be analyzed according to individual rights vs. the common good.

Essential Question:

- What steps can we make today to eradicate malaria around the world?
- What can be done to save the 3,000 people a day who are infected with malaria?

Learning Objectives:

Students will know…

- There are proven and unproven methods of dealing with malaria.
- There is research being done to discover preventative and curative agents for malaria.
- These methods must find a balance between the rights of individuals and the common good.

Students will be able to…

- Demonstrate understanding of the different treatment methods for malaria.
- Cite evidence of their arguments by conducting research.
- Consider historical evidence in light of today's society.
- Work in groups using multiple perspectives to decipher historical texts.

Vocabulary:

- Cerebral malaria
- Congenital malaria
- Dichlorodiphenyltrichloroethane (DDT)
- Endemic
- Epidemic
- Insecticide
- Malaria
- Pandemic
- Parasite
- *Plasmodium falciparum*
- Vaccine

Common Student Preconceptions:

- Malaria is problem that is caused by poverty.
- Malaria happens too far away for me to be concerned about it.

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Economics 2.1** Understands that people have to make choices between wants and needs and evaluate the outcomes of those choices.
- **Geography 3.1** Understands the physical characteristics, cultural characteristics, and location of places, regions, and spatial patterns on the Earth's surface.
- **History 4.2** Understands and analyzes causal factors that have shaped major events in history.
- **History 4.3** Understands that there are multiple perspectives and interpretations of historical events.
- **History 4.4** Uses history to understand the present and plan for the future.

TEACHER PREPARATION

Materials:

- Computer lab
- DVD player and TV/projector
- *Rx for Survival* DVD
- *Sales Pitch Rubric* Handout (1 per student)

Preparation:

- Student will be introduced to the science aspects of malaria in chemistry class. This lesson is intended to introduce students to the social aspects of the disease.
- Make sure the DVD is queued to the "Deadly Messengers" episode on malaria.
- Make copies of Student Handout.

PROCEDURE

Hook:

1. Show the Deadly Messengers segment on malaria from the *Rx for Survival* DVD. The video segment is intended to introduce students to malaria, its causes, treatments, and preventive measures.

Preconceptions:

2. Lead a brief class discussion about the video.
3. Ask students to share their ideas of how to find a solution to the global burden of malaria.

Activity:

4. Explain to students that malaria can be controlled and even eradicated. Malaria was eradicated in the U.S, by using aggresive tactics in the 1940's and 50's. Some of these tactics are now outlawed, but they were successful in eradicating the disease here.
5. Tell the students it will be there responsibility to become experts on one of these control and eradication methods and to teach the class their new knowledge.

6. Divide the students into seven teams. Assign each team one of the following elements for controlling malaria:
    - Using insecticide-treated bed nets.
    - Eliminating mosquito breeding areas with insecticides such as DDT.
    - Spraying indoor residences with insecticides such as DDT.
    - Treating infected people with antimalarial medicines and developing cheaper and more effective ones.
    - Educating African families about how to control and treat malaria.
    - Historical treatment methods used by indigenous people.
    - Current vaccination research and development.
7. Pass out copies of the *Sales Pitch Rubric* Handout, one per student. Review the criteria for a successful sales pitch presentation.
8. Schedule time for each team to present their findings. Each team should present their findings in a 10-15 minute sales pitch, using a persuasive presentation style to sell the class on their particular eradication method. Each presentation should include the following:
    - A scientific explanation of their method.
    - The pros and cons of their method.
    - Historical evidence that the method will be effective.
    - An explanation of how their method balances the common good and individual rights.
    - If the world adopts their method, what would the outcome be?

Wrap-Up:

9. After each team presents their findings, allow time for other students to ask questions.
10. When all teams have presented, give students an Exit Ticket with the following question:
    - If you had to choose three methods for a malaria eradication program, which three would you choose and why?

STUDENT ASSESSMENT

Assessment Opportunities:

- The class discussion provides an opportunity to hear students' thoughts on the video.
- The group presentations provide an opportunity to gauge students' understanding of the methods for controlling and eradicating malaria.

Student Metacognition:

- Students will present their findings and their opinions to the class.
- The Exit Ticket question challenges students to reflect on what they've learned about all seven eradication methods.

Scoring:

- Students' presentations can be graded using the provided scoring rubric.

EXTENSION ACTIVITIES

Extension Activities:

- The knowledge that students acquire during this lesson can be applied during a debate in the following lesson, *DDT Debate*.
- This lesson can be used to fulfill the Washington State Office of the Superintendent's (OSPI) Classroom-Based Assessment (CBA) *Dig Deep*. More information on this CBA is available from OSPI. See the websites in the Resources section.

Adaptations:

- Students unable to present their findings could create brochures or briefs on their position.

TEACHER BACKGROUND & RESOURCES

Background Information:
Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. In addition, it will be helpful to have a working knowledge of the U.S.'s eradication policy during the 1940's and 1950's. A list of helpful websites is provided in the Resources section.

Resources:

Rx for Survival: A Global Health Challenge DVD
WGBH, 2005, 336 minutes total running time

RX for Survival Deadly Diseases—Online Malaria Clips
Part I: Malaria in Africa Today (5:23)
Part II: Fred Soper's Valiant Campaign (4:45)
Part III: The New Approach (5:09)
http://www.pbs.org/wgbh/rxforsurvival/series/diseases/malaria.html

History of Eradication of Malaria in the U.S. (1947-1951)
http://www.cdc.gov/malaria/history/eradication_us.htm

Dig Deep Classroom-Based Assessment
http://www.k12.wa.us/SocialStudies/CBAs/HighSchool.aspx

Name:__________________________ Date:__________ Period:________

Sales Pitch Presentation Rubric

HANDOUT

CATEGORY	Excellent 4	Good 3	Satisfactory 2	Needs Improvement 1
Content - Accuracy	All content throughout the presentation is accurate. There are no factual errors.	Most of the content is accurate but there is one piece of information that seems inaccurate.	The content is generally accurate, but one piece of information is clearly inaccurate.	Content confusing or contains more than one factual error.
Sequencing of Information	Information is organized in a clear, logical way. It is easy to anticipate the next slide.	Most information is organized in a clear, logical way. One slide or piece of information seems out of place.	Some information is logically sequenced. An occasional slide or piece of information seems out of place.	There is no clear plan for the organization of information.
Effectiveness of sales pitch	Project includes all material needed to give a good understanding of the topic. The project is consistent with the driving question.	Project is lacking one or two key elements. Project is consistent with driving question most of the time.	Project is missing more than two key elements. It is rarely consistent with the driving question.	Project is lacking several key elements and has inaccuracies. Project is completely inconsistent with driving question.
Use of Graphics or PowerPoint	All graphics are attractive (size and colors) and support the topic of the presentation.	A few graphics are not attractive but all support the topic of the presentation.	All graphics are attractive but a few do not support the topic of the presentation.	Several graphics are unattractive AND detract from the content of the presentation.
Text - Font Choice & Formatting	Font formats (color, bold, italic) have been carefully planned to enhance readability and content.	Font formats have been carefully planned to enhance readability.	Font formatting has been carefully planned to complement the content. It may be a little hard to read.	Font formatting makes it very difficult to read the material.
Spelling and Grammar	Presentation has no misspellings or grammatical errors.	Presentation has 1-2 misspellings, but no grammatical errors.	Presentation has 1-2 grammatical errors but no misspellings.	Presentation has more than 2 grammatical and/or spelling errors.
Cooperation	Group shares tasks and all performed responsibly all of the time.	Group shares tasks and performed responsibly most of the time.	Group shares tasks and performs responsibly some of the time.	Group often is not effective in sharing tasks and/or sharing responsibility.
Delivery	Members spoke at a good rate, volume and with good grammar. They maintained eye-contact while using, but not reading, their notes.	Members spoke a little faster or slower than necessary, or too quietly or loudly. They used acceptable grammar. They maintained eye-contact, but relied too much on their notes.	Members spoke at a good rate and volume, but used poor grammar. They relied heavily on their notes. Very little eye contact.	Members demonstrated poor oratory skill. They paid little attention to rate, volume or grammar. They were hard to hear and or mumbled

Overall Score:___________

LESSON 4
DDT Debate

LESSON

Activity Time: 200 minutes (four 50 minute periods)

In this lesson, students will engage in a debate over the use of DDT to control mosquitoes and malaria. Students will consider which treatment methods best balance the rights of the individual with what is best for society as a whole. This lesson can be used to fulfill the Washington State Office of the Superintendent's (OSPI) Classroom-Based Assessment (CBA) *Dig Deep*.

This lesson should be taught in an interdisciplinary fashion with a chemistry teacher so that students receive science content on malaria in the chemistry classroom. The malaria chemistry lesson plans were specifically developed to be taught with the *Eradicating Malaria* and *DDT Debate* history lessons. This lesson should be preceded by the *Eradicating Malaria* history lesson.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Malaria:** Malaria is a treatable disease.
- **Individual Rights vs. Common Good:** To be effective, treatments methods for malaria must find a balance between the rights of individuals and the common good.

Essential Question:

- Which treatment methods best balance the rights of the individual with what is best for society as a whole?

Learning Objectives:

Students will know…

- It has been the responsibility of the government to decide when the good of the many outweighs the rights of the individual.
- In a society based on advanced citizenship this responsibility has been and continues to be debated.

Students will be able to…

- Take and defend a position that shows empathy towards those affected by malaria.
- Analyze DDT in light of the rights and limitations of individuals and what is best for the society.
- Actively participate in a debate.

Vocabulary:

- Dichlorodiphenyltrichloroethane (DDT)
- Insecticide
- Malaria
- Parasite
- *Plasmodium falciparum*

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Civics 1.1** Understands key ideals and principles of the United States, including those in the Declaration of Independence, the Constitution, and other fundamental documents.
- **Civics 1.2** Understands the purposes, organization, and function of governments, laws, and political systems.
- **Civics 1.3** Understands the purposes and organization of international relationships and U.S. foreign policy.
- **Civics 1.4** Understands civic involvement.
- **Economics 2.1** Understands that people have to make choices between wants and needs and evaluate the outcomes of those choices.

- **Social Studies Skills 5.1** Uses critical reasoning skills to analyze and evaluate positions.
- **Social Studies Skills 5.2** Uses inquiry-based research.
- **Social Studies Skills 5.3** Deliberates public issues.
- **Social Studies Skills 5.4** Creates a product that uses social studies content to support a thesis and presents the product in an appropriate manner to a meaningful audience.

Common Student Preconceptions:

- DDT is banned because it is dangerous to the environment.

TEACHER PREPARATION

Materials:

- Access to library or computer lab
- Clock/timer
- *Debate Research* Handout (1 per student)
- *Debate Scoring Rubric* Handout (1 per student)

Preparation:

- Coordinate this activity with the chemistry teacher. The debate should be held after the chemistry teacher has taught the *Structure of DDT* lessons.

PROCEDURE

Debate Format:

1. The basic format of the Lincoln-Douglas debate is a standard format used in competition and in classrooms. The Lincoln-Douglas Debate format is a one-to-one debate, in which two sides of a single resolve are debated.
2. The class should be paired together. Within each pairing one person will be named the speaker or debater, while the other member is the researcher/speechwriter. Once the groups have selected their role the teacher should assign the pair to one of the 6 roles in each of the two debate resolves: **AFFIRMATIVE**-(**1**) Introduction Debate, (**2**) Affirmative Rebuttal Debate, (**3**) Affirmative Conclusion Debate. **NEGATIVE**- (**4**) Introduction Debate, (**5**) Rebuttal Debate, (**6**) Negative Conclusion Debate.
3. The debate starts with a statement of purpose or policy called a resolve. For this specific debate, the Debate Resolve is as follows:
   - Three thousand people are infected with malaria every day. There is a way to eradicate this disease in Africa. To do so, the world community will have to drop the ban on DDT. In order to protect the common good of the people of Africa, this act needs to be done.
   - The United States is mired in one of the worst financial crises in a century. During these perilous times it is prudent for America to cut foreign aid to developing nations in order to better concentrate on stabilizing the American economy. Our national economy not withstanding, it is argued that our aid only hurts developing nations, turning them into

dependent nations. As such it is the best interest of the United States and the world to cut spending on foreign aid.

4. The debater who agrees with the statement (the Affirmative) begins the debate, which is structured in this way:
   - Affirmative position debater presents constructive debate points (6 minutes).
   - Negative position debater cross-examines affirmative points (3 minutes).
   - Negative position presents constructive debate points (7 minutes).
   - Affirmative position cross-examines negative points (3 minutes).
   - Affirmative position offers first rebuttal (4 minutes).
   - Negative position offers first rebuttal (6 minutes).
   - Affirmative position offers second rebuttal (3 minutes).
   - Negative position offers second rebuttal (3 minutes).
   - Affirmative position offers Conclusion Debate (7 minutes).
   - Negative position offers Conclusion Debate (7 minutes).

Activity:

5. Assign a debate partner to each student. Either assign the Affirmative/Negative positions, or allow students to choose their position. Each pair needs one Affirmative partner and one Negative partner.
6. Pass out copies of the *Debate Research* Handout, one per student. Provide time for in the library or computer lab for students to adequately research their position. Explain to students that they need to use the handout to record their research findings.
7. One the day of the debate, provide space for each pair to meet across a table. As the time keeper, announce when it is time to transition to the next stage of the debate.

Wrap-Up:

8. As soon as students complete their debate, ask them to respond to the following questions in writing:
   - What was the strongest argument that you made that supported your position? Why do you think it was so strong?
   - What was your partner's strongest argument? What did you say in response to this argument?
   - What is your personal opinion on the debate topic?

STUDENT ASSESSMENT

Assessment Opportunities:

- Student assessment should be based on the student's role in the debate. Students assigned to be debaters will be graded on a presentation rubric. Students assigned to be researchers/ speech writers will be graded on their research worksheets, and the final draft of the speech.

Student Metacognition:

- Students will show metacognition through the research worksheets and through the debrief.

Scoring:

- Use the provided scoring rubric to grade the debates.

EXTENSION ACTIVITIES

Extension Activities:

- This lesson can be used to fulfill the Washington State Office of the Superintendent's (OSPI) Classroom-Based Assessment (CBA) *Dig Deep*. More information on this CBA is available from OSPI. See the websites in the Resources section.

Adaptations:

- Require students to take research notes in a specific format (such as Cornell notes) and turn them into you for credit.
- Have students conduct peer-evaluations of each other using the Scoring Rubric.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on malaria can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum. Information about Lincoln-Douglas Debates can be found in the Resources section below.

Resources:

Dig Deep Classroom-Based Assessment
http://www.k12.wa.us/SocialStudies/CBAs/HighSchool.aspx

Lincoln-Douglas Debate Standards
http://wiki.idebate.org/index.php/Standards:Lincoln-Douglas_Debate

Lincoln-Douglas Debate Lesson Plan
http://www.education-world.com/a_lesson/03/lp304-01.shtml

Credit:

Debate Rubric from Greece Central School District.

Name:____________________________ Date:___________ Period:________

Debate Research

HANDOUT

Debate Role (circle role): Affirmative / Negative Intro / Rebuttal / Conclusion

Source:_______________________________Title:______________

Author:________________________________Pub. Date:______________

Short summary of research information:

How will this information be used in your debate?

What questions does this information raise?

1.

2.

3.

Name:_________________________ Date:__________ Period:_______

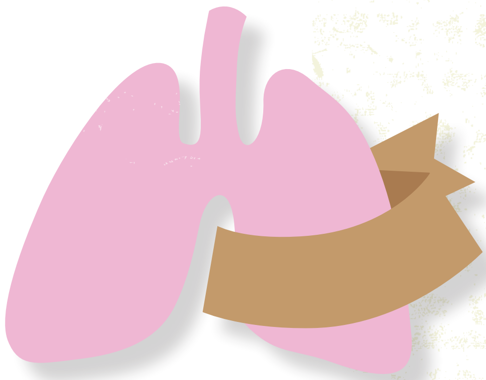
Debate Scoring Rubric

HANDOUT

Criteria	Mastery	Above Standard	Standard	Aproaches Standard	Below Standard
Opening & closing statements	- Extremely thorough, well-organized presentation of arguments and evidence - Opening statement engages the interest of audience; closing statement leaves no unanswered issues and resonates with the audience	- Well-organized and complete presentation of arguments and evidence - Opening statement successfully frames the issues; closing statement summarizes many arguments made in the debate	-Organized and generally complete presentation of arguments and evidence - Opening statement outlines or lists arguments and evidence but does not generate interest; closing statement does not reflect remarks made during debate	-Somewhat organized presentation of arguments and evidence -Opening statement minimally outlines arguments; closing argument briefly restates the ideas offered in the opening statement	-Arguments are unorganized, incomplete, or completely lacking in evidence -Opening statement and closing statements do little more than state the position of the team
Rebuttals	- Responds to issues raised by opponents with concise, accurate, logical answers - Effectively challenges the arguments made by opponents with argument and evidence	- Responds to issues raised by opponents with accurate and generally concise answers - Challenges the arguments made by opponents; challenges are generally effective	- Responds to most of the issues raised by opponents with generally accurate answers - Offers arguments, but no evidence, to counter the arguments made by opponents	-Seems to be caught off-guard by opponents; offers tentative, somewhat accurate, but possibly vague or illogical responses -Attempts to challenge arguments of opponents	-Is unable to respond to issues raised by opponents in a meaningful or accurate way
Effective use of historical evidence/content knowledge	-Demonstrates a sophisticated understanding of the issues, events and facts relevant to the topic -Demonstrates thorough and accurate understanding of details as well as the ability to make original connections and interpretations	- Demonstrates a sophisticated understanding of the issues, events and facts relevant to the topic -Demonstrates thorough and accurate understanding of details as well as the ability to make original connections and interpretations	-Demonstrates an basic and accurate understanding of the issues, events and facts relevant to the topic -Demonstrates the ability to make basic connections between facts and concepts	-Demonstrates a generally accurate understanding of relevant issues, events and facts, but may exhibit minor confusion or misunderstandings seem to understand general ideas, but do not support their ideas with relevant facts; OR, seem to understand facts but are unable to connect them into coherent arguments	-Demonstrates an inadequate understanding of the history content relevant to the topic -Supports statements with vague or irrelevant information, or no information at all

Criteria	Mastery	Above Standard	Standard	Aproaches Standard	Below Standard
Use of persuasive appeals	Makes deliberate and effective use of logical, emotional and ethical appeals in order to persuade justices	Uses logical, emotional and ethical appeals to enhance effectiveness of argument	Uses some appeals to make argument more persuasive, but may not include a mix of logical, emotional and ethical appeals	Makes minimal use of persuasive appeals	-Does not use persuasive rhetoric -Uses colloquial, overly simplistic language
Language use	- Uses language that is stylistically sophisticated and appropriate for the court - Uses literary devices to enhance the argument	- Uses language that is appropriate to the court - Uses literary devices to add interest	- Uses language that is appropriate to the court - Attempts to use literary devices to add interest	-Generally uses language that is appropriate to the court -Uses basic but clear language	-Uses language and syntax that is unclear
Performance	-Exhibits confidence, energy, and passion in the course of the hearing - Maintains respectful tone - Accesses preparation materials with ease	- Exhibits confi-dence and energy in the course of the hearing -Maintains respectful tone - Uses preparation materials effectively	- Appears nervous, yet somewhat confident, before the court - Maintains respectful tone - Use of preparation materials does not distract	-Lacks confidence -Maintains respectful tone - Use of preparation materials distracts from quality of performance	-Demonstrates little or no preparation -Fails to maintain respectful tone

Overall Score:____________



tuberculosis

LESSON 1: TB in Swaziland

Activity Time: 60–90 minutes

In this lesson, students will learn about the high HIV and TB rates in Swaziland and determine the amount of aid that can be provided with a very strict health care budget. Students will set up and graph the solution to a system of inequalities.

This lesson should be taught as part of a linear functions unit. Students should have already been introduced to inequalities before participating in this activity.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Limitations:** Certain constraints limit the amount of money that can be spent on a particular project, which ultimately results in a limited amount of TB aid that Swaziland receives.

Essential Question:

- How can health care services be allocated within a budget?

Learning Objectives:

Students will know…

- Health care services are just one of the many programs funded by a country's annual budget.
- Swaziland has the most TB infections in the world per population.
- People who have HIV/AIDS are more susceptible to TB infection.

Students will be able to…

- Set up and graph the solution to a system of inequalities.
- Solve a system of inequalities and choose a TB health care scenario that is feasible for Swaziland.

Vocabulary:

- Constraints
- Feasible region
- Inequalities
- Tuberculosis

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.B** Solve problems that can be represented by systems of equations and inequalities.

Common Student Preconceptions:

- There is no connection between HIV/AIDS and TB.
- Students may misinterpret the vocabulary used in order to determine the inequality sign.
- Both the x and y-axis must have the same scale.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- Articles on Swaziland (3-4 per group)
- Straight edge (1 per student)
- Graph paper (1 per student)
- *TB in Swaziland* Handout
- Teacher Answer Key

Preparation:

- Determine how you will group students.
- Make copies of the articles from the websites listed in the Resources section.
- Make copies of Student Handout.
- Read the articles and review the answer key prior to beginning this activity.
- Prepare to answer student questions during the activity.

PROCEDURE

Hook

1. Show the video **HIV/AIDS and TB—Breaking the Silence** to get students interested in the lesson topic.

   Swaziland: HIV/AIDS and TB—Breaking the Silence
   MSF, 4:25 minutes
   http://www.youtube.com/watch?v=NeJg3IJKC4E

2. Discuss the video. What surprised students? What is the take-away message from the video?

Preconceptions

3. Ask students what needs to be considered when making a graph. Furthermore, what considerations must be made for graphing inequalities?

Activity

4. Break students into groups of 3-4, depending on how many articles you use. You will need to have a copy of a different article for each student in a group.
5. Distribute copies of 3-4 Swaziland articles to each group. Ask students to follow the jigsaw instructions provided on the handout.
6. After students have completed the article jigsaw activity, discuss the common factors that each group came up with as a class.
7. Provide time for groups to complete the budget activity.
8. Discuss the conclusions that each group reached about the practical scenarios for Swaziland's TB prevention goals.

Wrap-up:

9. Lead a class discussion about the students' struggles while undertaking this assignment. Also ask students, what did you do to overcome those struggles?

STUDENT ASSESSMENT

Assessment Opportunities:

- In the activity, students will participate in a jigsaw activity where they will uncover the focus for their study by reading articles. Working as a group, they will determine the main idea and problems in each article, and share as a whole group and as a class.
- Students will be pair-sharing when cycling through the activity.
- The handout provides an opportunity for a summative assessment of student learning.

Student Metacognition:

- During the article jigsaw activity, students are challenged to consider what ideas in the article they feel are important.

Scoring:

- The Student Handout can be scored using the Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- Students can graph points or solve the system of inequalities algebraically.

Adaptations:

- Students of lower reading ability can be paired with students of higher reading ability.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Swaziland: HIV/AIDS and TB—Breaking the Silence video
MSF, 4:25 minutes
http://www.youtube.com/watch?v=NeJg3IJKC4E

Swaziland: Tuberculosis Still Killer Number One
UN IRIN, 4/4/07
http://www.irinnews.org/Report.aspx?ReportId=71139

TB: 'Indeed We Have a Problem'
IPS, 4/22/09
http://ipsnews.net/africa/nota.asp?idnews=46589

Swaziland: Poverty on the Increase, Says Govt
UN IRIN, 2/22/06
http://newsite.irinnews.org/Report.aspx?ReportId=58229

Proquest (Log-in Required)
http://proquest.umi.com/pqdweb?index=0&did=1716799981&SrchMode=1&sid=1&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1250015523&clientId=127889

Name:______________________ Date:__________ Period:________

TB in Swaziland

Title of your article: ________________________________

JIGSAW ACTIVITY
PEER-TO-PEER SHARING

HANDOUT

Directions: Read your article thoroughly and highlight key points. Consider the points outlined below and answer the questions.

1. In one sentence, describe the main idea in your article.

2. Write three factors from your article that support the main idea:

a.

b.

c.

3. What is the major problem outlined in your article?

4. List two main issues responsible for the problem.

a.

b.

5. List at least one more thing from the article that you think is important to mention.

When finished, share with your group (one at a time) the details of your article. Afterwards, discuss the similarities among all four articles and prepare to discuss them as a group with the class.

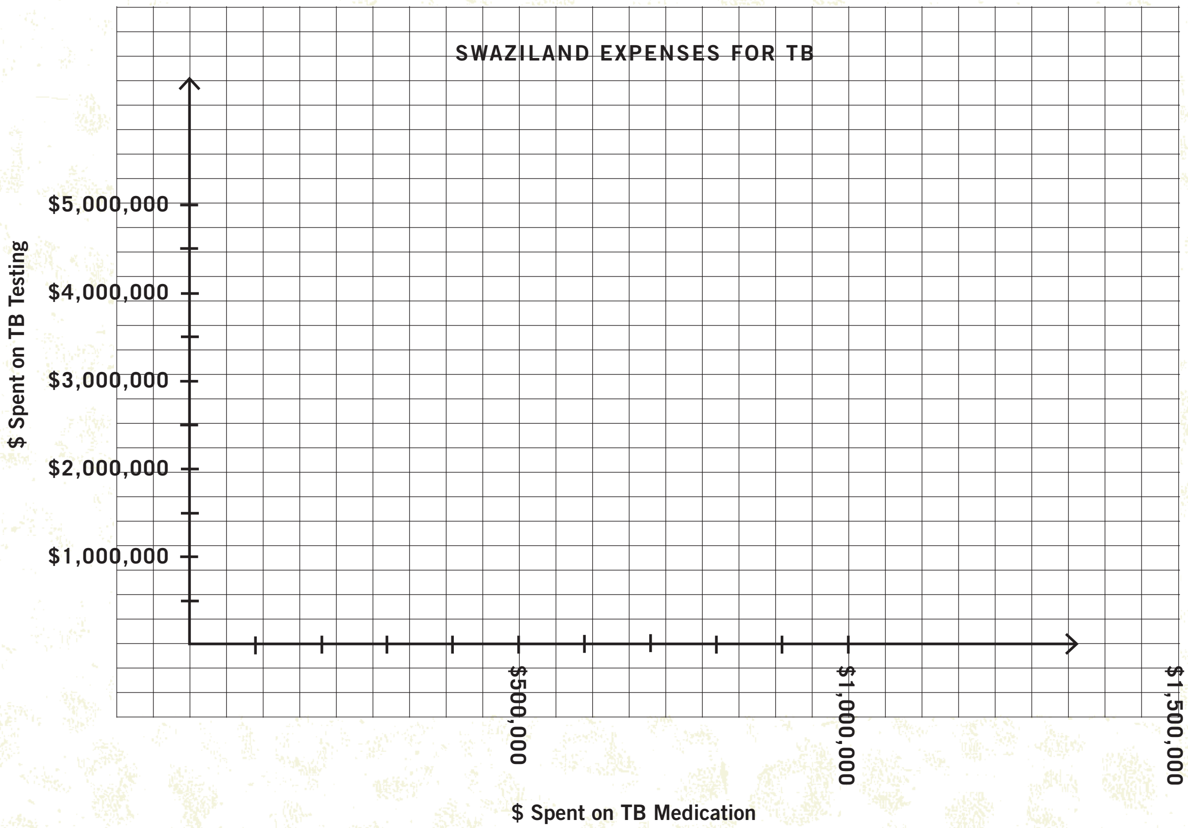
TB PREVENTION IN SWAZILAND

The annual national budget for Swaziland is $580 million and no more than 15% of the budget can be spent on tuberculosis medication and testing. It costs $120 to medicate one person with TB each year and $20 for each person to get tested for TB infection.

1. Write an inequality that represents all the possible solutions of TB medication and testing that Swaziland can afford while staying within their budget. Define all variables.

2. Determine the x- and y-intercepts and explain their meaning.

3. Graph the solutions to the inequality.



4. Although Swaziland has a population of nearly 1.1 million people, technical staff and technology limits the amount of yearly prescriptions and TB tests to no more than a combined 1.3 million. Write an inequality that represents this limitation.

5. Add the inequality from #4 to your graph in #3.

6. At this point, there exists 2,000 Swazilanders with TB who need to be medicated. Write an inequality that represents this situation and add it to the graph in #3.

7. At this point you should have a shaded quadrilateral in your graph. This is your feasible region. What does this feasible region represent?

8. Four scenarios for Swaziland's TB prevention goals have been listed below. Circle the scenarios that lie in the feasible region.
   a. Medical officials plan to test at least 100,000 Swazilanders.
   b. They determine that at least $240,000, but no more than $725,000, will be spent on medication.
   c. They will medicate only 5,800 people and test 1,500 people.
   d. 5,000 people will be medicated and 37,500 people will be tested.

9. According to this scenario, is it possible for Swaziland to go over their budget? Why or Not? Explain.

TB in Swaziland

KEY

The annual national budget for Swaziland is $580 million and no more than 15% of the budget can be spent on tuberculosis medication and testing. It costs $120 to medicate one person with TB each year and $20 for each person to get tested for TB infection.

1. Write an inequality that represents all the possible solutions of TB medication and testing that Swaziland can afford while staying within their budget. Define all variables.

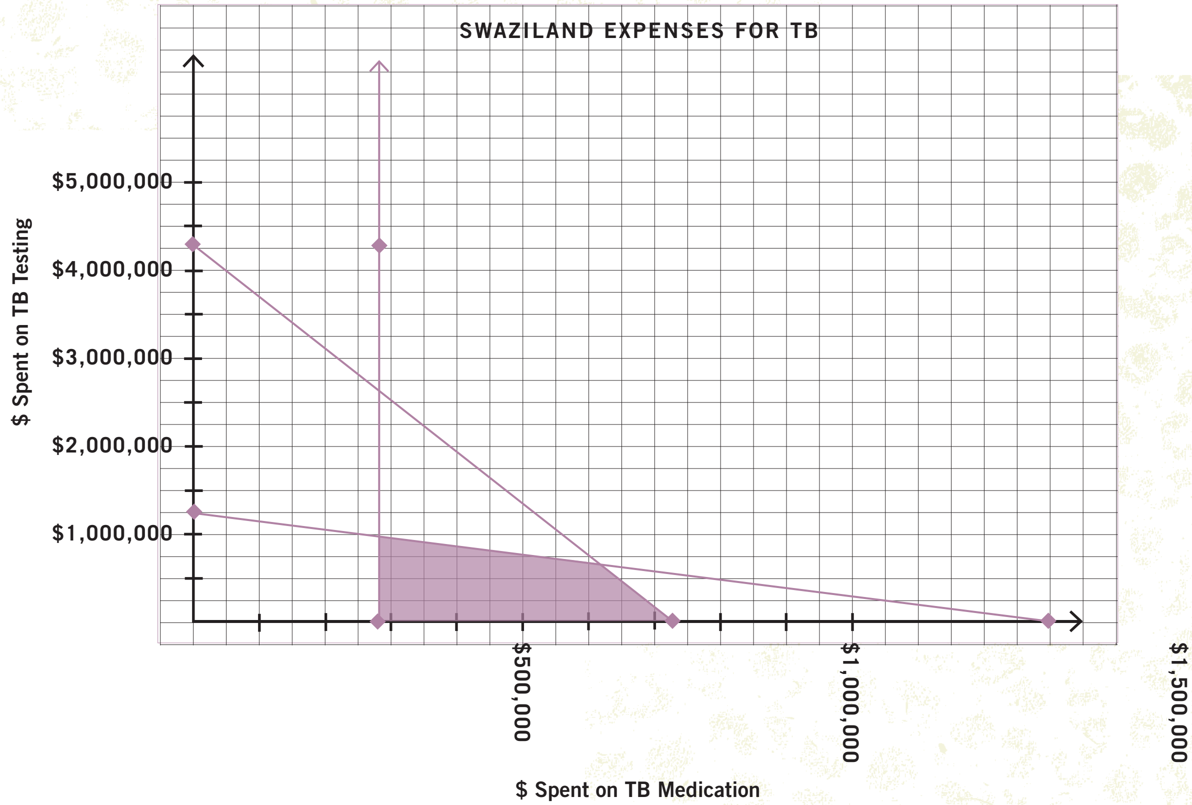
   120M + 20T ≤ 0.15(580,000,000) → 120 M + 20T ≤ 87,000,000

   M = number of people receiving medication
   T = number of people tested

2. Determine the x- and y-intercepts and explain their meaning.

   x-int = 725,000
   y-int = 4,350,000

3. Graph the solutions to the inequality.



4. Although Swaziland has a population of nearly 1.1 million people, technical staff and technology limits the amount of yearly prescriptions and TB tests to no more than a combined 1.3 million. Write an inequality that represents this limitation.

   $M + T \leq 1{,}300{,}000$

5. Add the inequality from #4 to your graph in #3.

6. At this point, there exists 2,000 Swazilanders with TB who need to be medicated. Write an inequality that represents this situation and add it to the graph in #3.

   $M \geq 2000(120)$
   $M \geq 240{,}000$

7. At this point you should have a shaded quadrilateral in your graph. This is your feasible region. What does this feasible region represent?

   Answers will vary.

8. Four scenarios for Swaziland's TB prevention goals have been listed below. Circle the scenarios that lie in the feasible region.

   a. Medical officials plan to test at least 100,000 Swazilanders.

   b. They determine that at least $240,000, but no more than $725,000, will be spent on medication.

   c. They will medicate only 5,800 people and test 1,500 people.

   d. 5,000 people will be medicated and 37,500 people will be tested.

9. According to this scenario, is it possible for Swaziland to go over their budget? Why or Not? Explain.

   Swaziland will not exceed their budget. In fact, the most they would spend is just over one million dollars. The technology and medical staff limitations are major factors in being able to reach more residents.

LESSON 2: Tuberculosis Has Wings

Activity Time: 90 minutes

In this lesson, students will take on the role of WHO officials dealing with an airline passenger who is infected with Extensive Drug Resistant TB (XDR TB). Students will evaluate growth and/or decay data stemming from factors contributing to the growth and/or decay of tuberculosis.

This lesson should be taught as part of an exponential functions unit. Students need to have already been introduced to exponential functions. In addition, this lesson can be used to introduce the *TB Flight* U.S. History lesson plan. See Wrap-Up 11.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Exponential Functions:** Data from an infectious disease such as tuberculosis can represent an exponential function.

Essential Question:

- What impact does air travel have on the potential spread of tuberculosis?

Learning Objectives:

Students will know…

- Properties of exponential functions and logarithms can be used to make predictions about tuberculosis.
- Tuberculosis can be transmitted during airline travel.
- Agencies like the CDC and WHO are responsible for protecting the public from the spread of infectious diseases, such as tuberculosis.

Vocabulary:

- Exponential function
- Tuberculosis
- XDR TB

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.4.A** Know and use basic properties of exponential and logarithmic functions and the inverse relationship between them.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.B** Select and apply strategies to solve problems.
- **A2.8.F** Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
- **A2.8.H** Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.

Common Student Preconceptions:

- Just coming in contact with someone with active tuberculosis doesn't mean that you will catch tuberculosis yourself.
- Tuberculosis is only a problem if you are in a homeless shelter or prison.
- People don't get tuberculosis in the U.S.
- Students may at first see the potential spread of tuberculosis as a linear relationship.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *TB Has Wings Entry Task* Handout (1 per student)
- *TB Has Wings Case Study* Handout (1 per student)
- Butcher paper
- Markers
- Straightedge

Preparation:

- Make copies of Student Handouts.
- It may be helpful to gauge students' basic understanding of tuberculosis before proceeding with this activity.
- Students will need to read the Student Background Reading on tuberculosis from the Introduction to Global Health section of the curriculum prior to participating in this math activity.

PROCEDURE

Hook

1. Pass out the *TB Has Wings Entry Task* handout, one per student. Ask students to complete the handout, working individually.
2. Discuss how TB is spread, what factors result in the spread of tuberculosis, and how this relates to the Entry Task dealing with the spread of an infectious disease. The following information may be helpful:

   "TB bacilli become aerosolized when a person with TB disease of the lungs or throat coughs, sneezes, speaks, or sings. These bacilli can float in the air for several hours, depending on the environment. Persons who breathe air containing these TB bacilli can become infected." (CDC, 2007).

   "The risk of acquiring any type of TB appears to depend on several factors, such as extent of disease in the source patient, duration of exposure, and ventilation." (CDC, 2007).

Preconceptions

3. Discuss two questions with the class:
   - What factors make the spread of an infectious disease, like TB, a global health issue?
   - How can mathematics be used to analyze this issue?

Activity

4. Show the video **Airline Passenger Apologizes for TB Exposure** to get students interested in the case study that they'll be examining.

   Airline Passenger Apologizes for TB Exposure Video
   CBS2 News, 6/1/07, 2:36 minutes
   http://cbs2.com/video/?id=40759@kcbs.dayport.com

5. Break students into groups of 3-4 students.
6. Pass out copies of the *TB Has Wings Case Study* Handout, one per student. Have students read the handout, including the *CDC Health Update*. Discuss any questions that students have about the case, about XDR TB, and about the expectations for the task.
7. Students must then work in their groups to prepare their mathematical model that will be used when notifying passengers. Have students paraphrase the instructions to each other and ask questions if they don't understand the task.
8. Pass out butcher paper, markers, and straight edges for students to use in designing their visual aids.
9. Each group will need to present their finished product to the class as if they were a representative of the WHO and the class were airline passengers.

Wrap-up:

10. Provide time after each presentation for the students to ask questions of the presenting group.
11. Ask students to share their thoughts on the government's responsibility for protecting people's health during airline travel. What is the government's responsibility? What is the responsibility of the individual traveler?

STUDENT ASSESSMENT

Assessment Opportunities:

- The discussions in the Preconceptions section of the lesson provide opportunities to capture students' preconceptions about global health, TB, and mathematical modeling.
- The Entry Task can be graded.
- During group work time, roam among the groups asking questions, observing, and redirecting whenever needed.
- Each groups' presentation and visual aid can be graded.

Student Metacognition:

- Students will paraphrase the expected outcomes of the activities. They will ask questions for clarification and use the numbered steps in the task as a checklist.

Scoring:

- The *Entry Task* handout can be graded.
- Participation points can be assigned for working in groups and contributing to class discussions.
- The visual aid will be scored on completeness and neatness.
- Presentations will be graded by individual and/or group participation. The telephone script must include data from students' model and their recommendation to get tested for tuberculosis.

EXTENSION ACTIVITIES

Extension Activities:

- Variables in the case study can be manipulated.

Adaptations:

- Multiple learning styles are represented in this lesson, including audio/visual, individual and group participation, and hands-on learning. However, because this lesson isn't specific as to the type of grouping that must exist, this can and should be altered accordingly.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section.

The case study in this lesson is based on an actual situation. In 2007, Atlanta lawyer Andrew Speaker, 31, flew from the U.S. to Europe and back with active tuberculosis. The situation sparked responses by the WHO, CDC, and other national governments to notify airline passengers of their risk of TB infection. Since then, other passengers have sued Speaker, and Speaker has sued the CDC. Learn more about this real life case by exploring the websites provided in the Resources section.

How did the CDC choose to respond to this actual case?

> "In accordance with the WHO TB and Airline Travel Guidelines, to ensure appropriate follow-up and care for persons who may have been exposed to XDR TB, CDC is recommending the following for passengers and crew onboard Air France # 385 departing Atlanta on May 12 and arriving in Paris on May 13, and on Czech Air # 410 departing from Prague and arriving in Montreal on May 24: **passengers seated in the same row as the index patient and those seated in the two rows ahead and the two rows behind, as well as the cabin crew members working in the same cabin should be evaluated for TB infection. This includes initial evaluation and testing with follow up 8-10 weeks later for re-evaluation."**
>
> Credit: *Official CDC Health Update: Investigation of U.S. Traveler with Extensively Drug Resistant Tuberculosis (XDR TB)*, Centers for Disease Control and Prevention, 5/29/07.

Resources:

Tuberculosis and Air Travel: Guidelines for Prevention and Control
World Health Organization, 2006.
http://whqlibdoc.who.int/hq/2006/WHO_HTM_TB_2006.363_eng.pdf

Official CDC Health Update Investigation of U.S. Traveler with Extensively Drug Resistant Tuberculosis (XDR TB) Centers for Disease Control and Prevention, 5/29/07
http://www2a.cdc.gov/HAN/ArchiveSys/ViewMsgV.asp?AlertNum=00262

Fact Sheet: Extensively Drug-Resistant Tuberculosis (XDR TB)
Centers for Disease Control and Prevention, Division of Tuberculosis Prevention
http://www.cdc.gov/tb/publications/factsheets/drtb/xdrtb.htmj
http://www.cdc.gov/tb/publications/factsheets/drtb/xdrtb.pdf

A Timeline of Andrew Speaker's Infection, National Public Radio
http://www.npr.org/news/specials/tb/

Andrew Speaker, Quarantined for TB in 2007, Sues CDC for Invasion of Privacy
NY Daily News, 4/30/09, http://www.nydailynews.com/lifestyl/health/2009/04/30/2009-04-30_andrew_speaker_quarantined_for_tuberculosis.html

Airline Passenger Apologizes for TB Exposure Video
CBS2 News, 6/1/07, 2:36 minutes, http://cbs2.com/video/?id=40759@kcbs.dayport.com

Credit:

Glencoe/McGraw-Hill. (1997). *Algebra 2: Integration Applications Connections*.

TripAdvisor LLC. Air France/Boeing 747-400 seating chart and Czech Airlines/Airbus A320-200 seating chart.

Center for Disease Control and Prevention (2007). *Official CDC Health Update: Investigation of U.S. Traveler with Extensively Drug Resistant Tuberculosis (XDR TB)*. 5/29/07.
Available from: http://www2a.cdc.gov/HAN/ArchiveSys/ViewMsgV.asp?AlertNum=00262

Name:______________________________ Date:___________ Period:________

TB Has Wings Entry Task

HANDOUT

A dreadful disease is predicted to spread across a South American country in just a matter of days. How could this disease spread so quickly?

Suppose that every day, a sick person infects four people before the disease is diagnosed and he or she is quarantined. Initially, one person is infected. During the first time period, this person infects four people. During the second time period, the first person is quarantined, but the four people he or she infected each infect four more people. During the third time period, the four people are quarantined, and the 16 people they infected are each running around infecting four more people. This pattern continues.

The number of people infected during a time period **y** can be expressed as a function of time where **x** is the number of days. This function $\mathbf{y = 4^x}$ is an **exponential function**.

1. Complete the table below:

Days	Number Infected	Pattern
0	1	4^0
1	1 x 4 = 4	4^1
2	4 x 4 = 16	4^2
3	16 x 4 = 64	_______
4	____________	4^4
________	____________	_______
x	y	y = _______

2. Create a table:

x	y = _________	y
1		
2		
3		
4		
5		
6		

3. Graph the results:

4. During the end of the 14th time period, how many new people will be infected?

Adapted from: Glencoe/McGraw-Hill. (1997). Algebra 2: Integration applications connections.

Name:____________________________ Date:___________ Period:________

TB Has Wings Case Study

You work in the Stop TB department of the World Health Organization (WHO). Your job is fascinating…every day you are challenged to develop mathematical models for how tuberculosis is spread in different kinds of environments.

Sipping your morning coffee as you check your email, your attention is suddenly grabbed by an urgent email message from your supervisor. An emergency meeting has been called to discuss a serious situation. An airline passenger has traveled from the U.S. to the Czech Republic and back. This passenger is infected with Extensive Drug Resistant Tuberculosis (XDR TB).

Uh-oh, you think. This passenger could have infected other passengers during those long flights. You slurp down the rest of your coffee and head to the meeting room. It is going to be a long day.

At the meeting, you are handed the following information to help you understand this situation:

- CDC Health Alert
- Passenger's Flight Itinerary
- Airline Seating Charts

In addition, you also know these facts:

- The index patient (infected passenger) sat in row 34 on the flight departing from Atlanta and sat in row 4 on the flight departing from Prague.
- Each flight had two flight attendants working in the area of the index patient.
- A person with active tuberculosis usually infects about 20 people.

The WHO, having learned of this issue, must now take on the task of notifying the passengers who were sitting in the area of possible infection of tuberculosis. The WHO must examine the worst case scenario of the possible tuberculosis infection and relay that information to the passengers to persuade them to get tested for tuberculosis.

Your boss has asked you and your team mates to use your mathematical skills to help respond to this situation. Your task is to:

1. Prepare a mathematical model that will be used to explain to passengers of the possible spread of tuberculosis. For instance, you may want to begin with explaining "If within the two flights, tuberculosis was spread to two of the surrounding passengers, this is the possible risk that we face if those two passengers are not tested and treated over a period of time…" Keep in mind, there is no accurate way to predict how many people will be infected. Therefore, you are going to have to use all the information you have at your disposal.

2. Prepare a representative model (graph) that demonstrates the possible spread of tuberculosis.

3. From your model, prepare your telephone statement, which will be made to the passengers that were on the same flight as the index patient. This statement must include data from your model and your recommendation to get tested for tuberculosis.

4. When finished, your group will present your model and statement to the class.

CDC HEALTH UPDATE

Tuesday, May 29, 2007, 15:30 EDT (03:30 PM)

Investigation of U.S. Traveler with Extensively Drug Resistant Tuberculosis (XDR TB)

The Centers for Disease Control and Prevention (CDC) is working with a number of international, state, and local partners on an investigation involving a U.S. citizen recently diagnosed with extensively drug-resistant tuberculosis (XDR TB). XDR TB has been recently defined as a subtype of multidrug-resistant tuberculosis (MDR TB) with additional resistance to the two most important second-line antibiotics (i.e., a fluoroquinolone and an injectable agent [amikacin, kanamycin, or capreomycin]) in addition to the two most important first-line drugs (i.e., isoniazid and rifampin).

CDC learned that a patient with XDR TB traveled to Europe via commercial airline (Air France # 385) departing Atlanta on May 12 and arriving in Paris on May 13, 2007, and returned to the United States after taking a commercial flight on May 24 from Prague, Czech Republic to Montreal, Canada (Czech Air # 0104). The patient re-entered the U.S. on May 24 via automobile. Since May 25, the patient has been hospitalized in respiratory isolation and is undergoing additional medical evaluation.

CDC is collaborating with U.S. state and local health departments, international Ministries of Health, the airline industry, and the World Health Organization (WHO) regarding appropriate notification and follow up of passengers and crew potentially at risk for exposure to XDR TB. Each country involved in the investigation is determining the most appropriate guidance for its residents.

In accordance with the WHO TB and Airline Travel Guidelines, to ensure appropriate follow-up and care for persons who may have been exposed to XDR-TB, CDC is recommending the following for passengers and crew onboard Air France # 385 departing Atlanta on May 12 and arriving in Paris on May 13, and on Czech Air # 0104 departing from Prague and arriving in Montreal on May 24: **Passengers seated in the same row as the index patient and those seated in the two rows ahead and the two rows behind, as well as the cabin crew members working in the same cabin should be evaluated for TB infection. This includes initial evaluation and testing with follow up 8-10 weeks later for re-evaluation**

Drug-susceptible (regular) TB and XDR TB are thought to be spread the same way. TB bacilli become aerosolized when a person with TB disease of the lungs or throat coughs, sneezes, speaks, or sings. These bacilli can float in the air for several hours, depending on the environment. Persons who breathe air containing these TB bacilli can become infected.

The risk of acquiring any type of TB appears to depend on several factors, such as extent of disease in the source patient, duration of exposure, and ventilation. Transmission has been documented in association with patients who have lung disease, and bacteria seen or cultured in sputum. Persons who become infected usually have been exposed for several hours (or days) in poorly ventilated or crowded environments. An important way to prevent the spread and transmission is by limiting an infectious person's contact with other people. Thus, people who have a confirmed diagnosis of TB or XDR TB are placed on treatment and kept isolated until they are no longer infectious.

##This Message was distributed to State and Local Health Officers, Public Information Officers, Epidemiologists, State Laboratory Directors, BT Coordinators and HAN Coordinators, as well as Public Health Associations and Clinician organizations##

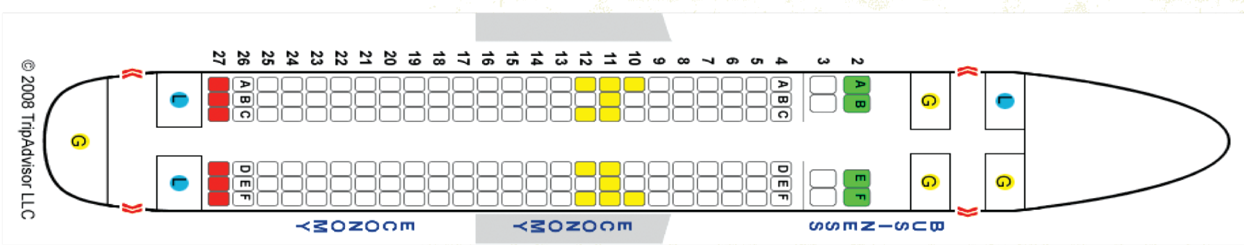
Credit: Excerpted from *Official CDC Health Update: Investigation of U.S. Traveler with Extensively Drug Resistant Tuberculosis (XDR TB)*, Centers for Disease Control and Prevention, 5/29/07.

U.S. TRAVELER'S FLIGHT ITINERARY

Airlines	Flight #	Date	Departing	Calculated Scheduled Duration	Arriving	Total # of passengers
Air France/ Delta	385/8517	5/12/07	Atlanta, GA	8 Hr. 27 Min.	Paris, France	433
Czech Airlines	0104	5/24/07	Prague, Czech Republic	8 Hr. 25 Min.	Montreal, Canada	191

AIR FRANCE/ BOEING 747-400

CZECH AIRLINES/ AIRBUS A320-200



Credit: Air France/Boeing 747-400 seating chart and Czech Airlines/Airbus A320-200 seating chart, TripAdvisor LLC.

LESSON

LESSON 3: Take TB Seriously

Activity Time: 150 minutes (three 50 minute periods)

In this lesson, students will analyze TB data from different countries and then determine the mathematical model that the data fits. Students will analyze graphs of TB death rates and mathematically derive data/patterns within that can be used to inform and persuade a country to increase their TB prevention measures.

Before delivering this lesson, students should have already covered linear, quadratic, and exponential functions. Students may need some help recognizing sine/cosine and logarithmic functions.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Disease Prevention**: The increase of diagnosed TB cases influences prevention measures.
- **Disease Prevention**: Increases in health care within a community result in a decrease in diagnosed TB cases.

Essential Question:

- How can math be used to persuade decision-makers about global health issues, such as tuberculosis?

Learning Objectives:

Students will know…

- Properties of quadratic functions, exponential functions, linear functions, logarithms, and inverse relationships can be used to make predictions about tuberculosis.

Students will be able to…

- Analyze mathematical models.
- Create a formula to make predictions.

Vocabulary:

- Exponential function
- HIV
- MDR TB
- Linear function
- Logarithmic function
- Quadratic function
- Sine/cosine function
- Tuberculosis
- XDR TB

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **A2.1.A** Select and justify functions and equations to model and solve problems.
- **A2.1.C** Solve problems that can be represented by quadratic functions, equations and inequalities.
- **A2.4.A** Know and use basic properties of exponential and logarithmic functions and the inverse relationship between them.
- **A2.8.A** Analyze a problem situation and represent it mathematically.
- **A2.8.E** Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics.

Common Student Preconceptions:

- The scales on graphs are usually the same.
- Tuberculosis is only a problem if you are in a homeless shelter or prison.
- People don't get tuberculosis in the U.S.
- There isn't any relationship between HIV and TB.

TEACHER PREPARATION

Materials:

- Computer with internet, speakers, and projector
- *The TB/HIV Crisis* Handout (1 per student)
- *Function Categories* Handout (1 per student)
- *Take TB Seriously* Handout (1 per student)
- *Article Review Rubric* Handout (1 per student)
- Teacher Answer Key

Preparation:

- Preview the video and article so that you are prepared to lead a discussion and answer students' questions. A transcript of the video is available from the PBS website.
- Photocopy the Student Handouts.

PROCEDURE

Hook

1. Show students the 12 minute video **TB, HIV Form Deadly Partnership in South Africa** to get students interested in the activity topic.

   TB, HIV Form Deadly Partnership in South Africa
   The Newshour with Jim Lehrer, PBS, 3/24/09, 12:35 minutes

   Video: http://www.pbs.org/newshour/video/module.html?mod=0&pkg=24032009&seg=5

   Transcript: http://www.pbs.org/newshour/bb/africa/jan-june09/southafricatb_03-24.html

2. Lead a brief class discussion about the video. Some possible discussion questions include:
   - Why are HIV-positive people more likely to get TB?
   - What are some of the challenges of diagnosing and treating TB patients in South Africa?
   - Why is it important for TB patients to take the full-course of drugs, rather than stopping after just a few months of treatment?
   - What kind of mathematical data would be helpful to better understand the problems of HIV/TB co-infection and the emergence of drug-resistant strains of TB?

Article Review

3. Hand out copies of the *The TB/HIV Crisis* article by Lucy Chesire, one per student. Ask students to critically read the article and to complete an Article Review. A rubric is provided to score students' Article Reviews. This rubric can also be used to review expectations with students for this learning task.
4. The Article Review should consist of the following five components:
   - Listing the title, author(s) and source of the article — publication and issue date.
   - A one or two paragraph description of what is discussed in the article, written in your own words. This describes the broad picture of the article, not the specific details.
   - A paragraph telling your opinion of the article, explaining why you either liked or disliked it.
   - A paragraph telling what new facts or ideas you gained by reading the article, including explaining rather than merely listing them.
   - A list of new words you learned in the article – with definitions for these words.
5. After students have completed their Article Reviews, lead a class discussion about the article, asking students to share their opinions of the article and what new information they learned.

Preconceptions

6. Pass out copies of the *Function Categories* Handout, one per student.

7. This learning task will help you to gauge students' understanding of linear, quadratic, exponential, sine/cosine, and logarithmic functions. While students complete the handout, provide just-in-time instruction to clear up any misconceptions or confusions. Depending on when this lesson is delivered, some students may need help recognizing logarithmic and sine/cosine functions.

Activity

8. Break the students up into small groups of 2 or 3.

9. Pass out copies of the *Take TB Seriously* Handout, one per student.

10. Read through the handout. Allow time for students to ask questions for clarification on the content and/or directions. Provide an example of how to fill out the table. Depending on the level of students' abilities, you may need to actually work through the table with students at first.

11. Ask students to analyze the graphs before them and pay close attention to the little details in the graphs. In what ways are they similar and different?

12. Optional: You may want to explore the WHO Countries website so that students can acquire a basic understanding of the countries featured in this lesson. Information on geography, demographics, culture, and health are available at this website.

    WHO Country Information
    http://www.who.int/countries/en/

13. After the students have completed the activity, provide time for each group to share their struggles and successes with the class. Groups will offer suggestions to other groups on ways they were able to succeed where others struggled.

Wrap-Up

14. Ask students to discuss the following question: How can math be used to persuade decision-makers about global health issues, such as tuberculosis?

STUDENT ASSESSMENT

Assessment Opportunities:

- The discussions in the Hook and Preconceptions section of the lesson provide opportunities to capture students' preconceptions about TB, mathematical modeling, and equations.
- Students can be assessed based on their participation, completeness of their chart analysis, and predictions.
- During group work time, roam among the groups asking questions, observing, and redirecting whenever needed.

Student Metacognition:

- Groups will be sharing with each other and discussing their strategies that led to success with the learning task.

Scoring:

- The Article Review can be graded using the provided rubric.
- The *Take TB Seriously* handout can be graded using the provided Teacher Answer Key.
- Participation points can be assigned for working in groups and contributing to class discussions.

EXTENSION ACTIVITIES

Extension Activities:

- An in-depth look at spikes in the graphs, consistencies, and inconsistencies can be further researched as to why they are happening. For instance, overcrowding in Russian prisons leads to an increase in the TB death rate.

Adaptations:

- Adaptations can be made by using a computer or graphing calculator. Graphing calculators will draw regression lines and determine equations.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section below.

Resources:

TB, HIV Form Deadly Partnership in South Africa Video
The Newshour with Jim Lehrer, PBS, 3/24/09, 12:35 minutes
Video: http://www.pbs.org/newshour/video/module.html?mod=0&pkg=24032009&seg=5
Transcript: http://www.pbs.org/newshour/bb/africa/jan-june09/southafricatb_03-24.html

Threat of TB Video
Multi-drug resistant tuberculosis in the Russian prison system
WGBH Educational Foundation, 2001, 5:05 minutes
http://www.pbs.org/wgbh/evolution/library/10/4/l_104_09.html

Azerbaijan Leading by Number of Drug-Resistant TB Patients in the World
TODAY.AZ, 2/27/08
http://www.today.az/news/society/43415.html

WHO Country Information
http://www.who.int/countries/en/

Credit:

National Council of Teachers of Mathematics. (2008). *Determine the Function Category for Each Graph*. Available at: http://illuminations.nctm.org/lessons/9-12/Regression/Regress-OV-graphs.pdf.

Chesire, L. (2008). The TB-HIV crisis. *The Boston Globe*, 12/1/08. Available at: http://www.boston.com/bostonglobe/editorial_opinion/oped/articles/2008/12/01/the_tb_hiv_crisis/

Data provided by The Institute for Health Metrics and Evaluation at the University of Washington.

Name:____________________________ Date:___________ Period:________

HANDOUT

The TB/HIV Crisis

By Lucy Chesire
December 1, 2008
Boston Globe

OVER the past two decades, the fight against HIV/AIDS has united the world as few other issues have before. As a result of the extraordinary efforts of scientists, activists, and world leaders, AIDS has gone from being a certain death sentence in most parts of the world to a treatable chronic condition. Much remains to be done, but the progress has been nothing short of remarkable.

Which is why it is unacceptable that we are allowing 25 years of progress to crumble before our eyes. Tuberculosis is the leading cause of death among people with HIV, and years of neglect have allowed it to become deadlier than ever, especially in those areas most ravaged by AIDS. By neglecting TB, we risk undoing some of the greatest achievements in global health activism.

One reason TB funding has languished is that in many developed countries it is regarded as a disease of the past. Some of those fortunate enough to have quality healthcare are surprised to hear that TB even still exists. But every year, 1.7 million people die from TB, and 9 million more are infected annually. Those who are most susceptible live in the poorest regions of the world, and those with compromised immune systems, like HIV/AIDS patients, are especially prone to catching TB.

As a TB-HIV survivor, I am one of the fortunate ones. After eight years of living with HIV/AIDS, I contracted a severe case of tuberculosis. My treatment required multiple surgeries and months in a hospital. I was lucky to have access to treatment. But there are many who do not have the same opportunity.

Approximately half of those living with HIV will develop TB in their lifetimes. Even more worrisome is the fact that increasingly drug-resistant forms of TB have emerged, often killing those who are infected before they are even diagnosed, but not before they have potentially passed the disease on to others. The first outbreak of the deadliest form of TB, extensively drug-resistant TB (or XDR-TB), occurred among HIV/AIDS patients. Fifty-two out of 53 of those infected died within weeks.

This need not happen. If caught early, TB can be treated for $20 worth of drugs. However, as the disease gets more drug-resistant, it becomes more expensive to treat. XDR-TB can cost hundreds of thousands of dollars to treat, and require surgery. In poor countries, it's a death sentence.

One major problem is that only 1 percent of people living with HIV/AIDS are tested for TB. This is because most AIDS clinics do not have the capacity to test for TB, and results sometimes take weeks to obtain. It is hard enough for those in rural areas to receive treatment for their HIV; it is impossible to ask them to seek separate treatment for TB.

The World Health Organization has calculated that universal access to coordinated TB-HIV services could be achieved, and TB-HIV deaths could be reduced by 80 percent, with a worldwide investment of $19 billion between now and 2015. Divided among the wealthy countries and donor institutions that already provide resources to fight AIDS, this is a tiny percentile.

President-elect Obama has been vocal about his commitment to continuing the progress made by the Bush administration in fighting infectious diseases, and upholding the US commitment to the Millennium Development Goals to fight poverty and disease. Last year, Congress passed a historic bill that authorized $48 billion to fight AIDS, TB, and malaria. My fellow Kenyans and I are grateful to President Bush for the work he has done, and to Obama and his colleagues for passing this historic bill. In order to make good on those commitments, Obama and other leaders must ensure that joint TB-HIV programs are adequately addressed. The fight against AIDS - and global health at large - depends on it.

Lucy Chesire, a patient activist, was the first female health professional in her native Kenya to publicly acknowledge her HIV-positive status.

Credit: Reprinted with permission of *The Boston Globe. Chesire, L. (2008). The TB-HIV crisis.*
The Boston Globe, 12/1/08.

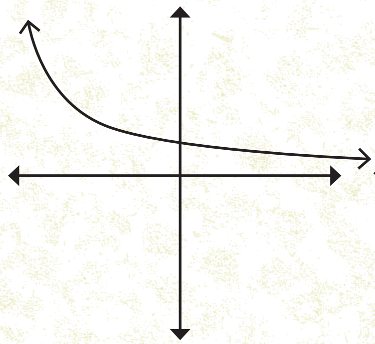
Name:________________________ Date:__________ Period:________

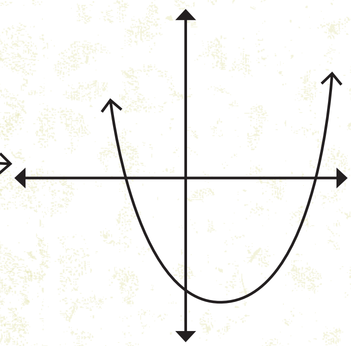
Function Catagories

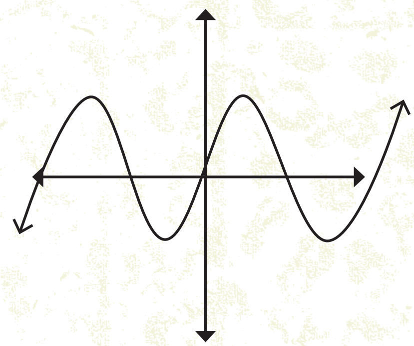
HANDOUT

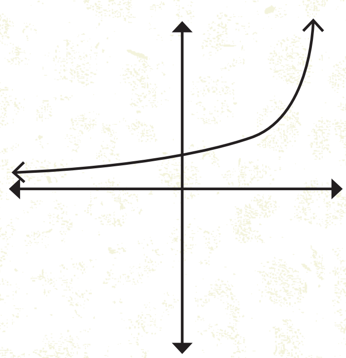
For each of the graphs below, write down the name of the function category that each graph represents. Your choices are:

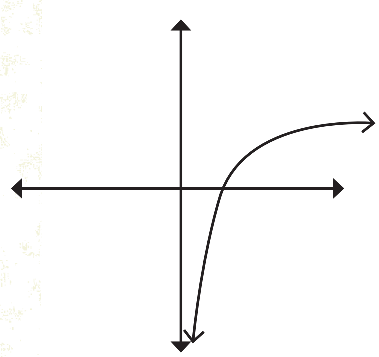
Exponential **Linear** **Logarithmic** **Quadratic** **Sine/Cosine**

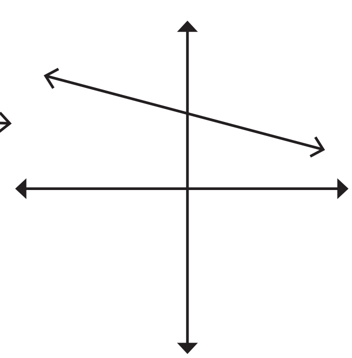












Adapted from: National Council of Teachers of Mathematics. (2008). *Determine the Function Category for Each Graph*. Available at: http://illuminations.nctm.org/.

Name:________________________ Date:_________ Period:_______

Take TB Seriously

"This is my frustration here—the world is not taking this epidemic seriously," said Dr. Mario Raviglione, director of the World Health Organization's Stop TB Department. This quote by Dr. Raviglione is in response to the limited data available for tuberculosis.

Current data tells us that TB is a serious issue in various parts of the world, and is particularly serious in many developing countries. If the data that we do have can be examined and explained to the decision-makers in developing countries, then a plan of action can be implemented. This plan of action can educate people and provide services to stop the spread of this infectious disease.

Many times, mathematicians are asked to use data for persuasion. Because of our efforts to increase global health awareness and stop the spread of infectious disease, we want you to use TB data to make a compelling case to persuade a country to participate in active measures in stopping the spread of TB.

Your task is to examine TB data of tuberculosis death rates from various countries and determine the mathematical model (if one exists) that the data fits. You will devise equations that can be used to make predictions about whether TB death rates will decline or grow. You will use this information to make a data-based recommendation for each country's government to participate in activities that will prevent the spread of TB.

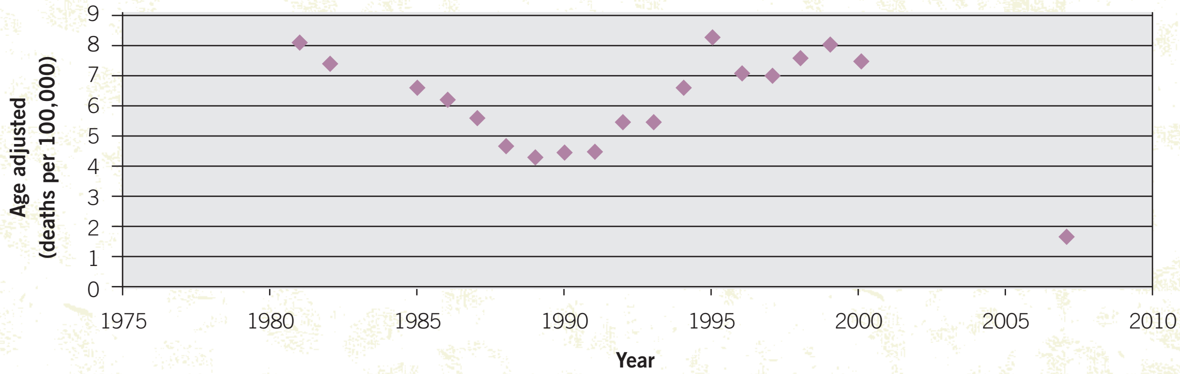
Tip: When examining the graphs, be sure to look carefully at the scales used for the x- and y-axis of each graph.

Use the chart on the next page to guide your analysis. In each cell of the chart, answer the following questions about each of the provided graphs:

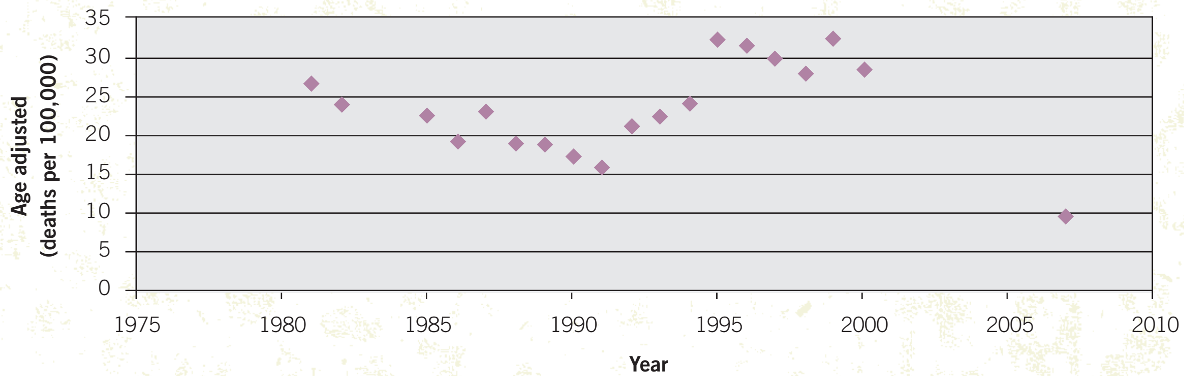
1. Graph Analysis:
   - Are there any major factors in the graph that would make you proceed in doing an analysis? Explain why/why not.
2. Mathematical Functions:
   - What type(s) of mathematical functions are represented? (Linear, logarithmic, exponential, quadratic, sine/cosine)
   - Why does this apply?
   - How does this help you make sense of the data?
3. Data Patterns:
   - What patterns can be derived and represented numerically/mathematically? Is there a general rule or formula that can be used to make predictions?
4. Predictions
   - What are your data-based predictions?
   - How can you use this data to make a compelling case to persuade this country to participate in active measures in stopping the spread of TB?

	Graph Analysis Yes/No & Explain	Mathematical Functions	Data Patterns	Predictions
Azerbaijan Female				
Azerbaijan Male				
South Africa Female				
South Africa Male				
Russian Federation Female				
Russian Federation Male				
Ukraine Female				
Ukraine Male				
USA Female				
USA Male				

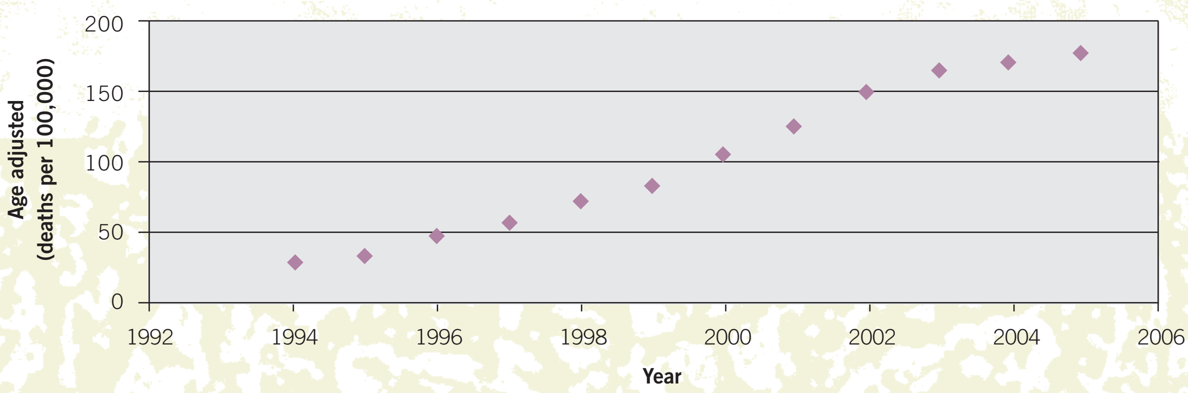
TB Death Rates (Azeraijan Female)

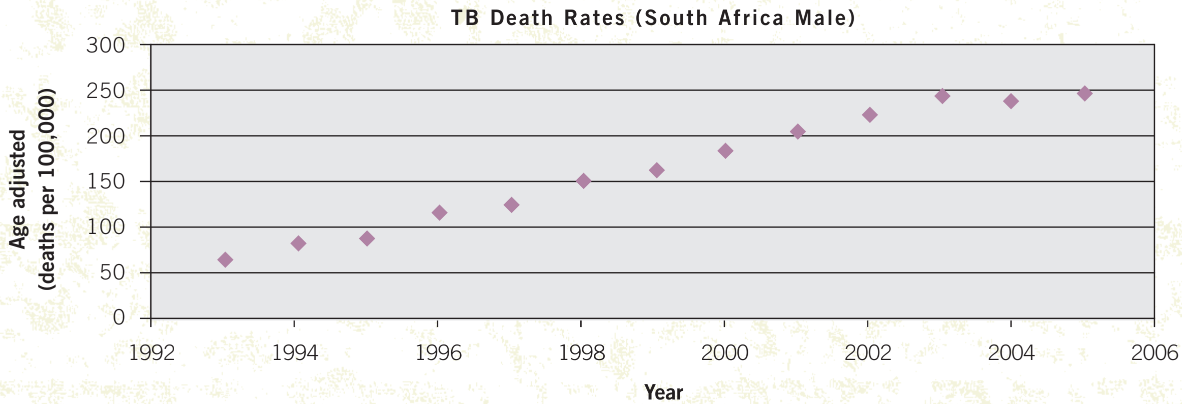


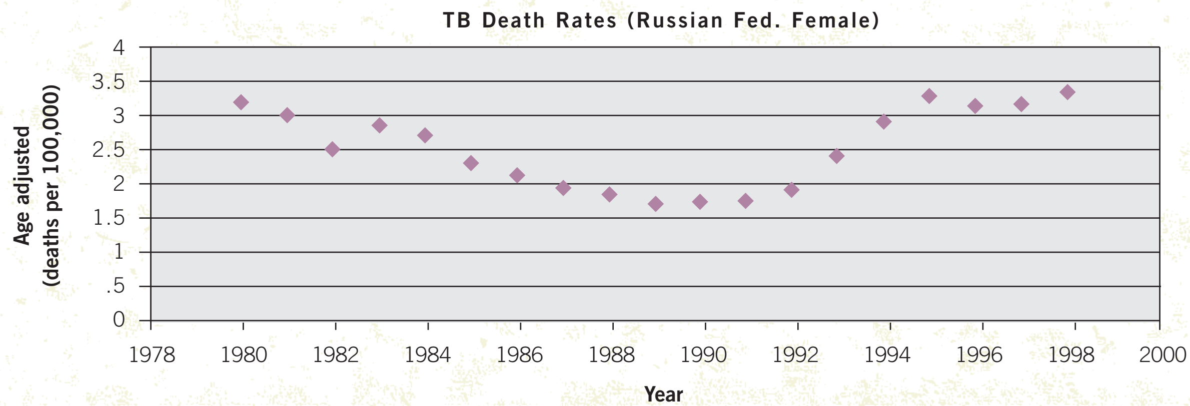
TB Death Rates (Azeraijan Male)

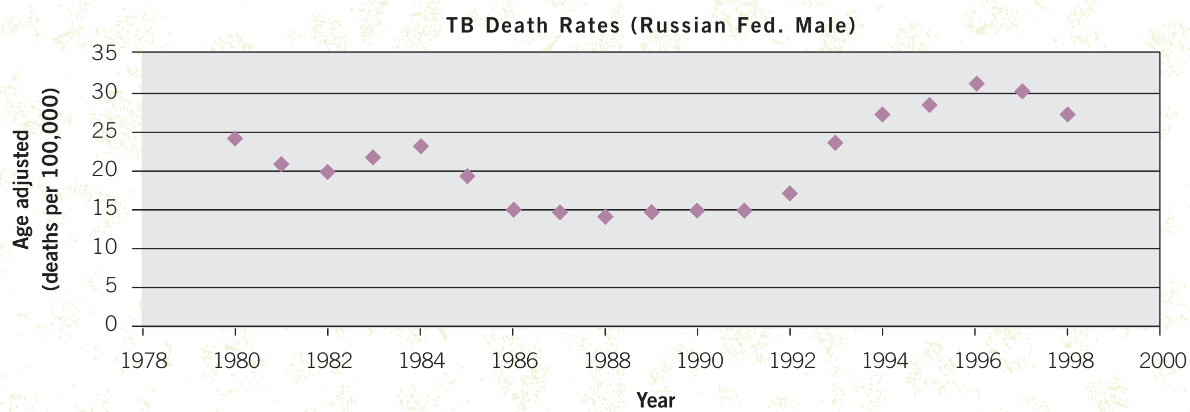


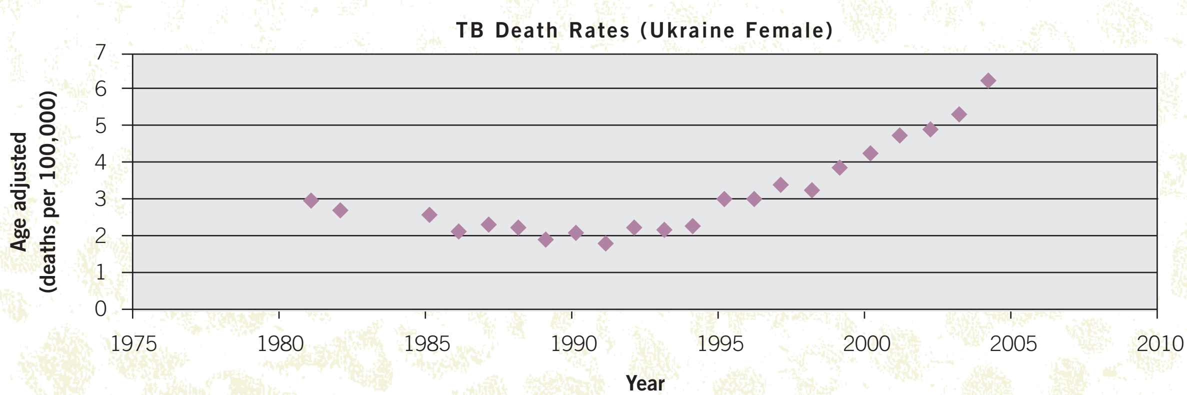
TB Death Rates (South Africa Female)

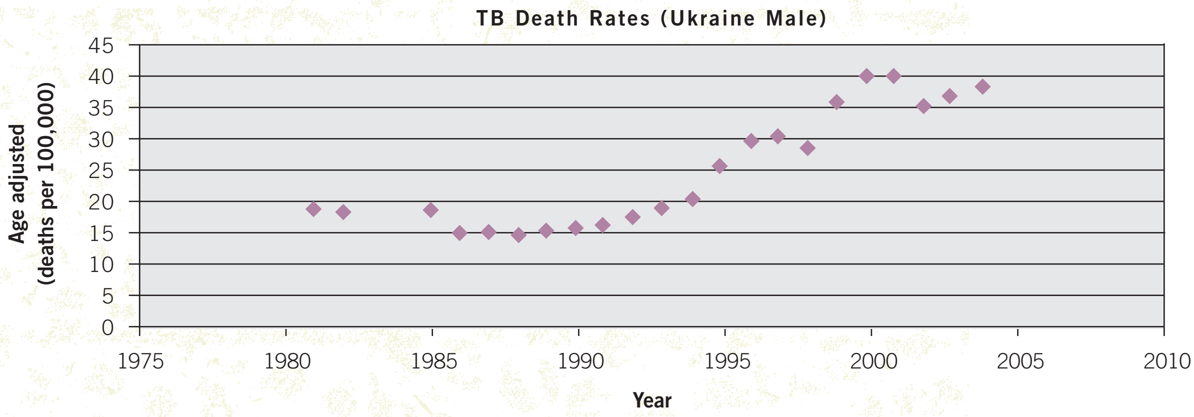


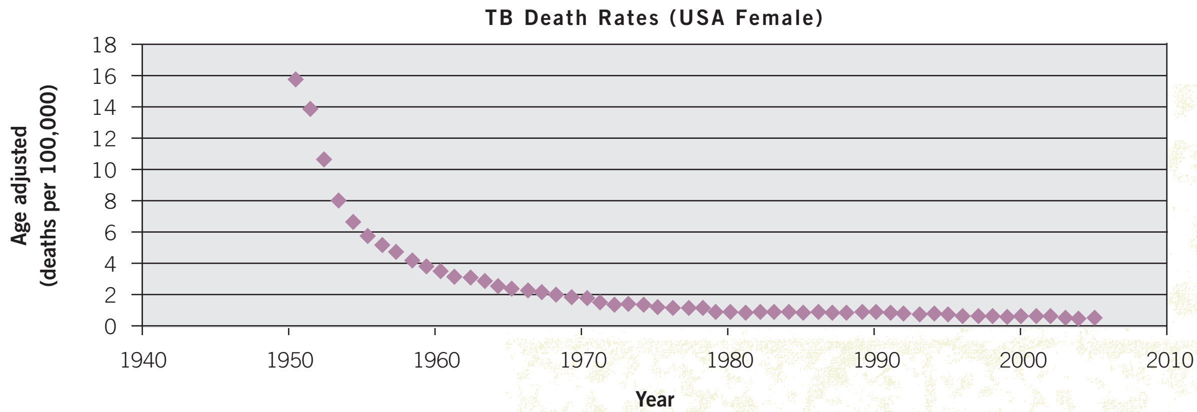

TB Death Rates (South Africa Male)
Age adjusted (deaths per 100,000)
300
250
200
150
100
50
0
1992
1994
1996
1998
2000
2002
2004
2006
Year

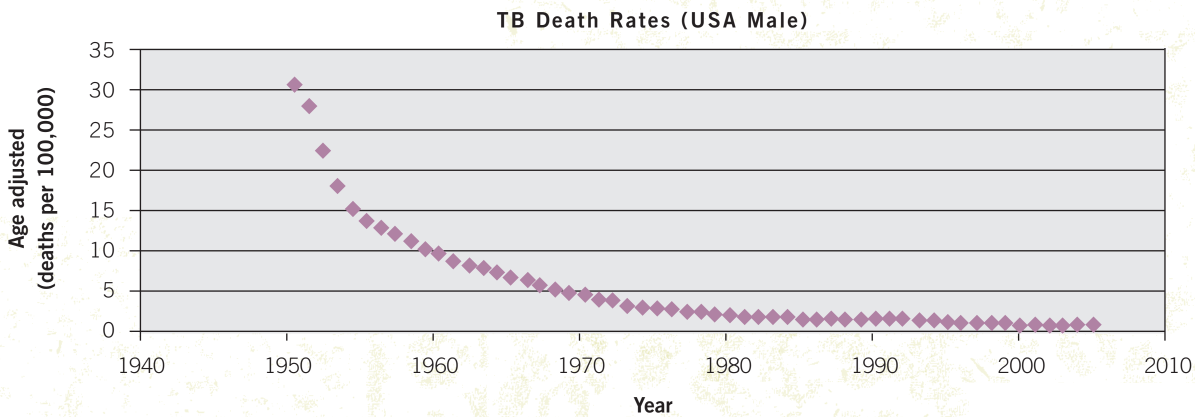

TB Death Rates (Russian Fed. Female)
Age adjusted (deaths per 100,000)
4
3.5
3
2.5
2
1.5
1
.5
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Year


TB Death Rates (Russian Fed. Male)
Age adjusted (deaths per 100,000)
35
30
25
20
15
10
5
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Year


TB Death Rates (Ukraine Female)
Age adjusted (deaths per 100,000)
7
6
5
4
3
2
1
0
1975
1980
1985
1990
1995
2000
2005
2010
Year







Credit: Data provided by the Institute for Health Metrics and Evaluation of University of Washington.

Take TB Seriously

	Graph Analysis Yes/No & Explain	Mathematical Functions	Data Patterns	Predictions
Azerbaijan Female	Some students may say that they should proceed further because death rates are increasing, which is okay. However, there shouldn't be too big of a scare because the value of the y-axis is rather low.	Quadratic	Pattern fits the quadratic formula or $y = a(x - h)^2 + k$. Have students find the general formula in quadratic form that fits the graph. The formula should be similar to $y = 0.12(x - 8)^2 + 4$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
Azerbaijan Male	Some students may say that they should proceed further because death rates are increasing, which is okay. However, there shouldn't be too big of a scare because the value of the y-axis is rather low. However, students should notice that the death rates are higher for males than females.	Quadratic	Pattern fits the quadratic formula or $y = a(x - h)^2 + k$. Have students find the general formula in quadratic form that fits the graph. The formula should be similar to $y = 0.39(x - 10)^2 + 16$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
South Africa Female	Yes, students should proceed further.	Linear	Pattern fits the linear equation $y = mx + b$. Have students find the general formula in linear form that fits the graph. The formula should be similar to $y = 17x$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
South Africa Male	Yes, students should proceed further.	Linear	Pattern fits the linear equation $y = mx + b$. Have students find the general formula in linear form that fits the graph. The formula should be similar to $y = 19x + 50$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
Russian Federation Female	This problem is very similar to Azerbaijan Female. The hope is that by now, students will see that the death rate increase is extremely low, which doesn't pose a major issue.	Quadratic	Students may choose to proceed, but don't have to. If they do they will get a quadratic formula similar to $y = 0.05(x - 9)^2 + 1.75$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
Russian Federation Male	This problem is very similar to Azerbaijan Male. Students need to see there's a difference between male and females in the graphs.	Quadratic	Should look similar to $y = 0.27(x - 8)^2 + 14$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.

KEY

	Graph Analysis Yes/No & Explain	Mathematical Functions	Data Patterns	Predictions
Ukraine Female	Death rates are increasing, but not at a high rate. Encourage students to proceed with their investigation.	While students could probably make a case for linear, guide them to the possibility of seeing an exponential function.	Pattern fits the exponential equation $\mathbf{y = ab^x}$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
Ukraine Male	Yes, students should proceed.	While students could probably make a case for linear, guide them to the possibility of seeing an exponential function.	Pattern fits the exponential equation $\mathbf{y = ab^x}$.	Answers will vary depending on the data points used to make predictions. Remind students to show their work in this section.
USA Female	The expectation is that students will see that there is no need to proceed.	Exponential		
USA Male	The expectation is that students will see that there is no need to proceed.	Exponential		

Name:______________________________ Date:__________ Period:________

HANDOUT

Article Review Scoring Rubric

The analysis will consist of 5 parts:

- Listing the title, author(s) and source of the article – publication and issue date. (This is required).
- A one or two paragraph description of what is discussed in the article, written in your own words. This describes the broad picture of the article, not the specific details.
- A paragraph telling your opinion of the article, explaining why you either liked or disliked it.
- A paragraph telling what new facts or ideas you gained by reading the article, including explaining rather than merely listing them.
- A list of new words you learned in the article – with definitions for these words.

The analysis will be scored based on the rubric that follows.

	+5	+4	+3	+2	0
General Outline	Clear, written in your own words; at least 3 sentences	Clear, written in your own words, but incomplete	Not clear or some of the phrases are copied or not in the article	Most of the phrases are copied	The article outline is missing
Your Opinion	Clear point of view; at least 3 sentences; relates to the article; tells why you have this opinion	Clear point of view; relates to the article; tells why you have this opinion	Clear point of view; varies in part from the article; tells why you have this opinion	Point of view is not clear or varies in part from the article	The opinion paragraph is missing
Learned Concept	Clear; in your own words; at least 3 sentences	Clear; short or some phrases are wrong	What you say is not clear	Merely a list of what you learned	This paragraph is missing
Grammar and Spelling	No errors in grammar or spelling in the analysis	1 to 4 errors in grammar and/ or spelling in the analysis	5 to 8 errors	9 to 12 errors	More that 12 errors
New Words	5 or more new words with correct definitions	4 new words with correct definitions	3 new words with definitions	1 or 2 new words with at least one definition	New word section is not done

LESSON 1: TB Colony Measurement

LESSON

Activity Time: 90 minutes

In this lesson, students will use black peas to model TB bacterium within colonies of various sizes and over different periods of time. Students will use the SI system and appropriate mathematical concepts to devise two methods for identifying how many bacterium are within their colony.

This lesson can complement students' study of physical measurement and the SI System.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **SI System of Measurement:** An understanding of the SI system and math is necessary to properly calculate and measure different quantities within chemistry.

Essential Question:

- What are the measurements of the TB bacterium in a colony?
- How can one calculate the number of TB bacterium in a colony?

Learning Objectives:

Students will know…

- The SI System is used for making measurements in the field of chemistry.
- Mathematical calculations are used for making measurements in the field of chemistry.

Students will be able to…

- Determine the measurements of the TB bacterium and calculate numbers of bacterium from various inputs.
- Calculate the number of bacterium by measuring.

Vocabulary:

- Bacteria/bacterium
- Colony
- Metric system
- *Mycobacterium tuberculosis*
- Petri dish
- Tuberculosis
- SI units

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Science 9-12 INQB** Scientific progress requires the use of various methods appropriate for answering different kinds of research questions, a thoughtful plan for gathering data needed to answer the question, and care in collecting, analyzing, and displaying the data.
- **Science 9-12 APPB** The technological design process begins by defining a problem in terms of criteria and constraints, conducting research, and generating several different solutions.

Common Student Preconceptions:

- Microbes are all around the same size (viruses, bacteria, parasites, etc...).

TEACHER PREPARATION

Materials:

- Computer and projector
- Rulers (16)
- Triple-beam balance (8)
- Bags of dried black-eyed peas (8)
- Paper plates (16)
- Plastic baggies (16)
- *TB Colony Measurement* Handout (1 per student)
- *Scoring Rubric* Handout (1 per student)

Preparation:

- Divide the black-eyed peas into sixteen plastic baggies. Make sure that the number of peas in each baggie is somewhat different.
- Make copies of Student Handout.

PROCEDURE

Hook

1. Ask students what they think the relative size is for atoms, viruses, molecules, and bacteria. Which is bigger than the other? By how much? How can this be shown mathematically?
2. Tell students the important chemistry content that they'll be exploring today: An understanding of why the SI system and math is necessary to properly calculate and measure different quantities within chemistry.
3. Show students the **Powers of 10** website. Go through the different measurements, from 10^{-18} m to 10^{25} m. On the right-hand side of the screen, you'll see a table of numbers. Choose different boxes in the table to show students the difference in size by moving the decimal.

   Powers of 10
   http://powersof10.com/index.php?mod=power_detail&id_power=0

Preconceptions

4. Explain that tuberculosis is caused by the bacteria, *Mycobacterium tuberculosis*. The size of the TB bacterium varies from 0.4 microns to 1.4 microns. Show students the measurement scale from the following website to help them understand how big bacteria are related to other common objects:

   NOVA The Size of Things
   http://www.pbs.org/wgbh/nova/teachers/activities/pdf/3302_04_nsn_01.pdf

Activity

5. Use the physical measurement chapter in your classroom textbook to discuss the SI System and metric system.
6. Briefly explain how measuring (by weight and distance) is one strategy for counting a large number of objects.
7. Ask students to sit next to their lab partners. Pass out copies of the *TB Colony Measurement* Handout, one per student. Ask students if they have any questions about the activity.
8. Distribute the activity materials to each lab station.
9. Provide time for students to work with lab partners to complete the activity and write-up.

Wrap-Up

10. Ask each pair of lab partners to share with the class the two measurement methods they devised and how many bacterium they think are in their colony.

STUDENT ASSESSMENT

Assessment Opportunities:

- The discussions allow for preconceptions to be addressed.
- Students will prepare an activity write-up about the activity, which should include the components listed on the Student Handout.

Student Metacognition:

- Students will discuss what they learned and how to apply it within the conclusion section of the activity write-up.

Scoring:

- The activity write-ups can be scored using the provided Scoring Rubric.

EXTENSION ACTIVITIES

Extension Activities:

- Show students images of TB bacterium.

Adaptations:

- The activity write-up directions and rubric can be adapted to meet your classroom needs.
- If students haven't yet been introduced to the measurement of microns, they may need some additional instruction.
- Some students may need help with the mathematical calculations required for question #4 on the handout.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section below.

Resources:

Powers of 10
http://powersof10.com/index.php?mod=power_detail&id_power=0

NOVA The Size of Things
http://www.pbs.org/wgbh/nova/teachers/activities/pdf/3302_04_nsn_01.pdf

NIAID Visual Tour of Drug-Resistant TB
http://www3.niaid.nih.gov/topics/tuberculosis/Understanding/WhatIsTB/ScientificIllustrations/firstLineIllustration.htm

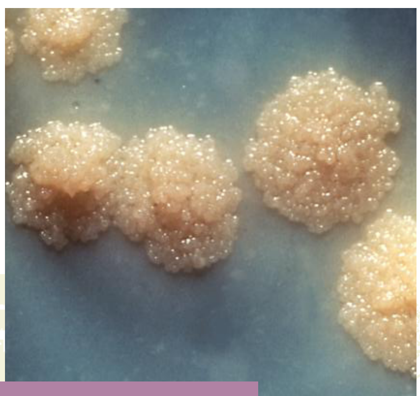
The Why Files: Microbes, Antibiotic Resistance, and TB
http://whyfiles.org/038badbugs/tb1.html

Name:______________________ Date:__________ Period:________

TB Colony Measurement

HANDOUT

You are a chemical engineer working at MycoBac Inc., a biotechnology company in Seattle. Your company is attempting to develop new antibiotic drugs that can be used to treat extensively drug-resistant tuberculosis (XDR TB). For XDR TB patients, first-line and second-line antibiotics don't work. For these patients, tuberculosis is a life-threatening condition… unless MycoBac Inc. can discover new antibiotics that can successfully fight these strains of *Mycobacterium tuberculosis*.



Close up of a *Mycobacterium tuberculosis* culture. Note the colorless rough surface, which are typical of *Mycobacterium tuberculosis* colonial growth

Source: CDC/Dr. George Kubica

Tuberculosis (TB) is an infectious disease caused by the bacteria, *Mycobacterium tuberculosis*. Bacteria grow in colonies. Colonies can be cultured in the laboratory by incubating petri dishes that are coated with a nutrient-rich gel and smeared with a sample of the bacteria.

In this activity, a paper plate will represent a petri dish and black-eyed peas will represent TB bacterium growing in a colony. This activity will introduce you and your lab partner to measurement by have you determine how many TB bacterium are within a colony.

Procedure

1. Empty your baggie of black-eyed peas out on your paper plate so that the peas form a tightly packed single layer.
2. Your challenge is to devise two methods for identifying how many bacterium are within your colony. You can choose to use rulers and/or the triple-beam balance, or some other method.

Questions to Answer

1. How many bacterium are within your colony using method number 1?
2. How many bacterium are within your colony using method number 2?
3. Which of your two methods do you think is more accurate? Why?
4. If a typical TB bacterium has a length of 1.0 micron, how many bacteria would fit into a colony with a radius of 2.5 cm.?

Activity Write-Up

Complete a write-up for this activity. Remember that a write-up contains the following components:

- Title – your choice.
- Objective – in a sentence.
- Hypothesis – (if appropriate) in a sentence.
- Materials – as a list.
- Procedure – step-by-step, in sentences.
- Data – as a table or graph, also shows calculations .
- Analysis – interprets your data and calculations and answers the questions above.
- Conclusion
  - > Summarizes the whole activity.
  - > Answers the hypothesis and why (if appropriate).
  - > Error Analysis - describes the experimental errors.

Each lab partner will complete a write-up. Only the Materials, Procedure, and Data sections can be word-for-word exact copies between lab partners. All other sections must be original to the individual writer.

Name:____________________ Date:__________ Period:________

TB Colony Scoring Rubric

HANDOUT

	5	3	1	0	Possible	SCORE
HEADING						
Name			Present	Not present	1	
Lab Partner			Present	Not present	1	
Date			Present	Not present	1	
Lab Title			Present	Not present	1	
OBJECTIVES						
The heading "Objectives" is listed			Present	Not present	1	
All objectives are present and clear	All objectives are present and clear	Some objectives are present and clear		No objectives are present-not clear	5	
HYPOTHESIS						
The heading "Hypothesis" is listed			Present	Not present	1	
Hypothesis (if appropriate for activity) is present and clear	Hypothesis is present and clear	Hypothesis is present - not clear		Hypothesis is not present	5	
MATERIALS						
The heading "Materials" is listed			Present	Not present	1	
Complete list of necessary materials is listed.	All materials are listed	Some materials are listed		No materials are listed	5	
PROCEDURE						
The heading "Procedure" is listed			Present	Not present	1	
Complete step-by-step procedure is written	Complete procedure is written	Partial procedure is written		No procedure is written	5	

	5	3	1	0	Possible	SCORE
DATA						
The heading "Data" is listed			Present	Not present	1	
Tables, graphs, figures are clear and appropriate	Present, clear and appropriate	Present, not clear and appropriate		Not present	5	
ANALYSIS						
The heading "Analysis" is listed			Present	Not present	1	
Appropriate calculations are included (if needed)	Complete calculations	Partial calculations		No calculation	5	
Questions are written			Written	Not written	1	
Questions are answered	Complete answer	Partial answer		No answer	5	
CONCLUSION						
The heading "Conclusion" is listed			Present	Not present	1	
Clear and concise summary of activity	Summary present and clear	Summary present or not clear		Summary not present	5	
Hypothesis (if appropriate) is answered	Hypothesis present and clear	Hypothesis present - not answered		Hypothesis not present	5	
Error analysis is included	Possible errors discussed			Possible errors not discussed	5	
				SCORE	**62**	

LESSON 2: TB Molecular Models

Activity Time: 90 minutes

In this lesson, students will construct molecular models of various functional groups and compounds that make up the tuberculosis bacterium cell membrane. This activity will show students that molecules are three-dimensional and that their different geometries are responsible for how they react with other molecules. Students will further study how the shape of these functional groups and compounds are effective at protecting the bacterium from immunological agents and antibiotics.

This lesson complements the study of chemical bonding. Before delivering this lesson, students should have been introduced to molecular geometry and the VSEPR Theory.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Functional Groups and Compounds:** The shape of the functional groups and compounds that make up the cell membrane of the tuberculosis bacterium cell membrane are instrumental in protecting the cell from attacks by immunological agents and antibiotics.

Essential Question:

- What is the structure and shape of the functional groups and compounds that make up the tuberculosis bacterium cell membrane?

Learning Objectives:

Students will know…

- The shapes and molecular geometry of various functional groups and components of the tuberculosis cell membrane help protect it from immunological agents and antibiotics.

Students will be able to…

- Build models of the various functional groups and components of the tuberculosis cell membrane.

Vocabulary:

- Functional groups
- Molecular geometry
- Mycolic acid
- Tuberculosis

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Science 9-11 PS2F** All forms of life are composed of large molecules that contain carbon (Molecular structure and geometry).

Common Student Preconceptions:

- Molecules are two-dimensional.
- Antibiotics work well for all kinds of bacteria.

TEACHER PREPARATION

Materials:

- *Chicken Wire and Sugar Coating* Handout (1 per student)
- Molecular model kits (16 kits)
- Sponges (2) – No specific type, however both should be cut to the same shape and size.
- Parafilm
- Bowl of water

Preparation:

- Cut each sponge into an identical rod shape, so that it models the shape of the TB bacillus. Wrap one sponge in Parafilm.
- Make copies of the Student Handout.

PROCEDURE

Hook

1. Share with students the following scientific mystery:
   - On March 24, 1882, a German scientist named Robert Koch delivered a lecture that has since been called "one of the most important lectures in medical history." Koch reported on his studies of the bacteria that causes tuberculosis, *Mycobacterium tuberculosis*. He had taken samples of pus from the abscesses of people who had died of tuberculosis and made slide mounts of the pus. He then tried to stain the samples using common staining techniques so that he could study the samples under the microscope. However, Koch realized that there was something special about the covering of the bacterium that prevented it from being stained with the usual chemicals. Koch rose to the challenge and ended up developing a new staining technique that worked on the TB bacterium. The staining technique was later perfected by Paul Ehrlich. What was it about the bacterium's covering that was resistant to the chemical dyes?

Preconceptions

2. Ask students to share their ideas of what could make a bacterium cell wall resistant to chemical dyes?

Demonstration

3. Show students the two rod-shaped sponges. Explain that *Mycobacterium tuberculosis* is a bacillus, the genus of rod-shaped bacteria. Tell students that one sponge is a model of *Mycobacterium tuberculosis* and the other sponge is a model of different bacillus species. While both bacteria look similar, there is a critical difference between the two.
4. Plunge both sponges in a bowl of water and then hold them up for students to observe.
5. What did students notice? Highlight how one sponge absorbed water and the other did not. Ask students to share their thoughts on what might be responsible for this result?

Activity

6. Explain that the *Mycobacterium tuberculosis* model didn't absorb water for the same reason that Koch couldn't get his slides of *Mycobacterium tuberculosis* to stain with normal chemical dyes. The bacterium wears an unusual waxy cell wall that, like a raincoat, makes is practically waterproof. This special characteristic of TB bacterium is what makes it so difficult to treat TB because the bacterium's cell wall makes it difficult for many types of antibiotics to enter the cell. The cell's waxy wall is made up of long chains of fatty acids called mycolic acids.
7. Pass out copies of the *Chicken Wire and Sugar Coating* Handout, one per student. Discuss any vocabulary from the article that you feel your students will not understand. Ask students to read the article and study the diagram of the cell wall.

8. Discuss the various layers of the cell membrane, the hydrophobic nature of mycolic acids, and the chemical structure of mycolic acids. In particular, discuss the functional groups present in the mycolic acid molecule.
9. Distribute a molecular model kit to each lab station.
10. Challenge lab partners to work together to build a model of the three forms of mycolic acid. Explain that instead of making a 60-90 carbon chain, students should create a generic tail that represents the chain.
11. Make sure to examine each pair's molecular models before the class period is over and sign under Question 1 of their handouts.

Wrap-Up

12. Wrap-up the activity with a class discussion of the following questions:
    - How does the functional groups on the end of various forms of mycolic acid affect the permeability of the membrane?
    - Why is it difficult to develop antibiotics that are effective against *M. tb* while also soluble in blood?
    - How can this new knowledge be applied to other concepts or ideas within science?

STUDENT ASSESSMENT

Assessment Opportunities:

- Students will write a conclusion statement for the day's lesson which provides a window into their thinking about the activity, their misconceptions, and application of new knowledge.

Student Metacognition:

- Students will include in the conclusion statement a misconception that they had and how their knowledge of this concept has changed due to this activity.

Scoring:

- The Student Handout can be scored based on the quality of student answers, including a completed and thoughtful conclusion statement.
- Students can be assigned points for correctly creating molecular models of the three forms of mycolic acid.
- Participation points can be assigned for contributing to class discussions.

EXTENSION ACTIVITIES

Extension Activities:

- Show students the molecular structures of some first-line and second-line antibiotics from the website **The Resumption of Consumption**, listed in the Resources section.
- Have students read Robert Koch's biography or his Nobel Lecture, delivered December 12, 1905.
- The lipid bilayer of cell walls is also discussed in the malaria chemistry lesson, *Structure of DDT—Part II*.

Adaptations:

- If molecular model kits are not available, colored miniature marshmallows and toothpicks can used. Another option is to use modeling clay and toothpicks.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum. In addition, a list of helpful websites is provided in the Resources section below.

Resources:

Nobel Prize: Robert Koch
http://nobelprize.org/nobel_prizes/medicine/laureates/1905/koch-bio.html
http://nobelprize.org/educational_games/medicine/tuberculosis/readmore.html

The Resumption of Consumption (see Fig. 2 and 3)
http://www.scielo.br/scielo.php?pid=S0074-02762006000700001&script=sci_arttext

***M. tb* and Tuberculosis**
Todar's Online Textbook of Bacteriology
http://www.textbookofbacteriology.net/tuberculosis.html

Taking Down TB
Chemical & Engineering News, 9/24/07
http://pubs.acs.org/cen/coverstory/85/8539cover.html

Credit:

National Institute of Allergy and Infectious Diseases. *The Whole Ball of Wax: TB's Distinctive Cell Wall*. Available at: http://www3.niaid.nih.gov/topics/tuberculosis/Research/basicResearch/biology_cell.htm.

Southern Illinois University, Department of Microbiology.
Available at: http://www.micro.siu.edu/micr201/chapter4N.html.

Chicken Wire and Sugar Coating

HANDOUT

THE WHOLE BALL OF WAX: TB'S DISTINCTIVE CELL WALL

National Institute of Allergy and Infectious Diseases

In 1882, Robert Koch had to invent a two-step staining procedure to get *Mycobacterium tuberculosis (M. tb)* to show up under his microscope lens. He speculated on why *M. tb* was so difficult to stain: "It seems likely that the tubercle bacillus is surrounded with a special wall of unusual properties." Unusual is an understatement: The waxy coats of mycobacteria (including the microbes responsible for TB and leprosy) are unique among living things.

Patrick Brennan, Ph.D., of Colorado State University, uses words like "amazing" and "chemically extraordinary" to describe *M. tb's* cell wall. Combining chemical and genetic techniques, he discovered some of the methods *M. tb* uses to make its wall. Continued research may lead to drugs that can squelch the microbe's ability to build up its wall and thus make it more vulnerable to destruction.

Chicken Wire and a Sugar Coat

Bacterial cell walls, explains Dr. Brennan, have a layer of chicken wire-shaped molecules (peptidoglycan) that give the wall rigidity and enclose the microbe's inner workings. Penicillin can kill certain bacteria by snipping apart the chicken wire. *M. tb*, too, has a layer of these molecules overlaying its innermost cell membrane. However, the TB microbe has three more layers that further insulate it from attack. Atop the chicken wire is a sugary coating (arabino-galactan) that forms a bridge to the third layer, which is packed with stringy molecules called fatty acids. Many kinds of cells contain fatty acids, but *M. tb's* (called mycolic acids) are exceptionally long. The tangle of mycolic acids is wrapped in a final layer of tightly packed waxy molecules that make the cell nearly waterproof.

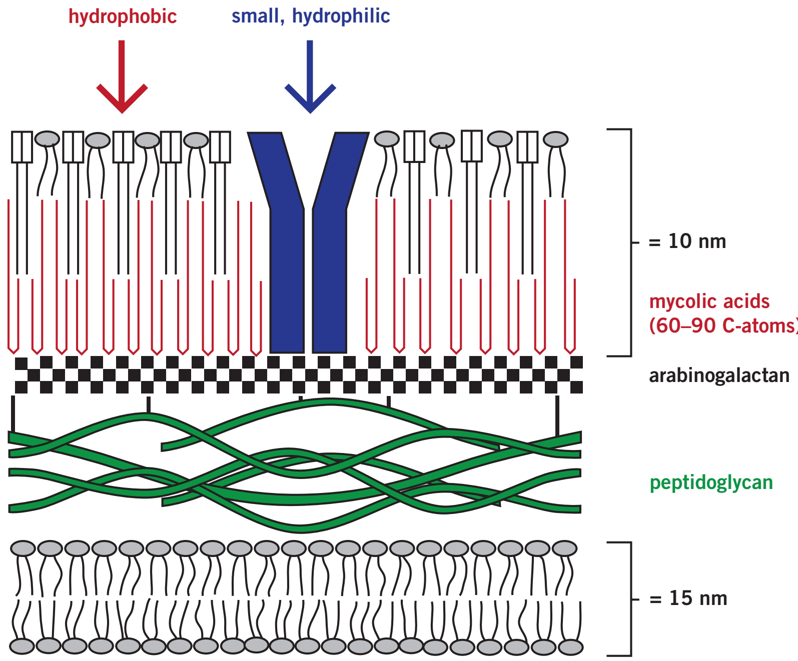
Beginning in the 1940s, chemists studied *M. tb's* cell wall by grinding up cells and extracting the assorted components for further analysis. It was not until the 1980s and the development of tools such as nuclear magnetic resonance and mass spectrometry, however, that chemists could determine the molecules' shapes, the chemical steps in their manufacture, and how they are arranged in an intact cell. In 1998, came a critical breakthrough—determination of *M. tb's* genetic sequence. Researchers gained clues into the genetic reasons behind *M. tb's* structural anomalies and its uncanny ability to survive in the human lung for long periods.

With the entire gene sequence in hand, Dr. Brennan and his colleagues started to tease out which genes *M. tb* must have to build its rugged cell wall. Those essential genes encode enzymes and they, in turn, might fall prey to specifically designed drugs, explains Dr. Brennan. In October 1990, the team at Colorado State University developed a more detailed picture of the multilayered cell wall. The core cell wall, they learned, is enormous—the biggest bacterial macromolecule ever discovered. This immense molecule has an equally long name that links together all of its components: mycolyl-arabino-galactan-peptidoglycan, or mAGP.

Breaking Down the Wall

Aided by a better understanding of the enzymes *M. tb* needs to make its wall, Dr. Brennan and Gurdyal Besra, Ph.D., (then a postdoctoral student in Dr. Brennan's lab), took a closer look at a drug called TLM. Through genetic engineering, the researchers created strains of mycobacteria that produced an overabundance of two key enzymes needed for the first steps in mycolic acid manufacture. Although TLM readily kills normal *M. tb*, it had little effect on the mutants. The conclusion: TLM targets and disrupts one or both of these required enzymes, thus inhibiting mycolic acid formation.

Refinements to the picture of *M. tb's* cell wall construction continue to be made with an eye towards finding drugs capable of destroying the microbe's wall. Among the efforts is an NIAID-funded consortium joining researchers from NIAID's intramural program, Colorado State University, St. Jude Children's Research Hospital in Tennessee, GlaxoSmithKline in Pennsylvania, and the University of Newcastle Upon Tyne in England.

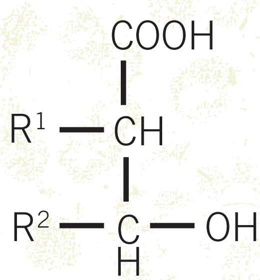


Credit: National Institute of Allergy and Infectious Diseases

STRUCTURE OF MYCOLIC ACIDS

Mycolic acids are fatty acids with a high molecular weight. They have a long hydrocarbon chain in the R^1 position of the molecule (with 60-90 carbon atoms).

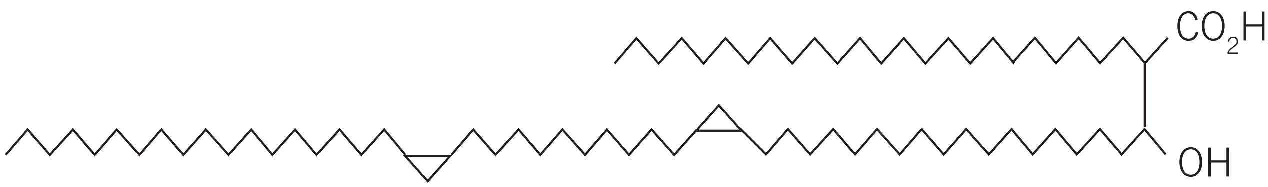
There are three types of mycolic acids in the cell membrane of *M. tb*: alpha-, methoxy-, and keto-. The names correspond with the group that is in the R^2 position.



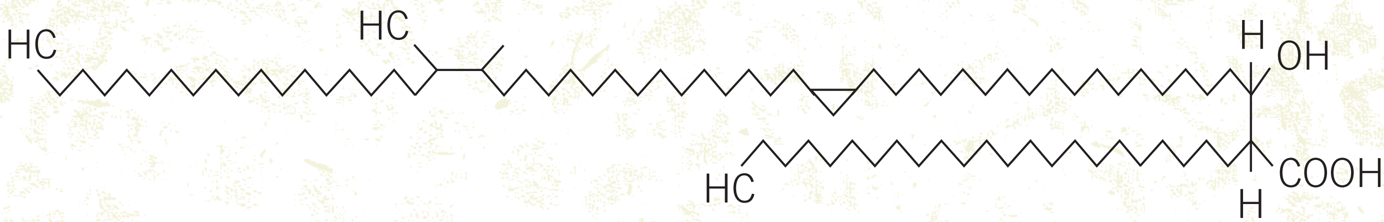
Mycolic acid

R^1 and R^2 = hydrocarbon chains (C_{20}–C_{60})

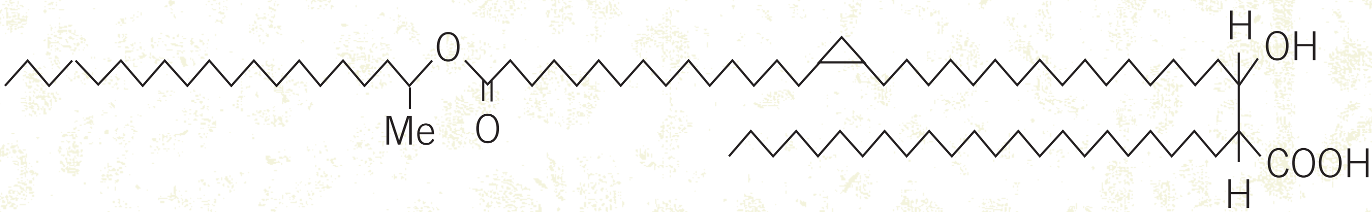
Alpha-mycolic acid



Methoxy-mycolic acid



Keto-mycolic acid



MOLECULAR MODEL ACTIVITY

1. Work with your lab partner to build a molecular model of each of the three types of mycolic acids present in the cell membrane of *M. tb.* Show the models to your teacher and obtain their sign-off below:

2. Draw the chemical structure of the alpha-, methoxy-, and keto- types.

3. Using your understanding of functional groups, how do you think the functional groups on the end of various forms of mycolic acid affect the permeability of the membrane?

4. Write a conclusion statement that summarizes our examination of *M. tb* today. Your statement should include the following:

- Summarize the activities you participated in during class today.
- Describe a misconception you had about this topic and how your knowledge of the concept has changed due to the activities today.
- Explain how your new knowledge can be applied to other concepts or ideas within science.

LESSON 3:
TB Article Review

LESSON

Activity Time: 60 minutes

In this lesson, students will critically read articles about tuberculosis. The instructor will review technical reading skills including, but not limited to, interpreting graphics, using contextual clues, and building technical vocabulary. Students will select, read, and critically review one scientific article about tuberculosis.

This interdisciplinary lesson can be used in chemistry classrooms studying any global health disease. The lesson can also be used in social studies and math classrooms with articles that focus on history or mathematics content. The suggested articles for this lesson are focused on tuberculosis, but the lesson could be adapted for use with other articles.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Technical Reading:** Technical reading skills are a necessity for understanding literature from specific subject areas.

Essential Question:

- How do you read subject-specific literature?

Learning Objectives:

Students will know…

- Technical reading skills, such as interpreting graphics, using contextual clues, and building technical vocabulary, are crucial to understanding subject-specific literature.

Students will be able to…

- Read subject-specific literature.
- Write an appropriate article review.

Vocabulary:

- Technical reading
- Contextual clues

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Science 9-12 APPF** It is important for all citizens to apply science and technology to critical issues that influence society.
- **Reading 1.2.2** Apply strategies to comprehend words and ideas.
- **Reading 2.1.4** Apply comprehension monitoring strategies for informational and technical materials, complex narratives, and expositions; use prior knowledge.
- **Reading 2.1.5** Apply comprehension monitoring strategies for informational and technical materials, complex narratives, and expositions; synthesize ideas from selections to make predictions and inferences.
- **Reading 2.1.7** Apply comprehension monitoring strategies for informational and technical materials, complex narratives, and expositions; determine importance and summarize the text.
- **Reading 3.1.1** Analyze web-based and other resource materials (including primary sources and secondary sources) for relevance in answering research questions.

Common Student Preconceptions:

- Technical reading is the same as reading in general.
- Scientific articles are too difficult to understand; only scientists can make sense of them.

TEACHER PREPARATION

Materials:

- Computer and projector
- Articles (1 per student) (See Resources section for suggested articles)
- *Guidelines for Critical Analysis* Handout (1 per student)
- *Article Review Scoring Rubric* Handout (1 per student)

Preparation:

- Preview the list of suggested articles to determine if they are appropriate for your students' reading level. If needed, located additional articles.
- Make copies of Student Handouts and articles (unless students will be finding articles on their own).

PROCEDURE

Hook

1. Ask students: What do you know about the differences in scientific papers, novels, and historical documents?
2. Show students the tutorial at the following website:

   How to Read a Scientific Paper Tutorial
   http://www.lib.purdue.edu/phys/inst/scipaper.html
3. Discuss why it is important to know how to read a scientific paper and what makes a scientific paper different from other types of writing.

Preconceptions

4. Ask students to share some of the strategies they use when struggling to read a particularly complicated article or book. What strategies do they use? Make a list of students' strategies on the board. When looking at scientific papers, what reading skills might you need?

Activity

5. Discuss strategies for technical reading, such as interpreting graphics, using contextual clues, and building technical vocabulary. The Resources section provides a few websites that may be helpful in preparing for this discussion.
6. Pass out copies of the *Guidelines for Critical Analysis* Handout, one per student. Review the handout. Point out any strategies that students' had already added to the list on the board.
7. Pass out copies of the *Article Review Rubric* Handout, one per student. Review the expectations for the task and how it will be graded.
8. Students can be challenged to locate their own articles, or you can provide articles for them to use for their reviews.
9. Discuss when article reviews will be due.

Wrap-Up

10. When students have completed their article reviews, ask each student to share with the class a 1-2 sentence summary of their article. Their summary should include the article title, periodical name, and a brief description of the article.

STUDENT ASSESSMENT

Assessment Opportunities:

- The discussion about reading strategies provides an opportunity to gauge students' preconceptions about technical reading.
- Students will complete an article review on a selected TB article.

Student Metacognition:

- Students will write about what they have learned from reading the article and about their impression of the article.

Scoring:

- The assignment can be scored using the provided Scoring Rubric.
- Participation points can be assigned for sharing article summaries with the class.

EXTENSION ACTIVITIES

Extension Activities:

- Article reviews can be extended to a monthly assignment, with one article review assigned each month.

Adaptations:

- Lower-level readers may need additional instruction on reading strategies.
- Articles can be chosen to accommodate your students' reading levels.
- If this lesson is being used in a social studies classroom, ask students to provide bibliography information in MLA style.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Technical Reading Resources:

Encouraging Active Reading in the Science Classroom
Science Teacher, NSTA, October 2002
http://science.nsta.org/enewsletter/2004-07/tst0210_56.pdf

How to Read a Scientific Research Paper—A Four Step Guide
http://hampshire.edu/~apmNS/design/RESOURCES/HOW_READ.html

How to Read a Scientific Paper Tutorial
http://www.lib.purdue.edu/phys/inst/scipaper.html

Suggested Articles Sources:

MedlinePlus Tuberculosis Articles
Look at the "Research" pages.
http://www.nlm.nih.gov/medlineplus/tuberculosis.html

New England Journal of Medicine Tuberculosis Articles
http://content.nejm.org/cgi/collection/tuberculosis

Tuberculosis Journal
http://www.tuberculosisjournal.com/

Name:____________________ Date:__________ Period:________

HANDOUT

Guidelines for Critical Analysis

PURPOSE

We live in a world that is increasingly dependent upon technology. The knowledge acquired through the scientific study of the world in which we all live provides the means to create this technology. By reading and analyzing magazine and/or newspaper articles from a variety of sources and on a variety of topics, it is your instructor's hope that you will become more aware of the role of science in your life, and become better at being able to find, summarize, and analyze information. Together these skills should provide you with the tools to be a better informed and more thoughtful citizen.

ASSIGNMENT

Choose an article from a newspaper, periodical, or from Proquest that is science-related. Some periodicals that can be used are *Discover, Scientific American*, and *Seed*. However there are many more periodicals that you can choose from. You can get help from the school librarian to help you find the other periodicals.

Using the "Guidelines for Critical Analysis" shown below, analyze the article. *Enjoy your reading!*

GUIDELINES

1. *Bibliography:* Using APA bibliographic style, provide the name of the author, article title, publication name, page numbers, and date of the article.
2. In *four sentences or less:* What do you think the author's purpose was for writing this article? This describes the broad picture of the article, not the specific details.
3. *What are the pertinent and unique facts that you learned?* A good suggestion is to jot down on index cards the main ideas, new information, or questions you might have for each paragraph or section as you read. Then describe, in your own words, the new concepts that you learned.
4. *What questions are raised by this article?* See if you can come up with questions for the paragraphs or sections to include on your index cards. (Do you question the facts or lack of facts given in the article? Its scientific validity? Ethics? Is further research required?).
5. Identify *one major science concept or principle* that was mentioned in the article and explain its connection to the subject. (Such as natural selection, conservation of energy law, extinction, biological magnification, pollution, pH, oxidation, momentum, etc.).
6. *Share your opinion*. Write a paragraph telling your opinion of the article, explaining why you either liked or disliked it.
7. *Vocabulary.* Create a list of new words you learned in the article – with definitions for these words.
8. Attach the original article, or a printout showing the website source and date printed, for the article that you analyzed.
9. Attach a blank copy of the *Article Review Rubric* to the back of your assignment for your teacher to use to grade it.

Name:________________________ Date:__________ Period:________

Article Review Rubric

HANDOUT

	+5	+4	+3	+2	+1	0
General Outline	Clear, written in your own words; at least 3 sentences	Clear, written in your own words, but incomplete	Not clear or some of the phrases are copied or not in the article	Most of the phrases are copied	Not clear and is incomplete	The article outline is missing
Your Opinion	Clear point of view; at least 3 sentences; relates to the article; tells why you have this opinion	Clear point of view; relates to the article; tells why you have this opinion	Clear point of view; varies in part from the article; tells why you have this opinion	Point of view is not clear or varies in part from the article	Point of view wavers and is not clear	The opinion paragraph is missing
Learned Concept	Clear; in your own words; at least 3 sentences	Clear; short or some phrases are wrong	What you say is not clear	Merely a list of what you learned	A list with copied phrases	This paragraph is missing
Grammar and Spelling	No errors in grammar or spelling in the analysis	1 to 4 errors in grammar and/or spelling in the analysis	5 to 8 errors	9 to 12 errors	13 to 16 errors	More that 16 errors
New Words	5 or more new words with correct definitions	4 new words with correct definitions	3 or 4 new words with definitions	2 or 3 new words with at least one definition	1 or 2 new words with no correct definitions	New word section is not done

Final Score: ____________

LESSON

LESSON 4: Mg's per Kg's

Activity Time: 90 minutes

In this lesson, students will determine the appropriate amount of antibiotic to give to various member of their family in order to maintain a consistent mg/Kg concentration. This activity will provide students with the understanding that dosage varies between individuals in order to maintain consistent concentrations.

This lesson complements the study of concentration. Before delivering this lesson, students need to have a basic understanding of conversions between the English system and the metric system. Students also should have been introduced to the concept of concentration.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Concentration:** Concentration is effected by the amounts of solute and solvent.

Essential Question:

- How much antibiotic must be given to ensure that each member of a family has the same mg/Kg concentration?

Learning Objectives:

Students will know…

- All substances can be poisonous if the dose is large enough.
- Dose calculations are important for preventing overdoses and for ensuring that the effective concentration of a medication is achieved.

Students will be able to…

- Convert units from lbs to Kg.
- Calculate mg/Kg concentration.
- Determine the amount of a solute needed in order to achieve a certain concentration.

Vocabulary:

- Antibiotic
- Concentration
- Dose
- Molality (mol/Kg)
- Molarity (mol/L)
- Poison
- Solute
- Solvent

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Science 9-12 APPC** Choosing the best solution involves comparing alternatives with respect to criteria and constraints, then building and testing a model or other representation of the final design.
- **Science 9-12 APPD** The ability to solve problems is greatly enhanced by use of mathematics and information technologies.

Common Student Preconceptions:

- The same amounts of medications can be given to anybody.
- Medications have the same concentration of active ingredient.

TEACHER PREPARATION

Materials:

- 1000-mL beaker (4)
- 400-mL beaker (1)
- 100-mL beaker (1)
- Food coloring
- *Family Prescription* Handout (1 per student)
- Teacher Answer Key for Student Handout

Preparation:

- Fill each beaker with water to measured capacity.
- Make copies of Student Handout.

PROCEDURE

Hook

1. Set out three different sized beakers (1000-ml, 400-ml, and 100-ml), filled with water to measured capacity, on the lab bench. If possible, place a piece of white paper behind the beakers to make a backdrop. Explain that each beaker represents a different sized person: an infant, a child, and an adult.
2. Place five drops of food coloring into each beaker, explaining that the dye represents a chemical that is ingested or injected into the body.
3. Have students do a Think-Pair-Share answering the following questions:
   - What differences did the students observe?
   - What response would each person have to the same dose of the chemical?
   - In this scenario, what is the solute and what is the solvent?
4. Next, place three 1000-ml beakers, filled with water to measured capacity, on the lab bench. Explain that the beakers represent three individuals, all of whom are about the same body size.
5. Place 5 drops of food coloring in the first beaker, 10 drops in the second beaker, and 15 drops in the third.
6. Have students do a Think-Pair-Share answering the following questions:
   - What differences did the students observe?
   - What response would each person have to the different doses of the chemical?

Preconceptions

7. Write the following quote on the board:

   "All substances are poison; there is none which is not a poison. The right dose differentiates a poison from a remedy." ~Paracelsus, 1493-1541
8. Ask students what they think the quote means. How can all things be poisonous? Can water be poisonous? Sugar? Salt?
9. Discuss the idea of how much of a substance is needed in order to do the same thing for people of similar and different body sizes.
10. Return to the Paracelsus quote and explain that oftentimes the quote is simplified to "the dose makes the poison."
11. Ask students for their definitions of dose and poison.

Activity

12. As needed, review molarity and concentration with students so that they are prepared for the activity and able to do the necessary unit conversions and calculations.
13. Introduce the definition of dose as the following concentration: mg per Kg of body weight.
14. Pass out copies of the *Family Prescription* Handout, one per student. Review the handout so that students understand the learning task.
15. Encourage students to work with their lab partners to complete the handout.

Wrap-Up

16. Encourage students to share their results with the class.

STUDENT ASSESSMENT

Assessment Opportunities:

- Students will share the results of their calculations with the class. These will be compared to other classmates' families and discussed if there are major differences.
- Using the data, students will create a dosing graph that shows amount of antibiotic compared to amount of body weight.

Student Metacognition:

- Students will be able to explain their results to their classmates and receive some feedback (i.e. another classmate has a family member of the same mass but a different dosage amount).
- Students are asked to share their definitions of dose and poison.

Scoring:

- The handout can be scored by checking the accuracy of student's calculations using the provided Teacher Answer Key.

EXTENSION ACTIVITIES

Extension Activities:

- Discuss the types of first-line and second-line antibiotics used to treat tuberculosis infections.

Adaptations:

- Instead of doing a demonstration of the dose/response activity, hand out materials to each lab station and ask students to complete the activity themselves.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Readings in the Introduction to Global Health section of the curriculum.

Resources:

Dose/Response Demonstration
A Small Dose of Toxicology
http://www.asmalldoseof.org/dose_resp_demo.swf

Credit:

Tylenol Formula and Dosage Chart.
Available from: http://www.tylenol.com/page.jhtml?id=tylenol/children/subchild.inc.

Name:____________________________ Date:___________ Period:________

Family Prescription

HANDOUT

PART ONE: CHILDRENS FORMULA AND DOSAGE CHART

You are babysitting your four year old niece Carmen over the weekend while your aunt and uncle are out of town.

Unfortunately, little Carmen is sick with an ear infection and a cold. Your uncle left a note telling you to give her some pain-reliever and cough medicine every four hours and to look for the medicine in a basket inside the kitchen cabinet. You pull down the basket and find a bottle of cough syrup along with three types of children's acetaminophen: infant drops, liquid syrup, and chewable tablets. Hmm….which acetaminophen product should you give Carmen, and how big of a dose should she take?

At the bottom of the basket, you find a crumbled piece of paper with a table on it. The table is labeled "Children's Formula and Dosage Chart" and appears to tell you how much of each product to use with a child, based on age and weight. *Perfect*, you think, before realizing that several parts of the table have been blurred by an old coffee stain.

You take Carmen into the bathroom and ask her to stand on the scale. The scale flashes her weight: 38.5 lbs. *Uh-oh*, you think. The chart uses Kilograms for weight. Looks like you are going to have to do some calculations to figure out what medicine formula and dosage to give Carmen.

Directions:

1. Convert Carmen's weight into Kilograms.
2. Complete the missing parts of the table.

Weight (Kg)	Infant Drops 80 mg/0.8 ml	Children's Liquid Syrup 160 mg/5 ml	Children's Chewable Tablets 80 mg each
10.9-15.9 Kg	1.6 ml	5 ml	2 Tablets
16.3-21.3 Kg	Not recommended		
21.8-26.8 Kg	Not recommended		
27.2-32.2 Kg	Not recommended		
32.7-43.1 Kg	Not recommended		

3. Explain which medicine formula and dosage you decided to give Carmen and why.

So you figured out the pain-reliever, but the note from your uncle also suggested that you give Carmen some cough syrup. Following the dosage instructions on the label, you give Carmen 15 ml of the cherry-flavored syrup. As you're wiping up a drip from the side of the bottle, you notice that along with the cough suppressant drug, the medicine also contains acetaminophen.

Wait, you think. *I've seen on the news that little kids can get really sick if they have too much acetaminophen*. You sit down at the computer and type "acetaminophen overdose" into the search engine. The following warning pops on the screen:

Acetaminophen Overdose Information

Age 5 and younger. Seek emergency care if a child age 5 or younger ingests 91 mg of acetaminophen per pound of his or her weight (200 mg/Kg) in a 24 hour period.

Age 6 and older. Seek emergency care if a child age 6 or older ingests 91 mg of acetaminophen per pound of his or her weight (200 mg/Kg) in a 24 hour period or ingests a total of 10,000 mg or more of acetaminophen.

Directions:

4. Keeping in mind the acetaminophen you already gave her for the earache pain, how much acetaminophen has Carmen ingested per Kg of body weight? (mg/Kg). According to the label, the concentration of acetaminophen in the cough syrup is 125 mg/5 ml.

5. Is it enough to cause an overdose? If not, how much more cough syrup could Carmen have today?

PART TWO: FAMILY DOSAGE GRAPH

Turns out Carmen didn't just have a minor cold like her parents thought; she had a very infectious bacterial infection in her respiratory track. Not only did you get sick with the same infection, but you brought the "bug" home with you and everyone in your family has come down with the same bacterial infection.

Your family doctor wrote a prescription for everyone in your family to take an antibiotic at a concentration of 5 mg per Kg of body weight, but everyone in your family has a different weight. How much of the antibiotic should each person take so that the concentration of the drug stays the same in each person's body?

Using your family, you will develop a graph that shows the relative amount of antibiotic dosage to give to individuals with varying body masses.

Directions:

1. Write down the name of all your family members, including yourself, on the table.
2. Estimate the weight of each family member. If needed, convert each person's weight from lb to Kg.
3. Determine the amount of antibiotic needed for each family member, keeping the concentration of antibiotic consistent at 5 mg per Kg of body weight.

Name	Body Mass (kg)l	Amount of Antibiotic (mg)	Calculation (mg/Kg)	Concentration (mg/Kg)
Example	*100 Kg*	*500 mg*	*500 mg/100 Kg*	5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg
				5 mg/Kg

4. Using the above information, create a graph that shows the dosage curve by weight.

PART THREE: TUBERCULOSIS MEDICATIONS

Several weeks after treatment for the bacterial infection, Carmen started coughing up blood. Her doctor suspected that she might have contracted tuberculosis (TB). After some extensive testing, the doctor diagnosed Carmen with TB. Her doctor prescribed a combination of drugs (isoniazid, rifampicin, pyrazinamide, and ethambutol) for her to take.

Since Carmen has recently been in contact with you, her doctor is suggesting that you and your family get tested as well. Being curious, you want find out how much of each drug is necessary in order to receive the same dosage as Carmen was prescribed. Using your family members as the example, develop a graph that shows the relative amount of antibiotic dosage to give to individuals with varying body masses.

Directions:

1. Write down the name of all your family members, including yourself, on the table.
2. Estimate the weight of each family member. If needed, convert each person's weight from lb to Kg.
3. Determine the amount of antibiotic needed for each family member, keeping the concentration of antibiotic consistent at the prescribed mg per Kg of body weight. (Each table has an example showing the prescribed amount)

Isoniazid (3.3 mg/Kg)

Name	Body Mass (kg)l	Amount of Antibiotic (mg)	Calculation (mg/Kg)	Concentration (mg/Kg)
Example	*90 Kg*	*300 mg*	*300 mg/90 Kg*	*3.3 mg/Kg*

4. Using the above information, create a graph that shows the dosage curve by weight.

Rifampicin (6.6 mg/Kg)

Name	Body Mass (kg)l	Amount of Antibiotic (mg)	Calculation (mg/Kg)	Concentration (mg/Kg)
Example	*90 Kg*	*600 mg*	*600 mg/90 Kg*	*6.6 mg/Kg*

5. Using the above information, create a graph that shows the dosage curve by weight.

Pyrazinamide (16.3 mg/Kg)

Name	Body Mass (kg)l	Amount of Antibiotic (mg)	Calculation (mg/Kg)	Concentration (mg/Kg)
Example	*90 Kg*	*1500 mg*	*1500 mg/90 Kg*	*16.6 mg/Kg*

6. Using the above information, create a graph that shows the dosage curve by weight.

Ethambutol (13.3 mg/Kg)

Name	Body Mass (kg)l	Amount of Antibiotic (mg)	Calculation (mg/Kg)	Concentration (mg/Kg)
Example	*90 Kg*	*1200 mg*	*1200 mg/90 Kg*	*13.3 mg/Kg*

7. Using the above information, create a graph that shows the dosage curve by weight.

Family Prescription

PART ONE: CHILDREN'S FORMULA AND DOSAGE CHART

	Weight (Kg)	Infant Drops 80 mg/0.8 ml	Children's Liquid Syrup 160 mg/5 ml	Children's Chewable Tablets 80 mg each
24 - 35 lbs	10.9-15.9 Kg	1.6 ml	5 ml	2 Tablets
36 - 47 lbs	16.3-21.3 Kg	Not recommended	7.5 ml	3 Tablets
48 - 59 lbs	21.8-26.8 Kg	Not recommended	10 ml	4 Tablets
60 - 71 lbs	27.2-32.2 Kg	Not recommended	12.5 ml	5 Tablets
72 - 95 lbs	32.7-43.1 Kg	Not recommended	15 ml	6 Tablets

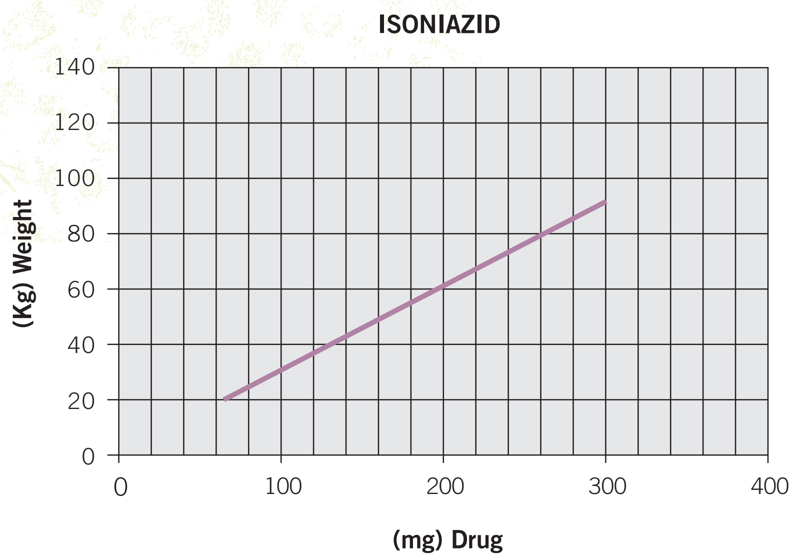
PART TWO: FAMILY DOSAGE GRAPH

Answers for the table depend on body weight of family members.

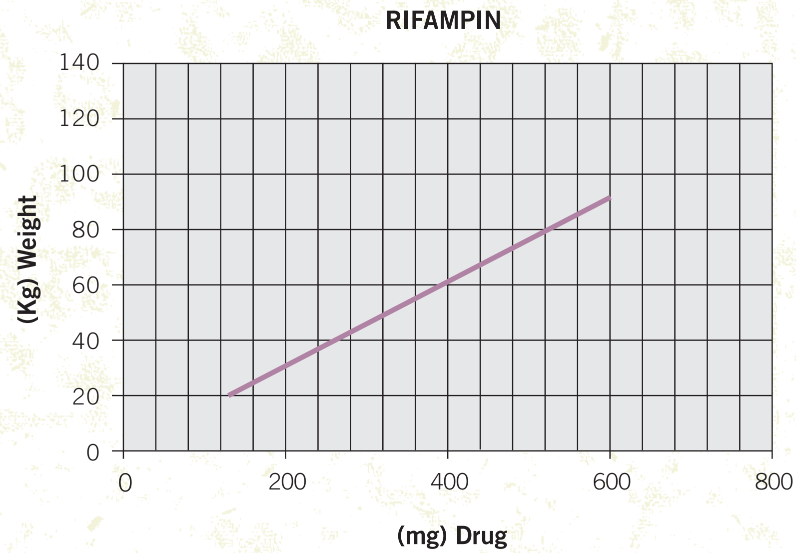
PART THREE: TUBERCULOSIS MEDICATIONS

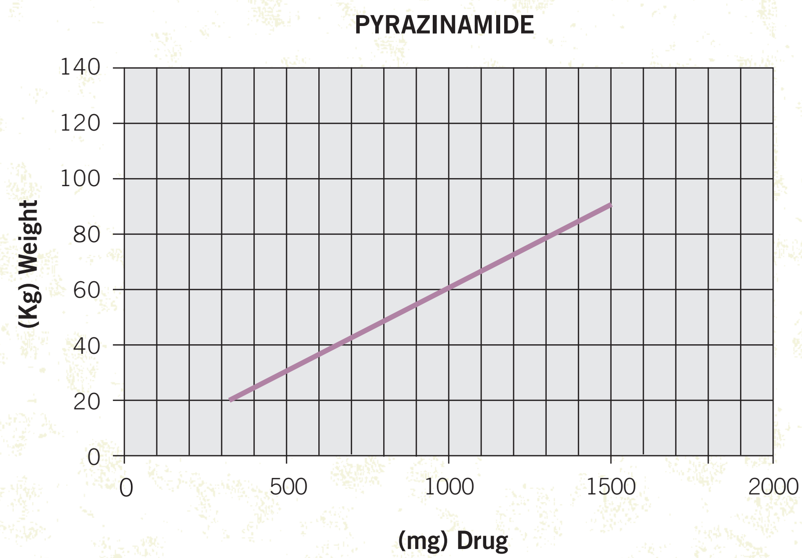
Answers for the table depend on body weight of family members.

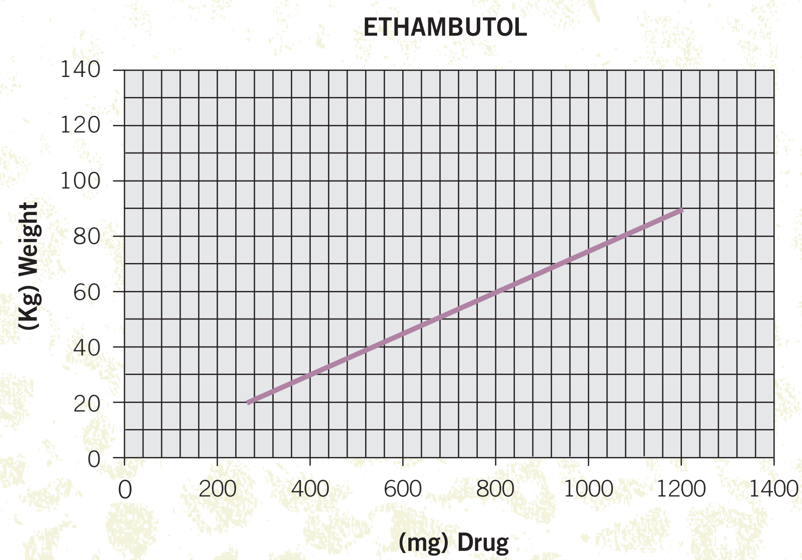
Sample dosing charts are provided.



KEY


RIFAMPIN
140
120
100
80
60
40
20
0
(Kg) Weight
0
200
400
600
800
(mg) Drug


PYRAZINAMIDE
140
120
100
80
60
40
20
0
(Kg) Weight
0
500
1000
1500
2000
(mg) Drug


ETHAMBUTOL
140
120
100
80
60
40
20
0
(Kg) Weight
0
200
400
600
800
1000
1200
1400
(mg) Drug

LESSON

LESSON 1: Historical Perspectives of TB

Activity Time: 250 minutes (five 50 minute class periods)

In this lesson, students will explore the impact of sanatoriums on society through several different perspectives. Each student will be assigned a perspective (medical professional, political leader, or TB patient). Students will research how sanatoriums came to be, the conditions of the sanatoriums, and successes and failures of the sanatoriums in terms of curing TB. Once research is complete, students will write a narrative for the Library of Congress to keep on file that tells their story from their perspective (similar to the slave narratives).

This lesson can be taught in conjunction with other lessons examining historical events that occurred between the 1910s and 1970s.

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Historical Perspectives:** Students will investigate periods in U.S. history through different perspectives.

Essential Question:

- Was the sanatorium movement effective in terms of eradicating tuberculosis in the early 1900's?

Learning Objectives:

Students will know…

- Sanatoriums played an important role in controlling tuberculosis in the 1910s-1970s.
- People played various roles while attempting to control tuberculosis.
- An understanding of the physical conditions of sanatoriums as well as the treatment of patients is helpful to fully understand the role that sanatoriums played in people's lives.

Students will be able to…

- Empathize with the different perspectives related to tuberculosis (medical professional, political leaders, and tuberculosis patients).
- Write a Tuberculosis Narrative for the Library of Congress.

Vocabulary:

- Common good
- Consumption
- Eradication
- Infectious disease
- Quarantine
- Sanatorium
- Tuberculosis
- White plague

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Civics 1.4.1** Analyzes and evaluates ways of influencing local, state, and national governments to preserve individual rights and promote the common good.
- **History 4.2.2** Analyzes how cultures and cultural groups have shaped the United States (1890 – present).
- **History 4.3.1** Analyzes differing interpretations of events in U.S. history (1890—present).
- **History 4.3.2** Analyzes multiple causes of events in U.S. history, distinguishing between proximate and long-term causal factors (1890—present).
- **History 4.4.1** Analyzes how an understanding of United States history can help us prevent problems today.

- **Social Studies Skills 5.2.2** Evaluates the validity, reliability, and credibility of sources when researching an issue or event.
- **Social Studies Skills 5.3.1** Creates and articulates possible alternative resolutions to public issues and evaluates these resolutions using criteria that have been identified in the context of a discussion.
- **Social Studies Skills 5.4.1** Evaluates and interprets other points of view on an issue within a paper or presentation.

Common Student Preconceptions:

- TB only affects the poor (Students will be assigned different social/ethnic roles to research).
- TB does not affect people in the U.S. anymore (Students will analyze TB in the decades to come).

TEACHER PREPARATION

Materials:

- TV and DVD player
- Computer with internet and projector
- Computer lab (for research time)
- *On the Lake* DVD
- *Circle Map Activity* Handout (1 per student)
- *Introduction to Task* Handout (1 per student)
- *Role Assignments* Handout (1 per student)
- *Note-Taking Guide* Handout (1 per student)
- *Suggested Resources for the TB Narrative* Handout (1 per student)
- *Rubric for Tuberculosis Narrative* Handout (1 per student)
- White board or chart paper
- Sticky notes

Preparation:

- Break students into three groups that mix students with IEP's, ELL backgrounds, and advanced placement in order to ensure student comprehension.
- Check listed internet resources to make sure that they are still available.
- Pre-read the student materials and preview movie clips.
- Make copies of Student Handouts.

PROCEDURE

Hook

1. Show students the World Clock at the following website, choosing both the "Death" and "Illness" options:

   World Clock
   http://www.poodwaddle.com/clocks2.htm
2. Ask students to observe rates of infections and the different types of disease shown on the World Clock. Show students the rates for TB and go through the *now, day, week, month*, and *year* tabs.
3. Ask students to find the percentage of people on earth that are infected with tuberculosis to date this year. Discuss this number with students, asking them to think about why we care.

Preconceptions

4. Pass out copies of the *Circle Map Activity* Handout, one per student. Draw a circle map on the board with the word "tuberculosis" in the middle.
5. Ask students to do a Think-Pair-Share for what they know about tuberculosis. First, give students one minute to write everything they know about the word in the circle. Then give them one minute to discuss with a partner. Finally, ask the pairs to share their thoughts on tuberculosis as you collect their responses on the circle map you drew on the board. As the lesson progresses, return regularly to the class' circle map, correcting misconceptions and adding new information.

Day One Activity

6. Introduce the learning task by telling students about the slave narratives created in the 1930's to document the experiences of former slaves in their old age. Similar to these slave narratives, their task is to write a fictional, but well-researched, Tuberculosis Narrative depicting either a medical professional, political leader, or tuberculosis patient.
7. Assign roles to each student in this ratio: 25% Medical Professionals, 25% Political Leaders, 50% Tuberculosis Patients and assign different races/social classes to students. (Gifted students should be given the roles of medical professionals and/or political leaders as information may be less accessible for these roles).
8. Pass out copies of the *Introduction to Task* Handout and *Role Assignments* Handout to each student. Review the handouts.
9. As a homework assignment, challenge each student to develop the name, age, sex, and occupation for their character.

Day Two Activity

10. Break students into groups, according to their assigned roles. You will have one group of Political Leaders, one group of Medical Professionals, and two groups of TB Patients. Ask each student to introduce their character to their small group.
11. Pass out copies of the *Note-Taking Guide* Handout, one per student. Show students the first 30 minutes of the **On the Lake** DVD. While watching the video, have students take notes on the handout. They can also add information to their circle maps as they watch the movie.
12. Give each group five minutes to compare notes taken during the movie that will help them develop their character's perspective.
13. As a homework assignment, challenge students to develop at least five questions they will need to find answers to in order to develop a strong narrative.

Day Three Activity

14. Begin class by asking students to meet in their small groups. Ask each student to share the homework questions with the group. Then, challenge each small group to develop a new list of questions that they will need to answer for their research.
15. Pass out copies of the *Suggested Resources for the TB Narrative* Handout, one per student. Provide research time and computer access for the remainder of the class period
16. Hand out Exit Tickets with the following task:
    - Write down 2-3 facts you have learned through your research today.

Day Four Activity

17. Lead a class brainstorm, creating a list of components that make up a strong narrative.
18. Pass out copies of the *Rubric for Tuberculosis Narrative* Handout, one per student. Review the expectations for the learning task and answer any student questions. Explain that the narratives will be due at the beginning of class on day five.

Day Five Activity

19. Collect students' Tuberculosis Narratives. Cover up student names from the narratives in order to keep them anonymous.
20. Create new small groups, dividing up students so that there is a representation of each role in the small groups. Hand out a packet of narratives and a pad of sticky notes to each group.
21. Within each small group, ask students to read the narratives and discuss the "winner" in each group, keeping in mind the criteria established by the rubric. Have students write on sticky notes both positive and negative comments that will help each writer strengthen their work.
22. Read aloud the winning narratives from each group to the class. Together, vote on the "ultimate winner."

Wrap-Up

23. Watch the last 15 minutes of the **On The Lake** DVD. Ask students to take notes on their circle maps. Re-visit the class circle map, making additions or changes so that the map reflects students' learning throughout the lesson.

STUDENT ASSESSMENT

Assessment Opportunities:

- The class and small group discussions, along with the Circle Map activity, provide opportunities to gauge students' preconceptions about TB, and their growing knowledge about the sanatorium movement.
- The homework assignments and Exit Tickets provide opportunities to assess student learning at the end of each class session.
- The written Tuberculosis Narratives can be graded.

Student Metacognition:

- Students record their preconceptions about tuberculosis on a Circle Map.
- Students are asked to share their thoughts in small group discussions.

Scoring:

- Points can be assigned for completion of homework assignments and Exit Tickets.
- Participation points can be assigned for contributing to class discussions and group work.
- Score each student's Tuberculosis Narrative using the provided Scoring Rubric. Also, return each narrative to its author, including the sticky notes with peer comments.

EXTENSION ACTIVITIES

Extension Activities:

- This lesson could be used to fulfill the requirements of the *Constitutional Issues* Classroom-Based Assessment (CBA). Students could use the Constitution to defend the use of quarantines for controlling the spread of infectious diseases.
- Share some of the slave narratives from the Library of Congress website to help inspire students to write their Tuberculosis Narratives.
- Show a clip from the HBO documentary *Unchained Memories*. Then, have students act out their Tuberculosis Narratives while being videotaped.

Adaptations:

- Partner ELL and SPED with students that communicate effectively to give them an opportunity to learn verbally from each other.
- Gifted students can be given roles that may be a little more difficult such as Sanatorium Director, Director of the local county Department of Health, Director of the Center for Disease Control, or President of the U.S.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

The documentary **On the Lake** provides background information on the sanatorium movement in the U.S. It is important to understand that there were many different experiences that developed throughout the sanatorium movement – some bad and some good. While tuberculosis did not discriminate, the treatment options available did. Racial and socio-economic status influenced who, when, and where patients were treated.

Resources:

Born in Slavery: Slave Narratives from the Federal Writers' Project, 1936-1938
from Library of Congress
http://memory.loc.gov/ammem/snhtml/

American Slave Narratives: An Online Anthology
University of Virginia
http://xroads.virginia.edu/~hyper/wpa/wpahome.html

On the Lake: Life and Love in a Distant Place DVD
Midway Pictures, 2009
http://www.onthelakemovie.com/

Unchained Memories: Readings from the Slave Narratives DVD
HBO Documentary Films, 75 minutes" Optional
http://www.hbo.com/docs/programs/unchained_memories/

Credit:

"Charity Anderson." *The American Slave*, Supplement Series 1, Vol. 1: 13-16;
see also *The American Slave*, Vol. 6: 12-14.
Accessed August 13, 2009 from http://xroads.virginia.edu/~hyper/wpa/anderso1.html.

Name:_____________________________ Date:___________ Period:________

HANDOUT

Introduction to Task

Tuberculosis Narratives

One of the most valuable resources in American history is the Slave Narratives collected from 1936 to 1938 by the Works Progress Administration (WPA). The interviewers collected firsthand accounts from over 2,300 former slaves. The narratives depicted slave experiences from the plantations, cities, and/or small farms throughout the United States. These personal stories captured the depth and texture of the American slave from servitude to emancipation and beyond. Slave narratives are currently stored in the Library of Congress.

Sample Narrative:

Charity Anderson
Mobile, Alabama
Interviewed by Ila B. Prine
Federal Writers' Project, Dist.2.
April 16, 1937.

Aunt Charity Anderson who claims to be one hundred and one years old, (101) was born at Belle's Landing, Monroe County, Alabama. Her white "Marster" was Mr. Leslie Johnson who kept a public wood yard at Belle's Landing on the Alabama River.

Aunt Charity now lives on St. Stephens Road, about one mile and a half north of Toulminville, a suburb of Mobile, Ala. She lives with a niece, in a very comfortable and modern four-room house.

Although her sight is impaired, and she is a little hard of hearing, her mind seems to be clear and her memory good. She is not able to leave the house, but with the aid of a stick, she manages to hobble around in the house. She quite often falls and recently had two severe falls, which left her with a scar on her forhead; otherwise she is a very nice old Mulotta darky. Fair of complexion and snow-white hair, which was neatly combed and braided at the back of her head. Having lost all teeth, she cannot eat solid food, but still is a tall, well proportioned woman.

Aunt Charity loves company and is delighted when any one comes to visit her, as she spends the day alone while her niece is away working. When asked if she did not get tired of staying alone in the house? She replied: "I has so much tr'uble gittin' up and down de steps, and tr'uble gittin' ober de groun', I Jes makes myse'f happy her, cause thank de Lord I'se on Zion's March".

Aunt Charity with gingham dress, which had yards of material in the skirt, and her black and white checked apron, white head rag, be-spectaled eyes, sitting in a rocking chair before a fire, sorting and folding clean rags, carried one back to the days of long ago, when she told of her happy life before the Civil War.

She said "Missy, peoples don't live now, and niggers ain't got no manners, and don't know nothin' about waitin' on white folks. I kin remember de days when I was one of de house servants. Dere was six of us in de ol' marster's house, me, Sarai, Lou, Hester, Jerry and Joe. Us didn't know nothin' but good times den. My job was lookin' a'ter de corner table whar nothin' but de desserts sat. Jo and Jerry were de table boys, and dey ne'ber touched nothin' wid dere hans', dey used de waiter to pass things wid. My! dem was good ol' days.

“My old Marster was a good man, he treated all his slaves kind, and took care of dem, he wanted to leave dem hisn chillun. It sho’ was hard for us older uns to keep de little cullered chillun out ob de dinin’ room whar ol marster ate, cause when dey would slip in and stan’ by his cheer, when he finished eatin’ he would fix a plate and gib dem and dey would set on de hearth and eat. But honey chile, all white folks warn ‘t good to dere slaves, cause I’se seen pore niggers almos’ tore up by dogs, and whipped unmercifully, when dey did’nt do lack de white folks say . But thank God I had good white folks, dey sho’ did trus’ me to, I had charge of all de keys in the house and I waited on de Missy and de chillun. I laid out all dey clos’ on Sat ‘dy night on de cheers, and den Sund’y mawnings I’d pick up all de dirty clos’, they did’nt hav to do a thing. And as for working in the field, my marster neber planted no cotton, I neber seed no cotton planted til’ a’ter I was free.

Source: The American Slave, Supplement Series 1, Vol. 1: 13-16; see also The American Slave, Vol. 6: 12-14. Taken August 13, 2009 from http://xroads.virginia.edu/~hyper/wpa/anderso1.html

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Your Task:

Just as the Slave Narratives were developed, your task is to develop a Tuberculosis Narrative. The political leaders charged with protecting the general public at the time, medical professionals racing to combat tuberculosis, and the people that were infected with tuberculosis and experienced life in the sanatoriums, are passing on without their stories being told. Through the eyes of your assigned perspective, you will write a Tuberculosis Narrative that captures the experiences of these people.

Name:______________________________ Date:___________ Period:________

Role Assignments

HANDOUT

POLITICAL LEADER

Use the following questions to guide your research:

1. What is your role in the tuberculosis epidemic of the early 1900's?

Political Leader (Specific role):

2. Provide more specific information about your role:

How old are you: Religion:

Male or Female: Hometown:

Race/ethnicity: Name:

3. What is your primary responsibility in terms of the tuberculosis outbreak?

4. What laws or policies will need to put into effect in order to protect the common good?

5. How will these laws/policies be enforced?

6. What steps will be taken to eradicate tuberculosis? (programs, policies, etc).

7. Develop at least five questions of your own that could be used to extend your research:

1.

2.

3.

4.

5.

8. List other questions gathered by your small group that you could incorporate into your narrative.

Name:_______________________ Date:__________ Period:________

Role Assignments

HANDOUT

TUBERCULOSIS PATIENT

Use the following questions to guide your research:

1. What is your role in the tuberculosis epidemic of the early 1900's?

Tuberculosis Patient (Specific role):

2. Provide more specific information about your role:

How old are you: Religion:

Male or Female: Hometown:

Race/ethnicity: Name:

3. What is your primary responsibility in terms of the tuberculosis outbreak?

4. How were you diagnosed?

5. What treatment options were you given?

6. Were there any long term effects in terms of your treatment?

7. Develop at least five questions of your own that could be used to extend your research:

1.

2.

3.

4.

5.

8. List other questions gathered by your small group that you could incorporate into your narrative.

Name:____________________________ Date:___________ Period:________

Role Assignments

HANDOUT

MEDICAL PROFESSIONAL

Use the following questions to guide your research:

1. What is your role in the tuberculosis epidemic of the early 1900's?

Medical Professional (Specific role):

2. Provide more specific information about your role:

How old are you:	Religion:
Male or Female:	Hometown:
Race/ethnicity:	Name:

3. What was your primary responsibility in terms of the tuberculosis outbreak?

4. What were the treatment options and the reasoning behind the treatments?

5. Was there a difference in treatment options based on class or ethnicity?

6. What actions were taken to finally "eradicate" tuberculosis?

7. Develop at least five questions of your own that could be used to extend your research:

1.

2.

3.

4.

5.

8. List other questions gathered by your small group that you could incorporate into your narrative.

Name:___________________________ Date:__________ Period:________

Circle Map

HANDOUT

Write down everything you know about tuberculosis in the circle below. Continue to refer to this map to add new information or delete misconceptions.

Tuberculosis

Name:_______________________ Date:__________ Period:________

Suggested Resource List
for the Tuberculosis Narrative

HANDOUT

Center for Disease Control and Prevention
http://www.cdc.gov/tb/

Washington State Department of Health
http://www.doh.wa.gov/cfh/TB/publications/WorldTBDay2009.pdf

World Health Organization
http://www.who.int/topics/tuberculosis/en/

American Lung Association
http://www.lungusa.org/site/c.dvLUK9O0E/b.23686/k.DE87/History.htm

History of TB Treatment
http://www.umdnj.edu/ntbc/tbhistory.htm

History of TB
http://www.nj.gov/health/cd/tbhistry.htm

On the Lake: Life and Love in a Distant Place
http://www.onthelakemovie.com/

Firland Sanatorium in Seattle
http://historylink.org

Trudeau Sanatorium in New Jersey
http://www.med.umich.edu/medschool/chm/influenza/trudeau.htm

Waverly Hill Sanatorium in Lousiville
http://whsmemorial.tripod.com/index.html

Arkansas State Tuberculosis Sanatorium
http://www.booneville.com/C-TB.htm

Sanatorium Patient's Personal Diary from the 1940's
http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1079536

Name:______________________ Date:__________ Period:_______

HANDOUT

Note-Taking Guide

As you watch the film *On the Lake*, take notes about the three roles listed below.
In particular, pay attention to information that will help you as you research your assigned role.

Medical Professional	Tuberculosis Patient	Political Leader

Name:_____________________________ Date:___________ Period:________

Rubric for TB Narrative

HANDOUT

	4	3	2	1
Focus on Assigned Role	Narrative relates to the assigned role and leaves reader with a clear understanding of their perspective.	Narrative slightly drifts away from the assigned role but the reader can still learn from the perspective.	Narrative drifts away from the assigned role and the reader does not learn much from the perspective.	Narrative does not relate to the assigned role and the reader learns very little from the perspective.
Personality of Character	Personality of the character is strong and knowledge of character is evident to the reader.	Personality of the character is fairly strong and knowledge of character is believable.	Personality of the character is limited and knowledge of character is not quite believable.	Personality of the character is not evident and no knowledge of character is apparent.
Creative Delivery	Many creative details are added that contribute to the readers enjoyment.	Few creative details are added that contribute to the readers enjoyment.	Creative details are added but distract from the narrative.	Little or no details were added leaving the reader with no imagination.
Sources	All sources are credible and cited correctly.	All sources are credible and most are cited correctly.	Most sources are credible and most are cited correctly.	Sources are not credible and not cited correctly.
Conventions	No grammatical, spelling, or punctuation errors.	Almost no grammatical, spelling, or punctuation errors.	Few grammatical, spelling, or punctuation errors.	Many grammatical, spelling, or punctuation errors.

LESSON

LESSON 2: TB Flight

Activity Time: 150-200 minutes (three to four 50 minute class periods)

In this lesson, students will use the *Constitutional Issues* CBA to answer the following question: "Should the United States Government have the right to quarantine infected individuals in order to protect the common good?"

STUDENT UNDERSTANDING

Big Idea & Enduring Understanding:

- **Individual Rights and Common Good:** Students will understand the delicate line between protecting the common good while also protecting the rights of individual citizens.

Essential Question:

- Should the government have the right to quarantine infected individuals in order to protect the common good?

Learning Objectives:

Students will know…

- The government has created policies in order to control tuberculosis.
- Economic, social, and political measures have been taken to protect individual rights while also protecting the common good from tuberculosis.

Students will be able to…

- Write a persuasive essay that meets the requirements of the *Constitutional Issues* CBA.
- Answer the Essential Question using tuberculosis as the guiding disease.

Vocabulary:

- Center for Disease Control (CDC)
- Common good
- Eradication
- Individual rights
- Infectious disease
- Quarantine

Standards Alignment:

This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):

- **Civics 1.1.1** Analyzes and evaluates the ways in which the U.S. Constitution and other fundamental documents promote key ideals and principles.
- **Civics 1.1.2** Evaluates how well court decisions and government policies have upheld key ideals and principles in the United States.
- **Civics 1.4.1** Analyzes and evaluates ways of influencing local, state, and national governments to preserve individual rights and promote the common good.
- **Social Studies Skills 5.2.2** Evaluates the validity, reliability, and credibility of sources when researching an issue or event.
- **Social Studies Skills 5.4.1** Evaluates and interprets other points of view on an issue within a paper or presentation.

Common Student Preconceptions:

- The government does not have the right to quarantine individuals based on "Land of the Free."

TEACHER PREPARATION

Materials:

- *Constitutional Issues CBA Rubric* (1 per student; from the OSPI website)
- *United States Constitution* (1 per student)
- "Officials Seek Links in Fugitive TB Patient Case" article (1 per student)
- "TB Traveler Hit With $1.3M Lawsuit" article (1 per student)
- "Lawyer in 2007 TB Scare Sues " article (1 per student)

Preparation:

- Discuss what a Classroom-Based Assessment (CBA) is and how they are used by the state and individual school to assess student learning.
- Pre-read materials to ensure accessibility for your students.
- Obtain the three articles and the CBA rubric from the respective websites (See Resources for website addresses). Make copies of these handouts.
- Arrange students in small groups that promote a positive learning environment.

PROCEDURE

Hook

1. Read aloud the falsified news article. Change the town name if needed.

...News Flash...

Toppewash (WA). Early this morning as the school bell rang, students from the rural town of Toppewash (616 students K-12) reported feeling congestion in the chest and fever. Later, the students began coughing up blood and the symptoms were being passed on through the student body at overwhelming rates. School officials reported these symptoms to the local health department. Health department officials then ordered the quarantine of all students until further notice. Twelve students are currently in serious condition and approximately 58 students have showed symptoms of the illness. Family members are anxious to connect with their children and are demanding answers, but school authorities have enlisted the help of the local police department to control the situation. Medical professionals are on scene. Updated information will be available soon.

2. Ask student for their reaction to the article. Is this legal? How do you think this disease surfaced? What do you think should happen next? What would happen if this was in our high school? How would you feel?

Preconceptions

3. Use the discussion of the falsified news report to elicit students' preconceptions about individual rights and the common good. You may want to record students' comments on chart paper for students to review throughout the lesson.

Day One Activity

4. Break students into small groups of 3-4 students.
5. Explain to students that they will be completing the *Constitutional Issues* CBA by examining a true story related to an infectious disease and air travel. Introduce the *Constitutional Issues* CBA and the steps needed to complete the activity. Take about 10 minutes to review the CBA documents from the OSPI website.
6. Pass out copies of the Reuters article "Officials Seek Links in Fugitive TB Patient Case," one per student. Have students discuss the article in their groups, in particular, the risks and actions taken by both the CDC and Mr. Speaker. Within their groups, challenge students to develop a list of questions that still linger about the incident, focusing their questions on protection of the common good and individual rights.

7. Pass out copies of the other two articles, “TB Traveler Hit With $1.3M Lawsuit” and “Lawyer in 2007 TB Scare Sues CDC.” Ask students to discuss the articles in their small groups.
8. Hand out an Exit Ticket with the following prompt:
   - Defend or criticize the actions of Andrew Speaker using at least two arguments.

Day Two Activity

9. Handout copies of the *United States Constitution*. Ask students to read the Preamble of the Constitution. Ask students to Think-Pair-Share at least two ideals/principles from the Preamble that relate to the “TB Flight” case.
10. Explain to students that for the CBA, they need to choose their own position in response to the following question:
    - Should the government have the right to quarantine infected individuals in order to protect the common good?”
11. Provide time and computer access for students to search for additional information that will help them defend their position. Some good places to begin researching include the websites for your local Health Department policies, the CDC, and the World Health Organization.
12. Hand out an Exit Ticket with the following prompt:
    - Defend or criticize the actions of Andrew Speaker using at least two arguments supported by at least one fact each.

Day Three Activity

13. Break students into small groups. Ask each student to share with their group members the information that they discovered through researching and suggested websites that are good sources of information.
14. Explain the learning task that students will complete in order to meet the requirements of the CBA. Students will write a persuasive letter to the editor of a newspaper, supported by research. Citations are required.
15. When students have completed their letters, ask them to trade with a partner and peer-edit the letters. Provide time for students’ to revise their letters.

Wrap-Up

16. Collect and score all letters.
17. Remove the students’ names from the letters. Hand a packet of student letters to small groups of students. Ask students to read the letters and vote on the best one in their group. Read the “winners” aloud and hold a class vote to determine the “ultimate winner” of the most persuasive letter.

STUDENT ASSESSMENT

Assessment Opportunities:

- The class discussions, small group discussions, and Exit Ticket questions provide opportunities to gauge student learning and misconceptions.
- The letter to the editor learning task meets the requirements of the CBA.

Student Metacognition:

- The Exit Ticket questions challenge students to take and defend a position with research, arguments, and facts.
- Students have the opportunity to share what they have learned with group members.

Scoring:

- A rubric for scoring the *Constitutional Issues* CBA is provided by OSPI at their website.
- Participation points can be assigned for contributing to class discussions and for group work.

EXTENSION ACTIVITIES

Extension Activities:

- Take students back to the fictional story and have each group develop a solution to the problem that would protect both individual rights and the common good. Present options to the class.
- Challenge students to consider the following question: How does this case of tuberculosis relate to the H1N1 influenza virus?

Adaptations:

- Small group activities allow opportunities for conversation.
- Adapt the rubric to add more requirements for gifted students.
- Pair gifted students with students that are ELL and SPED.

TEACHER BACKGROUND & RESOURCES

Background Information:

Basic information on tuberculosis can be obtained by reading the Student Background Reading in the Introduction to Global Health section of the curriculum.

Resources:

Constitutional Issues CBA Directions and Rubric
WA State Office of the Superintendent of Public Instruction
http://www.k12.wa.us/SocialStudies/CBAs/HighSchool/HSCivics-ConstitutionalIssues-CBA.pdf

"Officials seek links in fugitive TB patient case" article
Reuters, 6/3/07
http://www.reuters.com/article/topNews/idUSN3123541420070603?feedType=RSS

"TB Traveler Hit With $1.3M Lawsuit" article
CBS News, 7/13/07
http://www.cbsnews.com/stories/2007/07/13/health/main3054927.shtml

"Lawyer in 2007 TB Scare Sues" article
CNN, 4/30/09
http://www.cnn.com/2009/CRIME/04/30/tb.lawsuit/

CDC: Tuberculosis
http://www.cdc.gov/tb/

WHO: Tuberculosis
http://www.who.int/topics/tuberculosis/en/

Attachment B

Interdisciplinary Global Health Curriculum Unit

MALARIA UNIT

Lesson Plans for <u>(insert course name)</u>

Directions:
This packet includes 5 blank lesson plan templates. Use these templates to develop the lesson plans for your course that will be part of the Cholera Unit. You can add more lesson plans if needed by copying and pasting one of the blank templates.

These lesson plans should be developed with the guidance of the Curriculum Unit Overview that your school team developed together. Keep in mind that you will be presenting this document during Workshop #2 and will receive feedback from all of the other teachers. Therefore, your Curriculum Unit Overview is likely to undergo some revisions, which may affect your lesson plans.

An asterisk (*) denotes items that are prioritized. By the end of Workshop #2, at a minimum the items in the lesson plan with an asterisk need to be completed for ALL lesson plans in your unit.

Washington Global Health Alliance

Global Health Curriculum Unit: MALARIA

Lesson Plan Title:
***Subject:** ☐ Advanced Algebra ☐ Chemistry ☐ U.S. History ***Activity Time:** ***Activity Type:** ☐ Stand-alone ☐ Linked ☐ Interdisciplinary **Scheduling Instructions for "Linked" and "Interdisciplinary" Activities:**
***Lesson Plan Summary:** In a few sentences, briefly describe what the learning activity will entail.
In this lesson, students…

STUDENT UNDERSTANDINGS
***Big Idea & Enduring Understanding:** What is the big idea that serves as the focal point for this lesson? What understanding are desired?
***Essential Question:** What essential question will help develop students' deep understanding?
Learning Objectives: What knowledge and skills will students acquire, practice, and apply as a result of this learning activity?
Students will know… Students will be able to…
Vocabulary: What are the essential vocabulary words that students will understand and need to know in order to successfully participate in this learning activity?
Standards Alignment: What EALRs and GLEs are addressed by this learning activity?
This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):
***Common Student Preconceptions & Misconceptions:** What preconceptions and misconceptions related to this learning activity are common among eleventh grade students?

How can misconceptions be addressed by this activity?

TEACHER PREPARATION
***Materials:** List the materials needed for this lesson. For each material, include a description, amount needed, and if necessary, suggestions on where unusual supplies may be purchased.
***Preparation:** List any actions that a teacher needs to do in order to prepare for delivering this lesson. This may include prepping materials, setting up the room, etc.

PROCEDURE
***Hook:** How will you hook your students' interest at the beginning of the learning activity?
***Preconceptions:** How will you elicit students' preconceptions?
***Activity Procedure:** Provide step-by-step instructions for delivering this learning activity.
***Wrap-up/Discussion/Assessment:** Provides suggestions for wrapping-up the learning activity.

STUDENT ASSESSMENT
***Assessment Opportunities:** How will student knowledge, skills, and concepts for this lesson plan be assessed?
***Student Metacognition:** How will students monitor and reflect on their own learning, identify their preconceived ideas, and keep track of the changes in their knowledge, skills, attitudes, and behaviors?
***Scoring Rubric:** What does success look like? What evidence is needed? If this lesson plan includes student work that needs to be scored, develop a scoring rubric.

EXTENSION ACTIVITIES
Extension Activities: How could this learning activity be extended?
Adaptations: How could this learning activity be adapted for use in other settings or with learners with special needs (ELL, SPED, Gifted, etc.)?

TEACHER BACKGROUND & RESOURCES
Background Information: Provide a brief overview of any background information needed for someone to teach this unit.
Resources: What resources are relevant to this learning activity?
Print Materials: Multimedia Materials: Websites: Other Resources & Materials:

Other Items to Include:
*If any part of this lesson plan is an adaptation of another person or company's work, be sure to include a citation that gives credit to the original work.

*As needed, create and attach Student Master Pages to the end of this lesson plan, such as student readings, handouts, lab sheets, problem sets, etc.

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*As needed, create and attach Student Master Pages to the end of this lesson plan, such as student readings, handouts, lab sheets, problem sets, etc.

** An asterisk denotes items that are prioritized. By the end of Workshop #2, at a minimum the items in the lesson plan with an asterisk need to be completed for ALL lesson plans in your unit.*

Global Health Curriculum Unit: MALARIA

Lesson Plan Title:
***Subject:** ☐ Advanced Algebra ☐ Chemistry ☐ U.S. History ***Activity Time:** ***Activity Type:** ☐ Stand-alone ☐ Linked ☐ Interdisciplinary **Scheduling Instructions for "Linked" and "Interdisciplinary" Activities:**
***Lesson Plan Summary:** In a few sentences, briefly describe what the learning activity will entail.
In this lesson, students…

STUDENT UNDERSTANDINGS
***Big Idea & Enduring Understanding:** What is the big idea that serves as the focal point for this lesson? What understanding are desired?
***Essential Question:** What essential question will help develop students' deep understanding?
Learning Objectives: What knowledge and skills will students acquire, practice, and apply as a result of this learning activity?
Students will know… Students will be able to…
Vocabulary: What are the essential vocabulary words that students will understand and need to know in order to successfully participate in this learning activity?
Standards Alignment: What EALRs and GLEs are addressed by this learning activity?
This lesson addresses the following eleventh grade Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs):
***Common Student Preconceptions & Misconceptions:** What preconceptions and misconceptions related to this learning activity are common among eleventh grade students? How can misconceptions be addressed by this activity?

TEACHER PREPARATION
***Materials:** List the materials needed for this lesson. For each material, include a description, amount needed, and if necessary, suggestions on where unusual supplies may be purchased.
***Preparation:** List any actions that a teacher needs to do in order to prepare for delivering this lesson. This may include prepping materials, setting up the room, etc.

PROCEDURE
***Hook:** How will you hook your students' interest at the beginning of the learning activity?
***Preconceptions:** How will you elicit students' preconceptions?
***Activity Procedure:** Provide step-by-step instructions for delivering this learning activity.
***Wrap-up/Discussion/Assessment:** Provides suggestions for wrapping-up the learning activity.

STUDENT ASSESSMENT
***Assessment Opportunities:** How will student knowledge, skills, and concepts for this lesson plan be assessed?
***Student Metacognition:** How will students monitor and reflect on their own learning, identify their preconceived ideas, and keep track of the changes in their knowledge, skills, attitudes, and behaviors?
***Scoring Rubric:** What does success look like? What evidence is needed? If this lesson plan includes student work that needs to be scored, develop a scoring rubric.

EXTENSION ACTIVITIES
Extension Activities: How could this learning activity be extended?
Adaptations: How could this learning activity be adapted for use in other settings or with learners with special needs (ELL, SPED, Gifted, etc.)?

TEACHER BACKGROUND & RESOURCES
Background Information: Provide a brief overview of any background information needed for someone to teach this unit.
Resources: What resources are relevant to this learning activity?
Print Materials: Multimedia Materials: Websites: Other Resources & Materials:

Other Items to Include:
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