BioEd℠

Organisms and Environments

Invisible Threats

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Introduction: Organisms and Invisible Threats

No matter who you are, no matter where you live, and no matter what you do, you have a personal story that is unlike anyone else's. Your personal story includes family, school, trips, summer vacation, holidays, skills you have acquired, and so much more. Your story not only includes good things but bad things as well. One of the bad things is an infectious disease you may have caught, such as colds and flu. For some of those diseases, you recover quite quickly – a few days of sniffles and coughs and you are back to normal. Other diseases may not be so easy.

Infectious diseases take many forms and are caused by tiny microbes (microscopic-size organisms and viruses) that infect (get into) your body. They may enter through a bug bite or through something you ate. You may get them by coming in contact with another person who is infected. During contact, the microbes pass to you. You can also become infected through contact with objects or substances that contain infectious agents, such water, food, or everyday objects such as door handles. Knowing about infectious diseases, the microbes that cause them, and what to do about them is a useful and important life skill.

Hopefully, you will never contract one of the more dangerous infectious diseases. Scientists and health care workers continually strive to find ways to protect us from dangerous microbes and cure diseases when they are contracted. It is a constant battle because new diseases, and old diseases that mutate or change their structure and effects, appear from time to time. They can quickly spread from person to person in the modern world.

What follows here is a series of investigations that will help you and your students learn about and understand infectious diseases - how they are contracted and prevented. Investigations include infectious disease history, vaccines, links between infectious diseases and climate change, and a team challenge game. Also included are two stories about specific infectious diseases – polio and elephant endotheliotropic herpesvirus. Both stories provide up-close accounts of specific infectious diseases, caused by viruses – a kind of a germ. One affects humans and one affects baby Asian elephants.

Before You Start

The activities that follow are designed to be used with students who have already had some experience with the topic of microbes and infectious disease. If students have not had this experience, we recommend the following resource to prepare them for *Organisms and Environments: Invisible Threats*.

The Science of Microbes Teacher's Guide
http://www.bioedonline.org/lessons-and-more/teacher-guides/microbes/

Investigation 1

Polio

Time Needed
1-2 sessions

Before You Start
Become familiar with "Barbara's Story" and polio statistics.

You'll Need This Stuff for Each Team
Copy of "Barbara's Story"
Polio statistics graph

What It's About

Before a vaccine was developed to combat it, tens of thousands of people contracted poliomyelitis or polio every year and thousands died. During the warm summer months outbreaks of polio would occur, striking children most often. According to the Centers for Disease Control and Prevention (CDC) "Polio is an incurable, crippling and potentially deadly infectious disease caused by a virus that spreads from person to person invading the brain and spinal cord and causing paralysis."

Poliovirus is usually spread from person to person through infected feces entering the mouth. It can also be spread by food or water containing human waste. Proper sanitation and personal hygiene are important ways of reducing the possibility of infection. Polio can be prevented with a vaccine that is given orally through drops. The vaccine provides immunity in 95% of the children who receive it. Because the vaccine is inexpensive and easy to administer, it is used worldwide.

Polio is an ancient disease. Egyptian paintings and stele carvings show adults with deformed and withered legs believed to be caused by polio infections and children walking with canes. Outbreaks of polio were generally few and small because poor sanitation caused people to be continually exposed to the virus. This constant exposure enhanced natural immunity to the virus. It wasn't until much later, the early 1900s, that small, localized polio epidemics in Europe and the United states began to occur. The epidemics occurred as improvements in community sanitation and sewage disposal were made. Better sanitation meant less natural exposure to poliovirus and lowered immunity.

In 1952, the largest outbreak of polio in the United States occurred. Nearly 58,000 cases were reported. Just over 3,000 people died, and more than 21,000 people experienced paralysis.

In 1955, the first polio vaccine was ready for the public. Vaccines use killed versions or harmless parts of a virus or other disease agent to train the body's defence system to recognize and destroy the microbe if it invades the body again. Dr. Jonas Salk developed an injectable vaccine from an inactive poliovirus. A few years later, Albert Sabin developed an oral vaccine. It became available to the public in 1961. This vaccine was administered through liquid drops into the mouth. Cases of polio dropped dramatically and eventually

reached zero in the United States and other developed nations. Attempts to eliminate polio worldwide have been hampered by false claims about harmful effects of the vaccine. There has been a resurgence of polio cases in several nations due to rumors that the vaccine is unsafe. In Pakistan, a number of health care workers have actually been killed to prevent them from inoculating children. Innoculation resistance has hurt eradication efforts and could lead to new disease outbreaks around the world.

In this activity students will review the eyewitness account ("Barbara's Story") of contracting polio in 1954, and look for the important points (when, why, how). Students will then examine the statistics on Polio for a number of years and use the information to draw conclusions regarding the epidemic and the impacts of subsequent vaccine development.

What's The Question

Do vaccines reduce the frequency of a disease?

Objectives

Students will learn about the 20th century Polio epidemic in the United States and examine the relationship between the number of polio cases and vaccines.

What to Do

1. Read "Barbara's Story" to your students or have students read it independently or in small groups. Additional polio stories can be found at the following web addresses.

https://www.globalcitizen.org/en/content/polio-a-personal-experience/

http://www.marchofdimes.ca/EN/programs/PolioCanada/ppsurvivor/Pages/PolioStories.aspx

2. Ask what happened to Donnie and Connie in "Barbara's Story." How did they get sick? How do you think their parents and siblings felt?
3. Explain that according to the CDC, "Polio is an incurable, crippling and potentially deadly infectious disease caused by a virus. It inhabits the gut and is spread through waste. Polio spreads from person to person, invading the brain and spinal cord and causing paralysis." (http://www.cdc.gov/polio/) Explain that Polio survivors are one of the largest groups of persons with disabilities in the world. The World Health Organization estimates that there are 10 to 20 million polio survivors worldwide. Ask students to speculate why we rarely hear about Polio these days.
4. Tell students that they will analyze Polio data collected by epidemiologists. Epidemiologists are medical detectives that study the incidence, distribution, and effectiveness of treatment.
5. Provide student teams with copies of the Polio Cases 1937–2011 graph and the Polio Deaths 1950–2011 graph. Data, to create these graphs, were collected by the Centers for Disease Control and Prevention and focus on polio cases in the United States. Have teams discuss what the data on the graphs mean. Be sure that students understand that the years covered in the two graphs are different. The first graph covers 74 years and the second covers 61 years.

6. Have teams try to answer the following questions in their notebooks:
   - In what year did the maximum number of polio cases occur?
   - How many polio cases were there in that year?
   - In what years did cases of polio fall to 0?
   - In what year did deaths from polio fall to 0?
   - Why do you think the numbers of cases and deaths fell to 0?
   - Between 1937 and 1963, what was the approximate average number of polio cases? What do you have to do to answer this question?
   - Between 1963 and 2011, what was the approximate average number of polio cases?

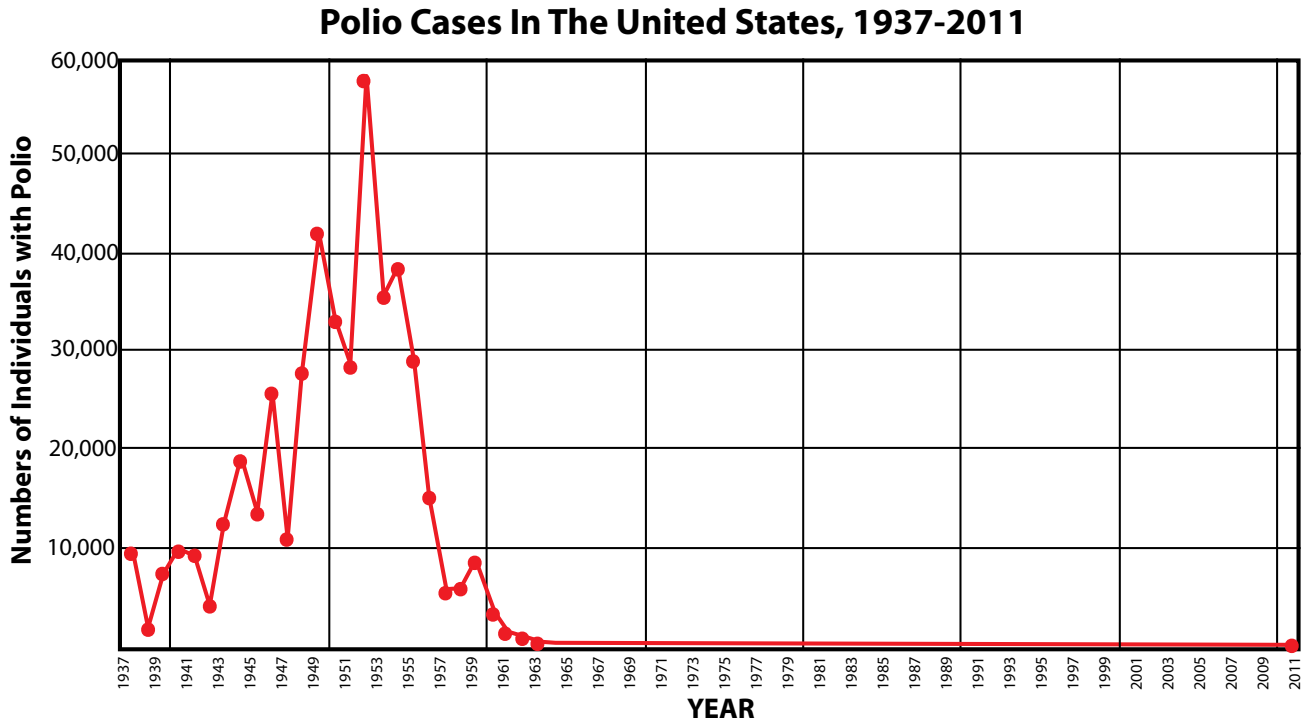
Wrap It Up

Hold a class discussion and ask the following questions to guide the discussion.

- When was the polio vaccine first offered to the public in the US? When was it offered worldwide?
- When did the polio epidemic reach its highest point (maximum number of cases)?
- What do the data tell you about the effectiveness of the vaccine?
- Examine the current worldwide polio situation at the following website. It features several maps showing where polio cases have occurred.

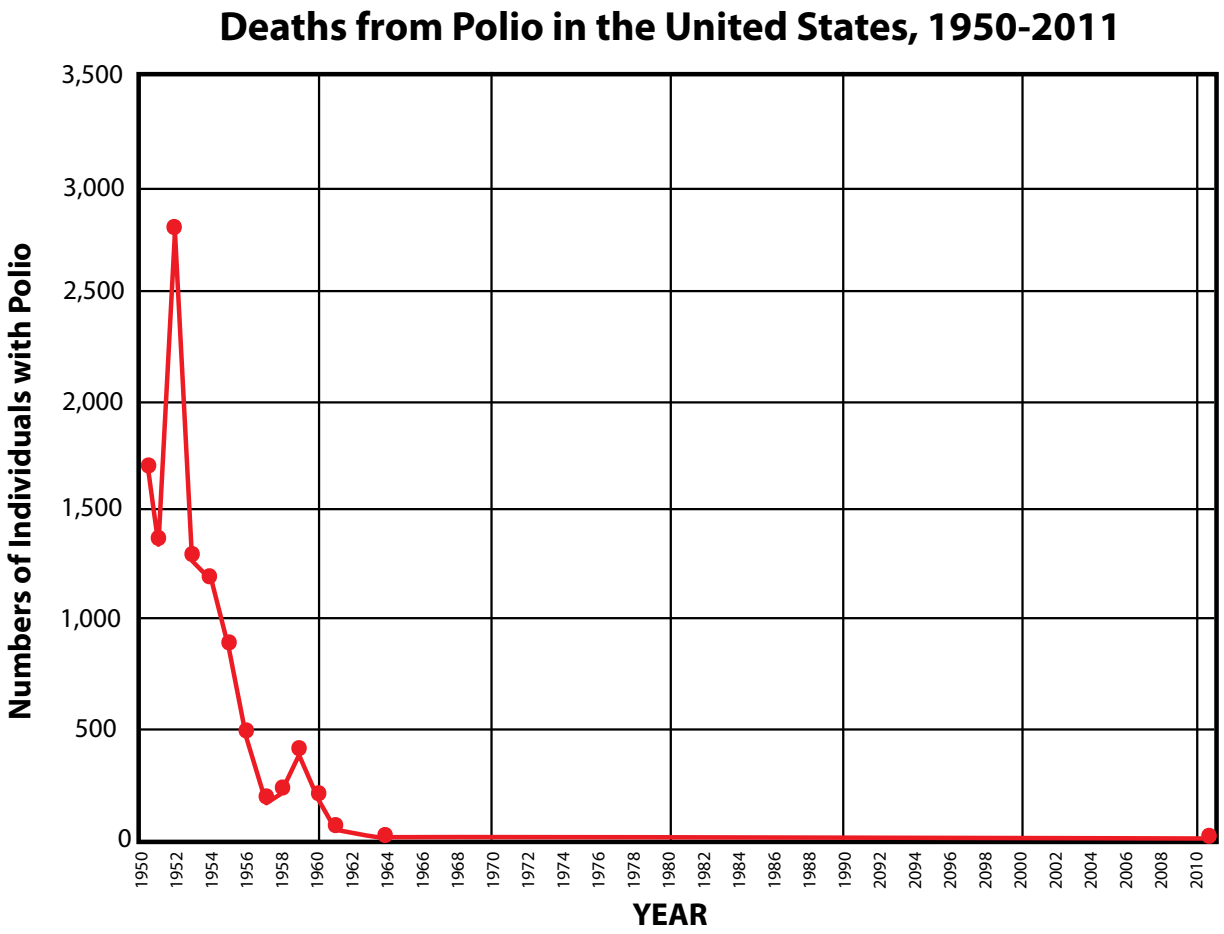
http://www.polioeradication.org/Dataandmonitoring/Poliothisweek/Poliocasesworldwide.aspx

- As an extra project, have students conduct research onn the post-polio syndrome using sites from the National Institute of Health (NIH) and the Centers for Disease Control and Prevention as sources.



Adapted from Polio Cases, Deaths, and Vaccination Rates

http://vaccines.procon.org/view.additional-resource.php?resourceID=005964



Adapted from Polio Cases, Deaths, and Vaccination Rates

http://vaccines.procon.org/view.additional-resource.php?resourceID=005964

Barbara's Story

It was 1954. My family liked to go fishing. Maybe it was the soothing sound of the water, or the warmth and early glow of sunshine, or the cool shade under the green canopy that offered respite from the hot sun. Or maybe it was just the escape from suburbia. The roads to the creek were narrow strips of smooth dirt surrounded by levies that held back the water until it flowed on to the farmland. The country was green, lush and slow with no signs of pavement or people.

This weekend we were excited to meet our cousins for a day of fishing. They lived in another city and we didn't visit very often. The parents fished. We fished for a while and then found more interesting pastimes. We muddled in the puddles as we made mud castles, chased crayfish, and built dams from available material, sticks, leaves and assorted odds and ends.

My brother, Donnie, and I always loved to join our three cousins, Karen, Connie and Shirley. They were all a bit older and we were cool hanging out with them, or at least we thought so! They offered freedom from adults since Shirley was 13!

On this trip it was nearing the end of summer. The muddy creek called Whiskey Slough was barely running. In fact, the water seemed curiously still with a fuzzy floating film on its surface, but that didn't bother us for long. It was hot and we had permission to wade along the edge. Shirley led the way. I held my little brother's hand as we waded into the murky water. Before long the fuzz was not a consideration, we were all splashing, muddy and cool. Unknown to us, there was something else in the water, a deadly virus spread through human waste.

That day was a turning point for all of us. Within a week by brother and my cousin were hospitalized. Donnie was only 4 years old. A week after the trip he developed severe pain in his neck, a headache and fever. Mom was worried because this was 1954 and tens of thousands of children had contracted, polio. Then, my Aunt Velma called. Connie had just been hospitalized with polio.

Donnie was admitted to the Alameda County Hospital and immediately taken from my parents and placed in isolation. My parents could only look at him through a glass wall. He was deathly ill, with shallow breathing, fever and crying with a painful headache. That year more than 38,000 people, mostly children under the age of 6 years contracted polio. Many died and many more would never walk again.

The hospital was teeming with sick children, many getting worse by the minute. Children that could not breathe were placed in large breathing machines called "Iron Lungs." Each day was torture as my parents took turns spending their time outside Donnie's door, looking through the window. They had to stand to the side so he couldn't see them otherwise he would become hysterical.

I was his big sister and while I did not contract polio, I was still considered contagious. I could not go to my kindergarten class at school. It was difficult for me to understand. My only sibling was taken away and our lives had changed. My parents felt only sadness and emptiness, as they dragged themselves home from the hospital each evening.

Almost everyday I got a new toy. So did Donnie. The stuffed animals, games and other toys lined his bed. He could look at them, but he did not have the strength or will to play.

Around the clock for two weeks, nurses and doctors came in and out of his isolation room. Slowly he seemed more aware, his breathing became easier and color returned to his little face. For Donnie the worst seemed to be over. He was a survivor!

He wanted his Momma. Once he was lucid he asked them if they could live in a trailer under his windows. Like most of the polio victims in the ward, he was pre-school age and not able to understand most of what was going on around him. He didn't know it, but Donnie was among the lucky ones.

Eventually, Donnie came home. He had to leave all his toys behind! This he could not understand. How can you explain invisible germs to a four-year old. No one knew if the toys were contagious, but they were not taking any chances. Little was known about Polio except that it crippled thousands of children each year. Its cause was illusive.

Donnie could breathe on his own again. He was weak, but could walk with help. He had a pronounced limp and had to have daily physical therapy. Gradually, he learned how to walk on his own and his limp became imperceptible.

The doctor released me from quarantine. I was going back to school. We lived only a few blocks from my school so I walked as usual. But when I arrived I was told I was not allowed into the building! I was six years old. I walked and cried all the way home. My mother, already under major stress, just cried. We cried together.

My neighbor arrived on the scene. She took control. She encouraged Mom to call the doctor and have them call the school. Then she took me to the bathroom and splashed cold water on my swollen face. After a while Mom and I calmed down. Then the doctor reassured my mother that I was safe to go to school and he would call the school.

I had to walk back to school. Of course, everyone was afraid. What was polio? What caused polio? Was I safe? Why didn't I get it like my cousin and brother? There may never be answers. Five children played in the stagnant water. Two of them contracted polio. Today, both Connie and Donnie are polio survivors, but they have muscle weakness and pain. Their condition is called post-polio syndrome and has no cure. The muscles and nerves that were affected by the poliovirus in their youth now seem to be wearing out.

Epilogue

Today, we know that polio is a viral disease. It is a virus that inhabits the human gut and passes from person to person through contact with body solid waste. Thanks to polio vaccines, polio has been eradicated around most of the world. In some third world countries, however, polio is on the rise because of superstition and civil unrest. Children there are not being vaccinated and many location do not have clean water or proper waste disposal. These conditions are enabling polio to spread once again.

Investigation 2

What Do You Know About Vaccines?

Time Needed
1-2 sessions

Before You Start
Make copies of the Infectious Disease Medical Log for each student.

What It's About
The body's immune system protects against "germs" (or foreign substances) that can invade the body and cause an infection or disease. Vaccines imitate an infection and boost the immune system to protect against many diseases including measles, mumps, chickenpox, polio and a host of other communicable diseases. (For detailed factual information on vaccines, how they work, and their effects, read the Vaccine Primer document that follows this activity.)

There are several ways to create a vaccine. Some vaccines use weakened "live" microbes while others use "killed" microbes. And some vaccines are created using a portion of the actual virulent antigen. Vaccines never contain enough of the weakened microbes to cause the disease - just enough to trigger the immune system to produce antibodies to fight the disease.

Once a person is vaccinated they are immune for long periods of time, with the exception of booster shots at periodic intervals for a few vaccines like tetanus.

In this activity teams of students will research a specific disease for which a vaccine is available and present the information regarding the disease including pros and cons of vaccine to the class. The class will take "guided" notes and discuss following each presentation.

What's The Question?
Can you be protected from infectious disease?

Objectives
Student teams will investigate specific infectious diseases and complete a medical log entry to share with other student teams.

What To Do
1. List the following diseases on the board:

   polio measles mumps chicken pox diphtheria
   tetanus whooping cough influenza hepatitis rubella
2. Ask, what might these diseases have in common? They may know that many are considered childhood diseases. They are all diseases that have vaccines. Make sure students understand the following important terms:

Antibody - a protein produced by cells of immune system (B lympophages) that binds to a specific part of a disease-causing agent and inactivates it.
Antigen – part of a bacteria, virus or other microbe that stimulates the production of antibodies – any substance that stimulates the immune system, (Antigens are also allergy triggers.)
Bacteria – a microscopic simple one-celled organism
Immune system – Network of cells, tissues, and organs that work together to protect the body from diseases
Immunization – The process of protecting the body against disease by training the immune system to recognize a disease-causing agent.
Vaccine – substance that protects the body from disease by stimulating the immune system to create cells that remember and recognize the disease-causing agent. These cells stimulate the production of antibodies by other cells in the immune system.
Virus – a very small infectious agent that replicates only inside a living cell of an organism.

3. Assign teams of three or four students to one of the diseases written on the board in step 1 . Give teams the blank Infectious Disease Medical Logs to guide their research. Explain that they are responsible for educating the their classmates on their chosen diseases. Remind them that many communicable diseases are life-threatening. The following questions can also guide their research:
    - What are the causes, symptoms, and ultimate results of the disease?
    - Who should be vaccinated and when?
    - Are there possible side effects of the vaccine?
4. As each team presents their information, be sure they answer the guiding questions in step 2.
5. Make sure students keep copies of their research. They will find the information useful in the last activity in this guide.

Special Note:

Information collected in this activity can assist students in preparing for the Infectious Jeopardy game at the end of this guide.

Wrap It Up

Ask students if they have ever heard of Edward Jenner. Discuss Jenner's life and work. He is said to have saved more lives than anyone else in history. His story involves treatment of smallpox and the development of the medical discipline of immunology. Many Internet sites discuss Jenner and his work. The following are good sources of information.
http://www.jennermuseum.com/vaccination.html
http://www.historyofvaccines.org/content/timelines/jenner
http://www.jenner.ac.uk/edward-jenner

INFECTIOUS DISEASE MEDICAL LOG

Disease Name: _____ **Investigator:** _____

Who are its usual victims? **Men** **Women** **Children** **Elderly**
(Circle all that Apply)

Cause: **Bacterium** **Virus** **Fungus** **Protozoan**
(Circle Answer)

How common (widespread) is the disease?

Symptom List:

_____ _____
_____ _____
_____ _____
_____ _____

Potential long term effects:

Associated diseases:

Treatment:

Vaccine available? **Yes** **No**
(Circle Answer)

Historical and miscellaneous information about this disease (who, what, when, why, etc.):

Vaccine Primmer – Understanding How Vaccines Work

(Adapted from a 2013 public information document provided by the Center for Disease Control. http://www.cdc.gov/vaccines/conversations)

The Immune System— The Body's Defense Against Infection

To understand how vaccines work, it is helpful to first look at how the body fights illness. When germs, such as bacteria or viruses, invade the body, they attack and multiply. This invasion is called an infection, and the infection is what causes illness. The immune system uses several tools to fight infection. Blood contains red blood cells, for carrying oxygen to tissues and organs, and white or immune cells, for fighting infection. These white cells consist primarily of B-lymphocytes, T-lymphocytes, and macrophages:

- Macrophages are white blood cells that swallow up and digest germs, plus dead or dying cells. The macrophages leave behind parts of the invading germs called antigens. The body identifies antigens as dangerous and stimulates the body to attack them.
- Antibodies attack the antigens left behind by the macrophages. Antibodies are produced by defensive white blood cells called B-lymphocytes.
- T-lymphocytes are another type of defensive white blood cell. They attack cells in the body that have already been infected. The first time the body encounters a germ, it can take several days to make and use all the germ-fighting tools needed to get over the infection. After the infection, the immune system remembers what it learned about how to protect the body against that disease.

The body keeps a few T-lymphocytes, called memory cells that go into action quickly if the body encounters the same germ again. When the familiar antigens are detected, B-lymphocytes produce antibodies to attack them.

How Vaccines Work

Vaccines help develop immunity by imitating an infection. This type of infection, however, does not cause illness, but it does cause the immune system to produce T-lymphocytes and antibodies. Sometimes, after getting a vaccine, the imitation infection can cause minor symptoms, such as fever. Such minor symptoms are normal and should be expected as the body builds immunity.

Once the imitation infection goes away, the body is left with a supply of "memory" T-lymphocytes, as well as B-lymphocytes that will remember how to fight that disease in the future. However, it typically takes a few weeks for the body to produce T-lymphocytes and B-lymphocytes after vaccination. Therefore, it is possible that a person who was infected with a disease just before or just after vaccination could develop symptoms and get a disease, because the vaccine has not had enough time to provide protection.

Types of Vaccines

Scientists take many approaches to designing vaccines. These approaches are based on information about the germs (viruses or bacteria) the vaccine will prevent, such as how it infects cells and how the immune system responds to it. Practical considerations, such as regions of the world where the vaccine would be used, are also important because the strain of a virus and environmental conditions, such as temperature and risk of exposure, may be different in various parts of the world. The vaccine delivery options available may also differ geographically. Today there are five main types of vaccines that infants and young children commonly receive:

- Live, attenuated vaccines fight viruses. These vaccines contain a version of the living virus that has been weakened so that it does not cause serious disease in people with healthy immune systems. Because live, attenuated vaccines are the closest thing to a natural infection, they are good teachers for the immune system. Examples of live, attenuated vaccines include measles, mumps, and rubella vaccine (MMR) and varicella (chickenpox) vaccine. Even though these vaccines are very effective, not everyone can receive them. Children with weakened immune systems—for example, those who are undergoing chemotherapy—cannot get live vaccines.
- Inact ivated vaccines also fight viruses. These vaccines are made by inactivating, or killing, the virus during the process of making the vaccine. The inactivated polio vaccine is an example of this type of vaccine. Inactivated vaccines produce immune responses in different ways than live, attenuated vaccines. Often, multiple doses are necessary to build up and/or maintain immunity.
- Toxoid vaccines prevent diseases caused by bacteria that produce toxins (poisons) in the body. In the process of making these vaccines, the toxins are weakened so they cannot cause illness. Weakened toxins are called toxoids. When the immune system receives a vaccine containing a toxoid, it learns how to fight off the natural toxin. The DTaP vaccine contains diphtheria and tetanus toxoids.
- Subunit vaccines include only parts of the virus or bacteria, or subunits, instead of the entire germ. Because these vaccines contain only the essential antigens and not all the other molecules that make up the germ, side effects are less common. The pertussis (whooping cough) component of the DTaP vaccine is an example of a subunit vaccine.
- Conjugate vaccines fight a different type of bacteria. These bacteria have antigens with an outer coating of sugar-like substances called polysaccharides. This type of coating disguises the antigen, making it hard for a young child's immature immune system to recognize it and respond to it. Conjugate vaccines are effective for these types of bacteria because they connect (or conjugate) the polysaccharides to antigens that the immune system responds to very well. This linkage helps the immature immune system react to the coating and develop an immune response. An example of this type of vaccine is the Haemophilus influenzae type B (Hib) vaccine.

Vaccines Require More Than One Dose

There are four reasons that babies—and even teens or adults for that matter—who receive a vaccine for the first time may need more than one dose:

- For some vaccines (primarily inactivated vaccines), the first dose does not provide as much immunity as possible. So, more than one dose is needed to build more complete immunity. The vaccine that protects against the bacteria Hib, which causes meningitis, is a good example.
- In other cases, such as the DTaP vaccine, which protects against diphtheria, tetanus, and pertussis, the initial series of four shots that children receive as part of their infant immunizations helps them build immunity. After a while, however, that immunity begins to wear off. At that point, a "booster " dose is needed to bring immunity levels back up. This booster dose is needed at 4 years through 6 years old for DTaP. Another booster against these diseases is needed at 11 years or 12 years of age. This booster for older children—and teens and adults, too—is called Tdap.

- For some vaccines (primarily live vaccines), studies have shown that more than one dose is needed for everyone to develop the best immune response. For example, after one dose of the MMR vaccine, some people may not develop enough antibodies to fight off infection. The second dose helps make sure that almost everyone is protected.
- Finally, in the case of the flu vaccine, adults and children (older than 6 months) need to get a dose every year. Children 6 months through 8 years old who have never gotten the flu vaccine in the past or have only gotten one dose in past years need two doses the first year they are vaccinated against flu for best protection. Then, annual flu shots are needed because the disease-causing viruses may be different from year to year. Every year, the flu vaccine is designed to prevent the specific viruses that experts predict will be circulating.

The Bottom Line

Some people believe that naturally acquired immunity—immunity from having the disease itself—is better than the immunity provided by vaccines. However, natural infections can cause severe complications and be deadly. This is true even for diseases that most people consider mild, like chickenpox. It is impossible to predict who will get serious infections that may lead to hospitalization.

Vaccines, like any medication, can cause side effects. The most common side effects are mild. However, many vaccine-preventable disease symptoms can be serious, or even deadly. Although many of these diseases are rare in this country, they do circulate around the world and can be brought into the U.S., putting unvaccinated children at risk. Even with advances in health care, the diseases that vaccines prevent can still be very serious – and vaccination is the best way to prevent them.

Investigation 3

To Vaccinate or Not to Vaccinate, That Is the Question

Time Needed
1 Session

Before You Start
Make Copies of the three Fairhaven USA pages for each student team.

You'll Need This Stuff for Each Team
Set of "Fairhaven USA" sheets
Red marker or red crayon

What It's About
Vaccinating children against serious childhood diseases has been controversial for a very long time. Opponents to vaccination question the effectiveness, safety, and necessity of vaccines. They further argue that vaccines violate individual rights or religious principles.

Most recently, a wide-ranging controversy erupted over the administration of the MMR or measles, mumps, and rubella vaccine. A research paper linked the MMR vaccine to autism in a very small group of boys in England. The paper was later retracted due to significant flaws, deceptions, and conflicts of interest and the principal author was eventually banned from practicing medicine.

Nevertheless, the damage was done and many parents, fearful of autism in their children, refused the vaccine. In 2000, measles was declared eliminated in the United States except for a few cases imported from other countries. As large groups of parents refused the vaccine, children again became at risk for the disease. In 2013, clusters of measles occurred in New York City, North Carolina, and Texas. In 2014, a large outbreak occurred in California. Outbreaks have continued 2015 including one confirmed death from measles.

The recent spread of measles and outbreaks of other infectious diseases like polio, smallpox, pertussis, and diphtheria relate to a concept called "herd immunity." Essentially, a disease outbreak occurs when an unprotected person becomes infected with a disease and then passes it on to other unprotected people, who also pass it on. Children, who are all linked by going to the same school, living in the same community, or attend the same event, can be referred to as a "herd." The term also applies to people of any age who gather together at sports events, work closely in a factory or office, or attend social gatherings.

In the case of the 2014 California Disneyland measles outbreak, one or more visitors from a foreign country brought the measles virus to the park. Many of the other visitors to the park had not been vaccinated with the MMR vaccine due to various reasons. In other words, the unvaccinated park visitors were unprotected when they came in contact with the measles virus. The disease quickly spread to several of these park visitors who then took it home and shared it with other unprotected persons. In just days, the largest outbreak of measles the state had seen in many years had occurred. Fortunately, no children died from the disease.

The ideal situation at the park should have been herd immunity. With most people in the herd protected by vaccines, a disease brought into the herd has a difficult or impossible task of spreading. Consequently, the disease transmission stops.

Herd immunity can be created by vaccination or by natural means. There is a natural immunity that occurs when a person is exposed to a pathogen and becomes sick. During the sickness, antibodies develop that fight the infection. In the process, the person becomes immune to future infections of the same disease. Another form of immunity is a maternal immunity that occurs when antibodies are passed from a pregnant mother to its fetus. To learn more about this form of immunity, read the story "The Index Elephant" that follows later in this guide.

What's The Question?
Why is vaccination important to communities?

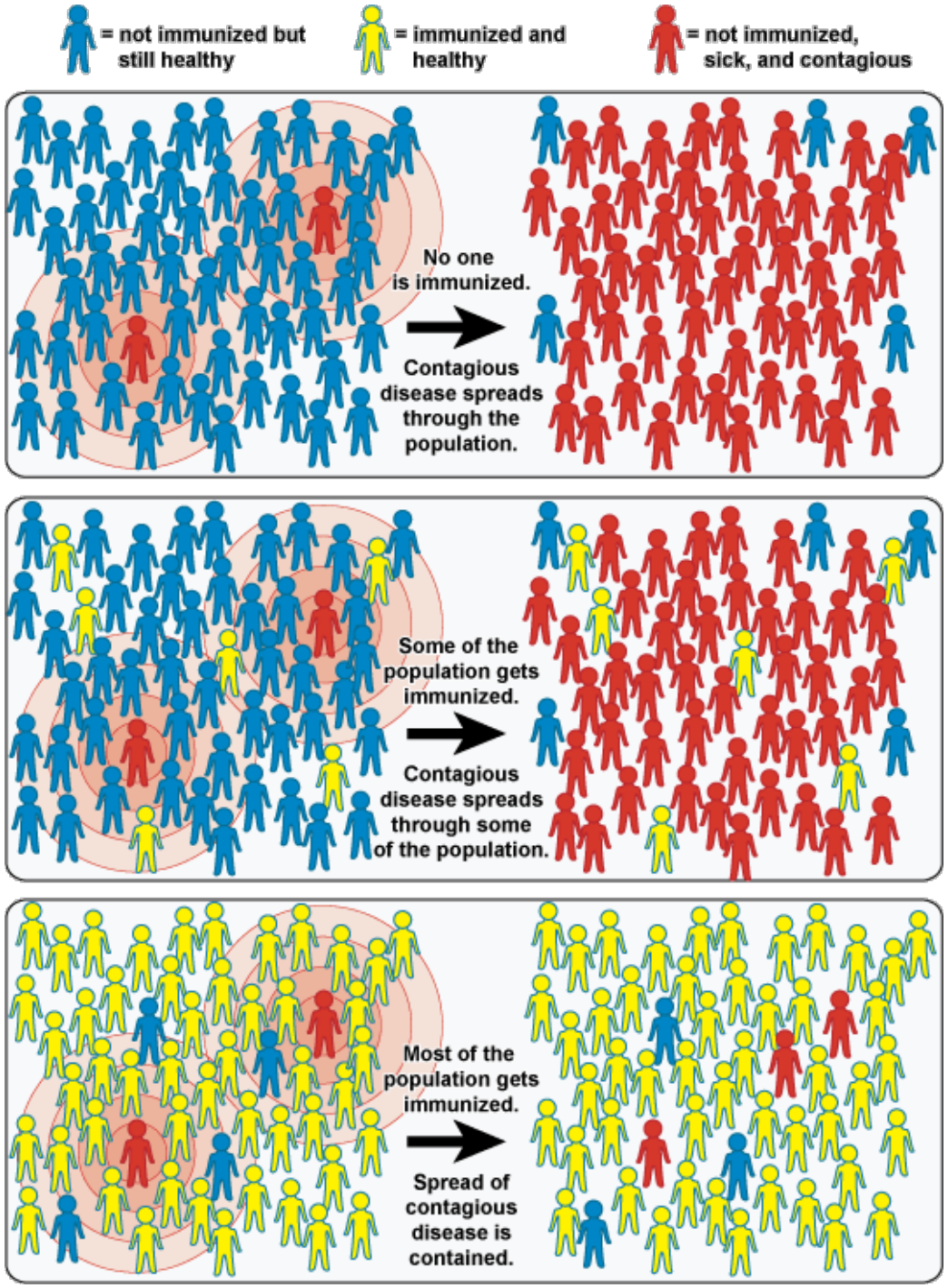
Objectives:
Student teams will learn about the concept of herd immunity by completing three paper simulations of the spread of an imaginary infectious disease.

Procedure
1. Briefly review what is meant by the term vaccination. Ask has anyone been vaccinated? Discuss different vaccinations that are given to children and vaccination schedules. The following site is a good source for information on vaccination schedules. http://www.cdc.gov/vaccines/parents/downloads/parent-ver-sch-0-6yrs.pdf

2. Organize students into teams of two or three students.
3. Give each team the first of three Fairhaven USA sheets and a red marker or red crayon.
4. Instruct teams to imagine that someone in the town of Fairhaven USA has contracted the dreaded infectious disease of *Yuckyitis*. If you wish, make up a few yucky symptoms for this imaginary disease. Have students note that there are more than 60 residents in the town and that straight lines indicate the persons with whom each individual has contact every day.
5. Point out that the symbols at the top represent different people. White represents someone who is healthy but unprotected with a vaccine. Green represents someone who is healthy, unprotected with a vaccine, but is immune to *Yuckyitis* because they have already had the disease. Blue represents someone who is protected with the *Yuckyitis* vaccine. Red represents people who have become infected with *Yuckyitis*. The lines show the different people individuals have contact with.
6. Tell teams to randomly pick one healthy unprotected person and color the person red to indicate that that person has acquired *Yuckyitis*. The simplest way to do this is to have one team member close his or her eyes and touch the paper with the pointer finger. The nearest figure in white is the infected person. Tell teams that that this person now passes on the *Yuckyitis* to the people he or she comes in direct the next day day. We are assuming that that *Yuckyitis* is 100% contagious (unless an individual is immune to it). Color those people red. Then, color the people they infect and so on. At the end, teams should count up the total number of people infected with *Yuckyitis* and write the number at the bottom of the page.

7. Distribute the second Fairhaven USA sheet. In this situation, some town members have been vaccinated against *Yuckyitis*. Again, teams pick one healthy unprotected person to be infected with the disease. Color that person red and all other persons that become infected through contact. Total the number of infected people at the bottom of the page.
8. Distribute the third Fairhaven USA sheet. On this sheet, many of the town residents have been vaccinated against *Yuckyitis*. Again, teams pick one healthy unprotected person, color that person red, and then color red all the other healthy unprotected people who catch *Yuckyitis*. Total the number of infected people at the bottom of the page.
9. Have students complete the Vaccine and Herd Immunity page for their science notebooks. Have a discussion with the teams. Review the concept of herd immunity. Have teams explain what is meant by the term, using their Fairhaven sheets as evidence.

The diagram on the next page explains the concept of herd immunity. Student teams will create their own version of the diagram in this activity. Source: Herd Immunity Diagram, National Institute of Allergy and Infectious Diseases, NIH



Wrap It Up

As an extension, have teams repeat the Fairhaven activity with one more sheet. Tell teams this time that the *Yuckyitis* infection only causes sickness 50% of the time. In other words, only half of the people (every other person) that come in contact with the initial sick person gets the disease. Use a different marker color to show people who do not get sick. How does this compare to the other Fairhaven sheets?

Have teams compare their Fairhaven charts to the Herd Immunity Diagram provided by the National Institute of Allergy and Infectious Diseases.

For more information, Dr. Robert Booy prevents a video demonstration about how herd immunity works. https://vimeo.com/11641696

Words to Know

Herd Immunity – Protection from infectious disease provided to a large group of people through immunization of its members.

Immunization – The process by which a person is made immune or resistant to a particular disease through a vaccine.

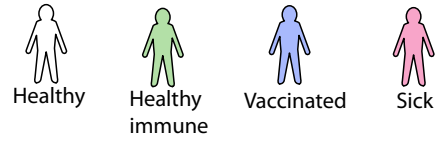
Transmission – Passing on an infectious disease through direct or indirect contact.

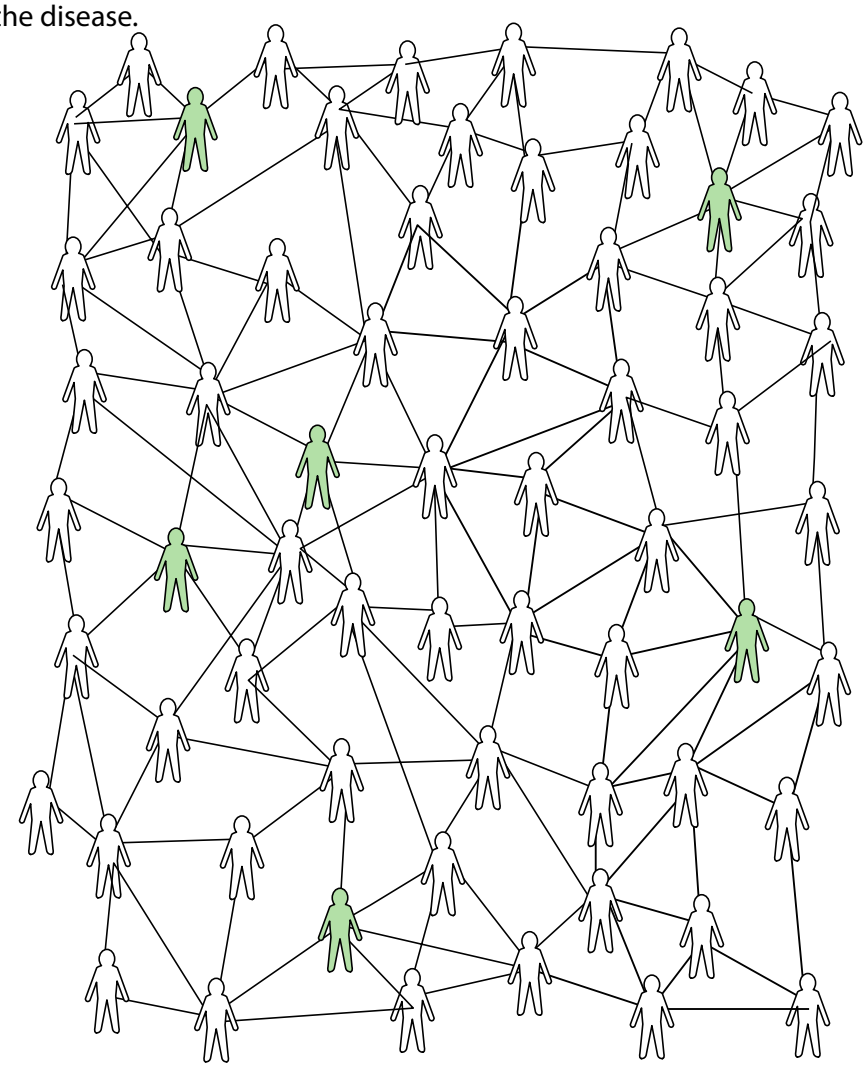
Vaccine – A biological preparation (usually a liquid) administered through injection that provides active acquired immunity to a particular disease.

1

Fairhaven USA

No one is immunized (vaccinated) against *Yuckyitis*
1 in 10 people are naturally immune to the disease.



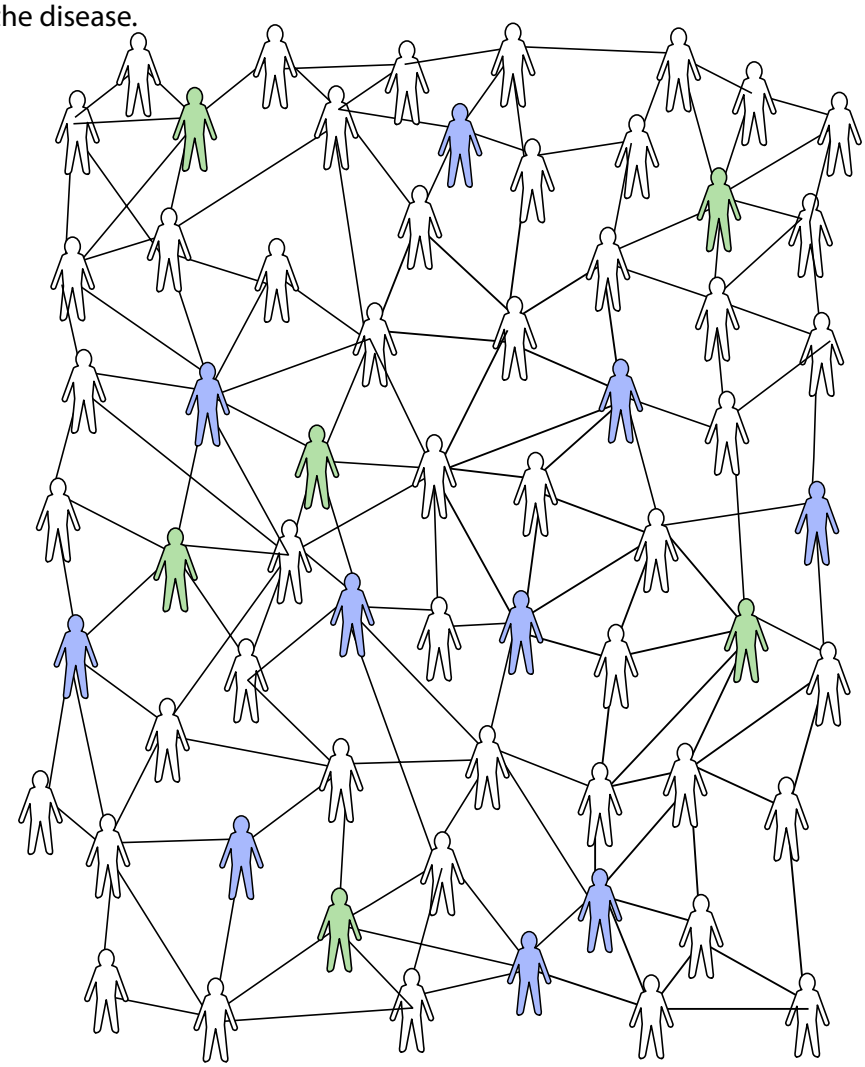


One citizen of Fairhaven comes in contact with a carrier (person infected with Yuckyitis) in another town. Pick one healthy person at random and color that person red for being infected. Follow all the lines from this person. Those people become infected too. Color them red. Trace the lines from those people and so on. How many people in Fairhaven eventually become infected with Yuckyitis?

Sick People of Fairhaven _____

Fairhaven USA

A few citizens are immunized (vaccinated) against *Yuckyitis*
1 in 10 people are naturally immune to the disease.



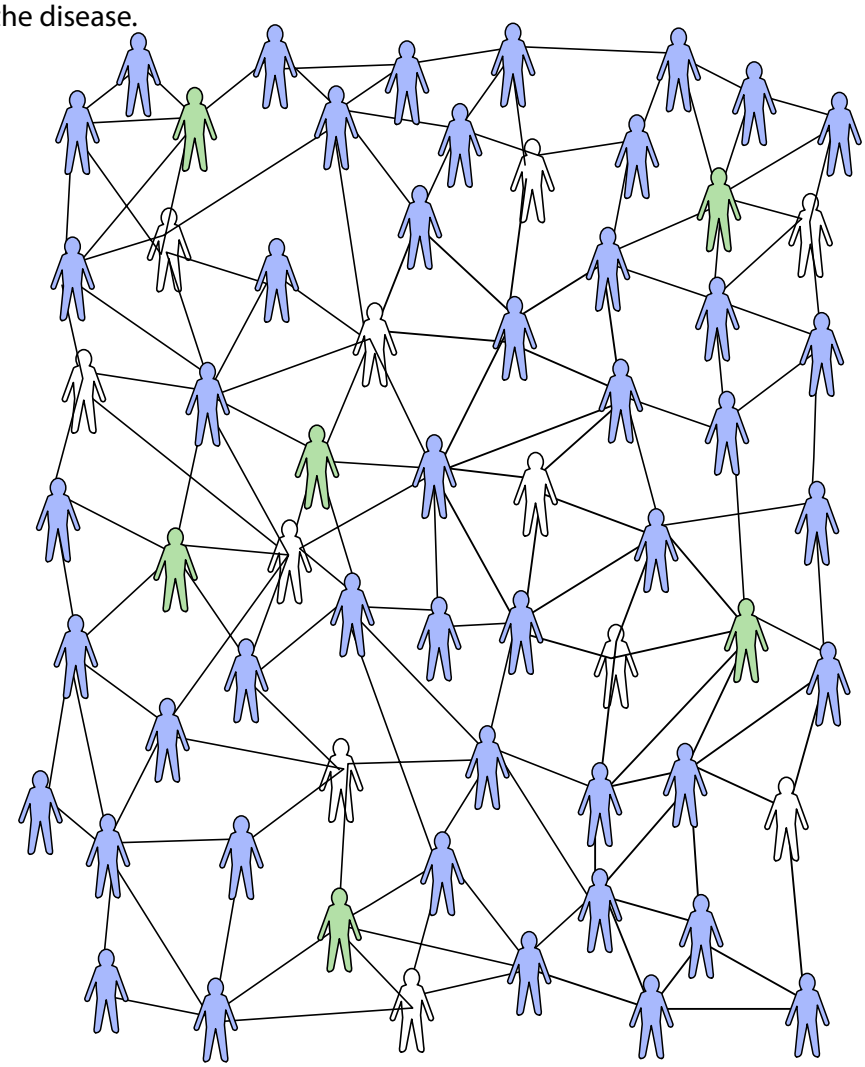
2

One citizen of Fairhaven comes in contact with a carrier (person infected with Yuckyitis) in another town. Pick one healthy person at random and color that person red for being infected. Follow all the lines from this person. Those people become infected too. Color them red. Trace the lines from those people and so on. How many people in Fairhaven eventually become infected with Yuckyitis?

Sick People of Fairhaven _____

Fairhaven USA

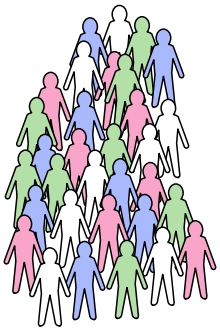
Many citizens are immunized (vaccinated) against *Yuckyitis*.
1 in 10 people are naturally immune to the disease.



One citizen of Fairhaven comes in contact with a carrier (person infected with Yuckyitis) in another town. Pick one healthy person at random and color that person red for being infected. Follow all the lines from this person. Those people become infected too. Color them red. Trace the lines from those people and so on. How many people in Fairhaven eventually become infected with Yuckyitis?

Sick People of Fairhaven _____

Vaccines and Herd Immunity



What is a vaccine?

In which scenario were the residents of Fairhaven USA most protected from *Yuckyitis*?

Why?

Define the term "herd immunity"? What does it mean?

Investigation 4

Who, What, When, Where?

Time Needed
2-3 Sessions

Before You Start
Make one set of the seven-page timeline folders for each team. If you do not have enough computers for student teams to use, schedule use of the school's computer lab for Internet access.

You'll Need This Stuff for Each Team
Timeline folder set
Scissors
Glue sticks or clear tape

What It's About
For thousands of years, various plagues of infectious diseases have decimated populations around the world, even altering the course of history. Evidence of smallpox has been found in 3000-year-old Egyptian mummies. Some Egyptian papyrus paintings depict poliomyelitis (polio) victims. In the 2nd century, the Antonine Plague, possibly smallpox or measles, nearly crushed the Roman Empire, killed two Roman emperors, caused 2,000 deaths a day in Rome, and decimating the Roman Legions. The Black Plague or Bubonic Plague is thought to have resulted in 75 million deaths worldwide in the 14th century. In the 16th century Native American cultures nearly collapsed as populations severely dropped when large-scale contact with Europeans spread smallpox and other diseases. In the last century, an estimated 75 million people died worldwide during the influenza pandemic of 1918. And recently, starting in the year 2000, more than 38 million people have died of HIV/AIDS-related illnesses. Today, malaria, another major infectious disease, has spread to over 300 million people around the world causing approximately one-half million deaths annually.

Infectious diseases are humanity's greatest enemy and countering them is an army of doctors, health care workers, and scientists seeking to prevent their spread. Many diseases have been greatly diminished through improved hygiene and sanitation. Clean drinking water and effective sewage treatment completely stops the spread of cholera. Eliminating garbage piles where rats and other rodents find food and places to nest fights the bubonic plague, caused by a bacterium carried by rats and spread by fleas.

By and large, some of the most effective weapons for fighting infectious diseases are vaccines that produce immunity to specific diseases. One disease, smallpox, has been completely eliminated worldwide by vaccines. Other vaccines control a wide range of diseases.

The development of vaccines began more than 200 years ago with a Dr. Edward Jenner. Jenner learned of the common belief that people, mostly milkmaids who had had a

cowpox infection, never got smallpox. Working on this belief, he produced immunity to smallpox in a boy by injecting him with matter from a cowpox lesion. The rest is history.

What's The Question?
What are the important events in the history of the development of vaccines and their use to prevent diseases?

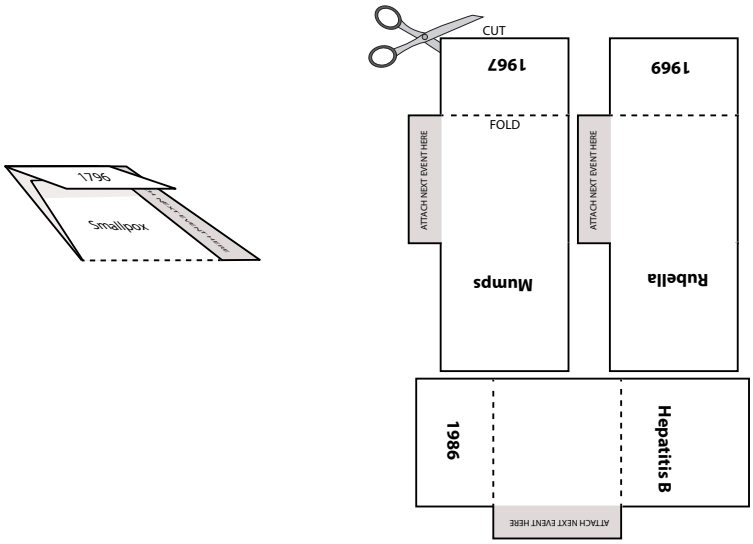
Objectives: Student teams will construct an infectious disease timeline consisting of significant events related to specific diseases.

Procedure

1. Ask your students to name infectious disease they have heard about or have contracted. Explain that infectious means that you get the disease from another person or organism, an insect bite, eating or drinking something, etc. List the diseases they name on the board. Students will come up with some of the following diseases:

Polio	Measles	Mumps	Rubella	Strep throat
Cold	Flu	Pertussis	Hepatitis	Staph infection
Chicken Pox	Smallpox	Tuberculosis	Cholera	Croup
Typhoid	Rabies	Lime Disease	Tetanus	Scarlet fever
AIDS	Malaria	Yellow Fever	Ebola	

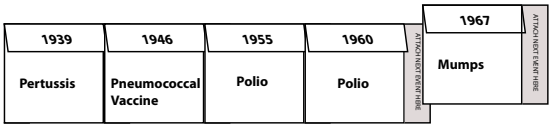
   In making the list, watch out for suggestions such as headache, rashes, muscle ache, and sore throat. Use this opportunity to discuss the difference between diseases and the symptoms caused by the diseases.
2. Ask students if they have ever gotten any of these diseases. All are likely to have had a cold or flu. Ask why they haven't gotten more of the diseases on the list. Why not measles, mumps, or tetanus? The answer you are looking for is "vaccination." Ask "What do vaccines do?" They produce immunity against specific infectious diseases in people that receive them. (Note: Unless your school system has strict rules regarding vaccination, some of your students may not have been vaccinated.)
3. Point out to your students that the development and use of vaccination began 1796 when a boy became immune to the deadly smallpox disease after being vaccinated with matter from a sore on a cow, with a similar disease, called cowpox. For more information, go to the following site: http://www.historyofvaccines.org/content/timelines/all
4. Divide your students into teams of three or four. Provide each team with a set of timeline folders. Each of the 20 folders (3 per page) is marked with a year and a specific disease. Teams will cut out each folder on the solid lines and fold them on the dashed lines. When folded properly, the year and the disease can be read. The year paper flap goes over the disease paper flap. See the diagram below.



5. Have teams divide up the folders into sets for each team member. The folders in each set become the responsibility of the team member that receives them. Team members will access the Internet to find out information about each event identified by their folders. In most cases, simply typing in the year and the disease name in a search engine will bring up information about the event. Team members will open the folder and write information about the disease and the event on its inside. For example, the folder reads 1939 Pertussis. The student could write something like this:

   Pertussis, or whooping cough, is a highly contagious respiratory disease. It can lead to pneumonia, brain damage, and even death.
   The pertussis vaccine provides protection from the disease.

   Note: It is not OK for students to copy directly from their sources. They should record information in their own words. Make sure students look up terms they encounter in their research that they are not familiar with.
6. When team members have completed researching all the event folders they have been assigned by their team, the folders should be joined together. Have them use glue stick or clear tape to the shaded "ATTACH NEXT FOLDER HERE" TAB. It is advisable for teams to place all folders in their correct order before joining them together. When teams join all their folders together, the completed timeline will stretch nearly 4 feet.
7. Have teams review all their findings by starting with the 1796 folder and read the notes. Encourage them to ask questions of each other. This will provide an opportunity to share things learned by the individual team members that do not fit on the folders.
8. Make room on a wall or board to display team timelines.



Segment of the timeline under construction

Wrap It Up

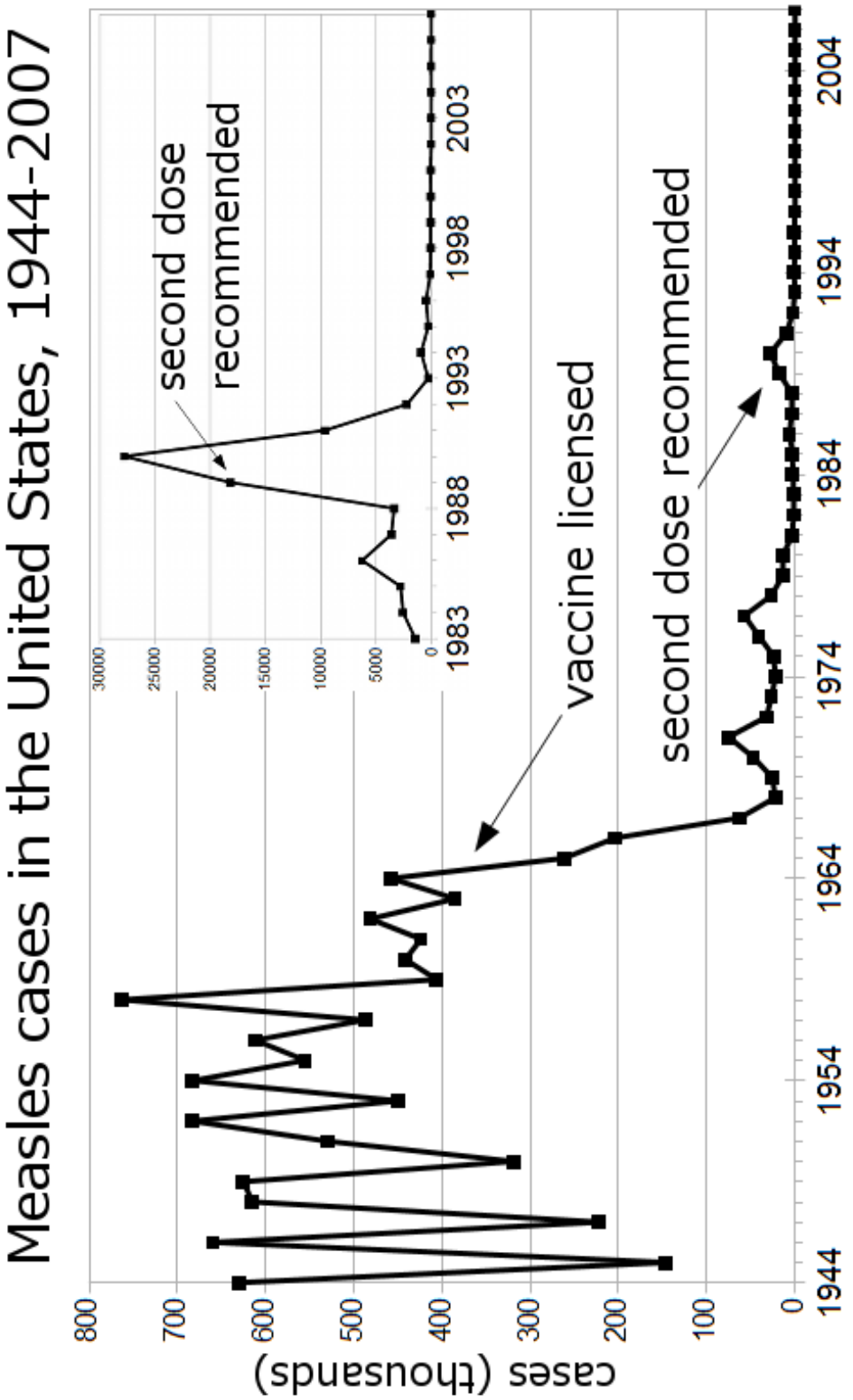
Hold a class discussion about vaccination and what students have learned from their timelines. Display the graphs that follow as examples of the effects of vaccination on the incidences of measles. The first graph shows the number of measles cases in the United States from the years 1944 through 2007. Make sure students understand how to read the graph and know what the zigzag line tells them. The second graph shows what occurred between 2001 and 2015 when large numbers of children were not getting immunized because of parent concerns about vaccine safety.

Words to Know

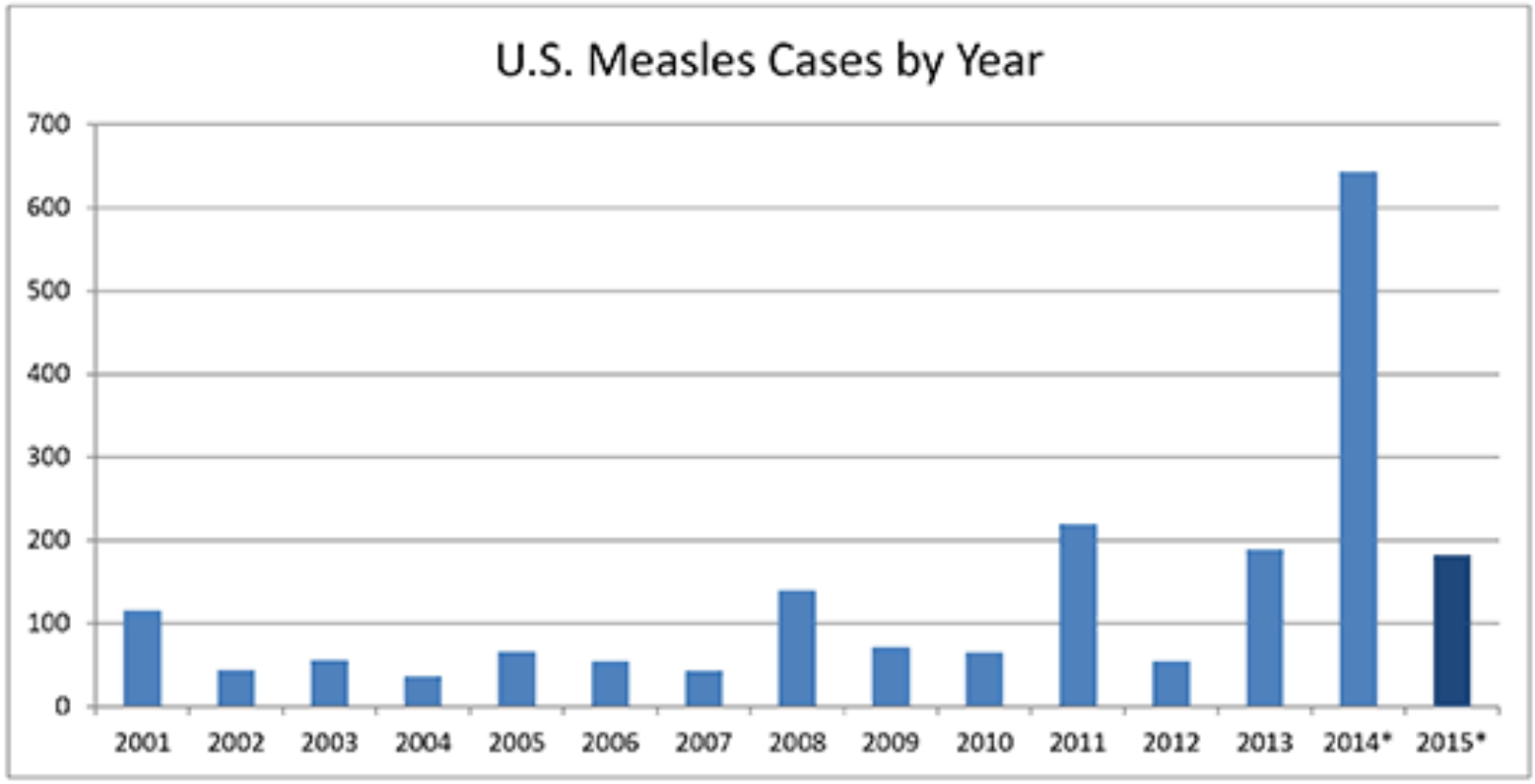
Immunity – Protection from infectious disease usually through vaccination.

Lesion – A sore produced by injury or infection. In this case, the lesion is a kind of a puss-filled blister on the skin that can leave a scar when it heals.

Vaccine – A biological preparation (usually a liquid) administered through injection that provides active acquired immunity to a particular disease.



https://commons.wikimedia.org/wiki/File:Measles_US_1944-2007_inset.png



*Provisional data reported to CDC's National Center for Immunization and Respiratory Diseases

Conclusions Provided by the CDC National Center for Immunization and Respiratory Diseases.

- The majority of people who got measles were unvaccinated.
- Measles is still common in many parts of the world including some countries in Europe, Asia, the Pacific, and Africa.
- Travelers with measles continue to bring the disease into the U.S.
- Measles can spread when it reaches a community in the U.S. where groups of people are unvaccinated.

1796

ATTACH NEXT EVENT HERE

Smallpox

1800

ATTACH NEXT EVENT HERE

Smallpox

1885

Rabies

ATTACH NEXT EVENT HERE

1896

ATTACH NEXT EVENT HERE

Cholera

1896

ATTACH NEXT EVENT HERE

Thphoid

1921

Tuberculosis

ATTACH NEXT EVENT HERE

1923

ATTACH NEXT EVENT HERE

Diphtheria

1924

ATTACH NEXT EVENT HERE

Tetanus

1939

Pertussis

ATTACH NEXT EVENT HERE

1946

ATTACH NEXT EVENT HERE

Pneumococcal Vaccine

1955

ATTACH NEXT EVENT HERE

Polio

1960

Polio

ATTACH NEXT EVENT HERE

1963

ATTACH NEXT EVENT HERE

Measles

1967

ATTACH NEXT EVENT HERE

Mumps

1969

Rubella

ATTACH NEXT EVENT HERE

1995

ATTACH NEXT EVENT HERE

Chicken Pox

1987

ATTACH NEXT EVENT HERE

Haemophilus Influenzae Type B

1986

Hepatitis B

ATTACH NEXT EVENT HERE

2015

ATTACH NEXT EVENT HERE

Human Papilloma virus

2006

ATTACH NEXT EVENT HERE

Human Papilloma virus

Investigation 5

EEHV By The Numbers

Time Needed
2 sessions

Before You Start
Make display copies of Asian elephant pictures from the Internet and post them for the students to see. A good source of pictures is the Smithsonian National Zoo.
https://nationalzoo.si.edu/animals/asian-elephant

You'll Need This Stuff for Each Group
- *The Index Elephant* storybook
  http://www.bioedonline.org/library/storybooks/the-index-elephant/
- Copies of the "Elephant Deaths Due to Elephant Endotheliotropic Herpesvirus – EEHV" data table.
- 3, 2, 1 Study Guide for the Index Elephant
- Calculators (optional)

What's The Question?
What is happening to Asian elephants around the world?

Objective
In this activity, student groups will analyze the data for elephant deaths due to elephant endotheliotropic herpesvirus (EEHV). They will look for commonalities that have been used by scientists to understand the disease and focus on ways to combat it.

What It's About
Elephant Endotheliotropic Herpesvirus or EEHV is a serious threat to world elephant populations. Wild elephant populations are already threatened by poaching, habitat destruction, and climate change. EEHV is an added threat because it is a disease that can lead to mortality not only to elephants in the wild but also in zoos, animal preserves, and circuses. *The Index Elephant* story tells how scientists discovered the culprit, EEHV, after the death of a young Asian elephant at the Smithsonian's National Zoological Park in 1995. Many elephants in zoos and circuses had already died from this unknown ailment. The loss of Kumari, a 2-year old female elephant, put scientists directly on the trail of this deadly disease.

One of the first steps in fighting a new disease is to know everything about it. A special kind of doctor, called an epidemiologist, begins the fight by collecting data. In a sense, an epidemiologist is a disease detective who looks for patterns in disease outbreaks. Data includes a variety of information. In this case, are all elephants threatened by the disease or just one species of elephant? Are males or females at greater risk? What about the age when the disease is most likely to strike? Is the disease only prevalent in the wild or

does it strike captive animals? Where in the world is the disease most common? These are just a few of the important questions epidemiologists ask.

To help scientists focus on the important issues, epidemiologists collect and tabulate data to see what the commonalities are. In this activity, students will analyze a data table that lists 66 elephant deaths attributed to EEHV. Included in the table are the animal's names, whether or not they were born in the wild or in captivity, the sex, age at the time of death, and the location where they lived.

What To Do

1. Read the *Index Elephant* story to your students or have student groups read the story. Provide the 3, 2, 1 study guide to students to assist them in focusing on key issues.
2. Hold a "book club" type discussion on *The Index Elephant* story. What did students learn about elephants and EEHV? Make a list on the board of relevant Elephant/EEHV information.
3. Give a copy of the "Elephant Deaths Due to Elephant Endotheliotropic Herpesvirus – EEHV" data table to each group. Review each column.
   Number: Most recent death to least recent death
   Elephant Name:
   Origin: Captive Born or Wild Born
   M/F: Male or Female
   Age: At the time of death
   Birth Date:
   Death Date:
   Location: Where the elephant lived
4. Assign student groups the task of determining what data in the table is most important and what is least important. Are there commonalities or patterns such as the most common age at death or the sex of the elephant? What will student teams uncover about EEHV?
5. Before turning groups loose, discuss a few limitations of the table.
   - Only two of the elephants listed (#58 and65) are African bush elephants. The rest are Asian elephants. Most zoos and circuses keep Asian elephants. African bush elephants are less common at zoos and this could skew the data. (FYI: Other studies have concluded that African bush elephants are less likely to die from EEHV.)
   - Zoos tend to keep more female Asian elephants than males.
   - EEHV does exist for wild elephants but data collection is difficult. Only a few wild-born elephants are kept in zoos. Most elephants in the herds are captive born.
   - Birth and death dates are not known for some of the animals. When 00 is listed, the month, day, and (or) year is unknown.
6. Have student teams review the tables and create graphs or other graphic organizers to display their conclusions.
7. Conduct a class discussion where groups share their findings on EEHV.

Wrap It Up
Try to arrange a field trip to your local zoo and meet the elephant manager to discuss the practical side of EEHV and other elephant care issues. If you are unable to take a field trip, invite zoo experts to come to you or to connect through the Internet.

References

The Index Elephant and other elephant resources, such as elephant videos and a presentation by a Baylor College of Medicine scientist are found at the following address:

http://www.bioedonline.org/library/media/photos-and-video/saving-baby-elephants-from-a-lethal-virus-eehv/

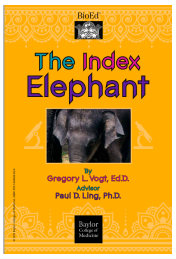
Elephant Deaths due to Endotheliotropic Herpesvirus

#	Elephant Name	Origin	M/F	Age	Birth Date	Death Date	Location
1	**Sumitra**	Captive	F	2	2/4/14	1/23/16	Ostravia Zoo, Czech Republic
2	**Mumba**	Captive	F	4	5/18/11	12/8/15	Natura Artis Magistra , Amsterdam, The Netherlands
3	**Jade**	Captive	F	7	5/4/08	11/30/15	Le Pal Zoo, Dompierre-sur-Besbre, France
4	**Hari Hi Way**	Captive	M	3	11/25/12	10/27/16	Chester Zoo, Cheshire, England
5	**Malee**	Captive	F	4	4/15/11	10/1/15	Oklahoma City Zoo, USA
6	**Bala Hi Way**	Captive	F	2	1/21/13	9/14/15	Chester Zoo, Cheshire, England
7	**Max**	Captive	M	2	10/13/13	6/5/15	Whipsnade Zoo, Bedfordshire England
8	**Daizy**	Captive	F	6	9/2/09	5/9/15	Albuquerque Biological Park, USA
9	**Mike**	Captive	M	2	6/27/13	1/25/15	Ringling Brothers Barnam and Bailey Center for Elephant Conservation, , USA
10	**kao Sok**	Captive	M	1	2/25/13	11/24/14	Copenhagen Zoo, The Netherlands
11	**Ganesh**	Captive	M	1	2/14/13	5/00/14	Tadoda Anghari Tiger Reserve, Maharashtra state in central India
12	**Naka**	Captive	M	1	1/00/13	2/12/14	FAE Elephant Hospital, Thailand
13	**Nayan Hi Way**	Captive	M	3	7/18/10	7/29/13	Chester Zoo, Cheshire, England
14	**Arwen**	Captive	F	1	5/29/12	6/25?/13	Zoo de Pont-Scorff, Pont Scorff, France
15	**Jamilah Hi Way**	Captive	F	2	1/22/11	6/3?/13	Chester Zoo, Cheshire, England
16	**Unknown?**	Captive	F	?	?	11/00/12	Sauraha Elephant Breeding Center, Slauraha, Nepal
17	**Mohini**	?	F	?	?	10/17/12	Bhopal Operation Durga, Bhopal, India
18	**No Name**	Captive	F	0, Stillborn	3/25/12	3/25/12	Twycross Zoo, Twycross, England
19	**Gauri**	Captive	?	4	12/00/08	1/00/12	Tadoda Anghari Tiger Reserve, Maharashtra state in central India
20	**Ko Raya**	Captive	F	2	3/15/09	5/27/11	Berlin Zoo, Berlin, Germany
21	**Ganesh Vijay**	Captive	M	2	8/6/09	4/13?/11	Twycross Zoo, Twycross, England
22	**Shaina Pali**	Captive	F	6	6/15/05	4/5/11	Berlin Zoo, Berlin, Germany

23	**Tong Tae**	Captive	M	3	5/13/08	4/1/11	Wanchai Manapermpian, Thailand
24	**Bhadra**	Captive	?	?		00/00/11	Sauraha Privatte Resort, Nepal
25	**Jp**	Captive	M	4	12/12/06	6/22/10	Have Trunk Will Travel, USA
26	**Baby Zeno**	Captive	F	2	9/24/08	00/00/10	FAE Elephant Hospital, Thailand
27	**Chellam**	Wild	F	4	00/00/05	11/20/09	Madras Vandelur Zoo, India
28	**Raman**	Captive	F	3	11/12/06	7/23/09	Chester Zoo, Cheshire, England
29	**Leelee**	Captive	F	2	1/19/07	5/17/09	Whipsnade Zoo, Bedfordshire England
30	**Donaldson**	Captive	M	1	1/17/08	5/3/09	Whipsnade Zoo, Bedfordshire England
31	**Mac**	Captive	M	2	10/1/06	11/9/08	Houston Zoo, Texas
32	**Aswathy**	Captive	F	0	00/00/07	12/28/07	Kodanadu Elephant Training Center, India
33	**Malti**	Captive	F	1	8/9/07	11/1/08	Calgary Zoo, Alberta, Canada
34	**Niranian**	?	F	1	00/00/06	12/26/07	Kodanadu Elephant Training Center, India
35	**Nisha**	Captive	F	1	7/18/06	12/1/07	Dickerson Park Zoo, USA
36	**Hansa**	Captive	F	7	11/3/00	6/8/07	Woodland Park Zoo, USA
37	**Aneena**	Captive	F	2	3/16/04	12/17/06	Whipsnade Zoo, Bedfordshire England
38	**Logan**	Captive	M	0	4/13/06	4/13/06	African Lion Safari. Ontario, Canada
39	**Plai**	Captive	M	?	?	1/3/06	Sublanka Wildlife Sanctuary, Thailand
40	**Ganesh**	Captive	M	7	3/15/98	8/16/05	Columbus Zoo and Aquarium, Ohio, USA
41	**Sitang**	Captive	M	3	6/30/02	8/15/05	Port Lympne Zoo, England
42	**?**	Captive	M	0, Stillborn	5/28/05	5/28/05	Port Lympne Zoo, England
43	**Kimba**	Captive	F	13	7/17/91	9/5/04	Houston Zoo, USA
44	**Seima**	Wild	?	3	00/00/01	5/6/04	Phnom Toma Zoo and Wildlife Rescue Center, Cambodia
45	**Baby Jennie**	Captive	F	8	9/6/98	4/12/04	Endangered Ark Foundation, OK
46	**Aishu**	Captive	M	3	6/10/00	10/15/03	Zurich Zoo, Switzerland
47	**Preya**	Captive	F	3	2/10/00	4/12/03	Syracuse Zoo, USA
48	**Senang**	Captive	M	0	2/1/20	2/12/20	Rotterdam Zoo, The Netherlands
49	**Kathy ShBoom**	Wild	F	42	11/25/60	11/21/02	Niabi Zoo, Illionos, USA

50	**Haji**	Captive	M	3	11/28/99	6/7/02	Dickerson Park Zoo, USA
51	**Kiri**	Captive	M	0	4/5/00	12/28/00	Berlin Zoo, Berlin, Germany
52	**Kala**	Captive	M	2	5/17/98	11/28/00	Six Flags Discovery Kingdom, California, USA
53	**Singgah**	Captive	F	7	12/29/93	1/1/00	Houston Zoo, USA
54	**Xian**	Captive	M	2	9/8/97	11/20/99	Zurich Zoo, Switzerland
55	**Willi**	Captive	M	0	1/11/99	1/12/99	Munster Zoo, Germany
56	**Citta**	Wild	F	26	1972	11/15/98	Krefield Zoo, Gemany
57	**Kiba**	Captive	M	11	12/31/87	8/30/98	Berlin Zoo, Berlin, Germany
58	**Kijana**	Captive	M	1	11/3/95	10/7/96	Oakland Zoo, USA
59	**Kumari**	Captive	F	2	12/14/93	4/26/95	Smithsonian National Zoological Park, USA
60	**Maverick**	Captive	M	7	10/5/86	11/26/93	Tulsa Zoo and Living Museum, USA
61	**Maiva**	Captive	F	2	7/26/91	2/28/93	Dickerson Park Zoo, USA
62	**Pearl**	Captive	F	3	12/7/88	9/2/91	Lincoln Park Zoo, USA
63	**Bopper**	Captive	M	4	2/1/84	8/26/88	African Lion Safari. Ontario, Canada
64	**Lohmi**	Captive	F	3	5/24/85	7/21/88	Circus Knie, Switzerland
65	**Susie**	Wild	F	16	00/00/71	00/00/87	Heidelberg Zoo, Germany
66	**Astor**	Captive	M	2	8/20/81	1/26/83	Bronx Zoo, USA

3, 2, 1 Study Guide



Your Name: _____

3 Write down 3 things you learned by reading this story.

2 Write down 2 things you found out about EEHV

1 Write down 1 question you would like to ask

The EEHV Menace

Time Needed
3-4 sessions

Before You Start
Students will need to have read *The Index Elephant* story and conducted Investigation 6 in advance of this investigation.

What It's About
Infectious diseases can become worldwide problems very quickly because of international travel and commerce. A disease, acquired by a traveler in a faraway location, can be brought home in a matter of hours because of airplane and other forms of travel.

We have seen the tragic effects of a traveling virus recently in the "explosive" spread of the zika virus across North and South America and Caribbean island countries. Zika virus is passed to humans through the bite of a common mosquito found in every North and South American country except Canada and Chile.

Following up on Investigation 6, student teams will create posters and other exhibit materials that can be used to share their learning about EEHV, a disease affecting Asian elephants. EEHV or elephant endotheliotropic herpesvirus is a deadly disease greatly affecting baby elephants. It is a threat to the survival of Asian elephants in particular. Zoos and circuses around the world keep small herds of Asian elephants. Bringing in new elephants from the wild and shared breeding programs has enabled the virus to spread worldwide.

What's The Question?
Why do viral diseases spread so rapidly around the world?

Objectives
Students will investigate ways viral diseases spread around the world. They will then create, in teams, exhibits to explain EEHV and its worldwide spread to other classes.

Materials:
- Project boards
- Art supplies
- Butcher paper
- Paper maché
- Yarn

Procedure

1. Ask students what they know about the zika virus (or any other disease that is currently being discussed in the news). Make a list on the board of what students know about the disease, symptoms, and the way it spreads.
2. Show the following video about worldwide commercial airplane travel. It animates airplane traffic over a 24-hour period. The video provides a time sense by the way day and night moves across Earth's surface. Use the video to discuss why diseases can spread so rapidly. A passenger with a disease can not only spread the disease to others on the plane but also carry the diseases to another country or even continent. (Foreign travelers to the US brought the measles virus to Disneyland in 2015 and triggered a measles outbreak.)
   https://www.youtube.com/watch?v=o4g930pm8Ms

3. Point out that humans aren't the only animals that have problems with diseases. Ask students for the names of different kinds of animal diseases they have heard of or diseases their pets at home have acquired (E.g., kennel cough, swine fever, rabies, etc.) Review student knowledge about elephant endothelitropic herpesvirus or EEHV.
4. Tell your students that they will be creating exhibits or videos on the EEHV crisis that can be shared with other classes at your school. Teams of students, with each team working on a different part, design and construct exhibit components. "The Index Elephant" and the data table in the previous activity will be the primary source of information for the exhibit. Much additional information about EEHV can be found on the Internet. Teams will make posters, models, dioramas, charts, display titles, download elephant videos on laptops, etc. The following is one suggestion for how the exhibit can be coordinated:

   Part 1 - Kumari's Story (pictures, who, what, why, where, etc.)
   Part 2 – African and Asian elephants (where they live, differences, paper maché models, etc.)
   Part 3 – EEHV (what it is, what it does, how was it discovered, what is being done, etc.)
   Part 4 – The Houston Zoo and the Baylor College of Medicine (how the Houston Zoo elephant population is protected)

Wrap It Up

Set up the exhibit in the classroom, a hallway, cafeteria, or other space in the school. Invite other classes to tour the exhibit. Have students on hand to explain the exhibit to visitors and answer questions. The exhibit will make a nice addition to open house and parents night activities.

If your school is near a zoo, arrange for a zoo fieldtrip and make special arrangements to meet with elephant handlers to learn about their animals and how they protect their health.

Investigation 7

Climate Change and Disease

Time Needed
1 session

Before You Start
Load the following National Oceanic and Atmospheric Administration website on classroom computers: http://www.ncdc.noaa.gov/temp-and-precip/state-temps/

What It's About
Because of its rapid spread, a worldwide health emergency was declared in early 2016 for the zika virus. Appearing in Brazil in May of 2015, the virus expanded to over 20 western hemisphere countries in just 8 months. The risk of catching this and other viral diseases has increased greatly due to long-distance travel, population growth, urbanization, lack of sanitation, and international commerce.

Another potentially serious factor in the spread of infectious disease is climate change. The reason for concern is that areas that are habitable for disease carriers, such as mosquitoes, appear to be expanding north and south. For example, the zika, dengue, chikungunya, and west Nile viruses are all carried by the *Aedes aegypti* mosquito. This mosquito dwells in the tropical and subtropical regions of Earth where temperatures get no colder than 10°C (50°F). These temperatures are typically found between 35° north and 35° south of the equator.

The climate of any location is the average yearly condition for that area. This includes temperature, precipitation, sunlight, and many other weather factors. Temperature is of special importance to the survival of mosquitoes. In cold climates, the *Aedes aegypti* mosquito is unable to complete its life cycle and consequently, its ability to acquire and spread viruses is very limited in those areas. In warm climates, the mosquito can be active year round.

Precipitation and the pooling of water are other essential ingredients for the life cycle of mosquitoes. Female mosquitoes lay their eggs in standing water. There, eggs develop and hatch into larva that go through several growth stages. The larva become pupa, that remain in the water until the adult mosquito emerges. Pools of water include natural pools but also human-made pools such as old tires, barrels, cans, clogged rain gutters. The human-made pools are often more valuable to the mosquitos because they are usually clustered near the mosquito's food source – humans and domesticated animals.

How could climate change affect the spread of EEHV, zika, and other viral diseases? The idea is simple. As the climate warms, the mosquito habitable areas of Earth increase while the areas that are inhospitable (too cold) decrease. In addition, warmer temperatures contribute to conditions that promote diseases like cholera. Deforestrationalso contributes to disease by changing the habitats of rodents that carry diseeases, or by forcing different groups of animals to come together (as can happen with herd animals like elephants).

The health effects of climate change are widespread. The spread of many infectious diseases is enhanced by climate change along with many other signigicant health effects. Additional information is available from the Center for Disease Control. https://www.cdc.gov/climateandhealth/effects/default.htm#factsheets

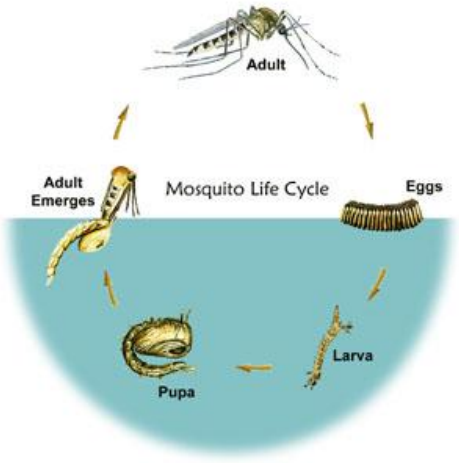
What's The Question?
Are we at risk for the spread of infectious viral and other diseases because of climate change?

Materials:
- Blank USA map
- Colored Markers
- Internet access: http://www.ncdc.noaa.gov/temp-and-precip/state-temps/

Procedure

1. Ask students what they know about climate change. Make a list on the board of their ideas. To facilitate discussion, be sure students know the difference between weather and climate.
   Weather is what is happening outside right now. Climate is the average weather over a year - average temperature, precipitation, sunshine, winds, etc. Show videos of climate change to your student. Here are a few suggestions.
   https://www.youtube.com/watch?v=OtY8DpA_XNE
   https://www.youtube.com/watch?v=OtY8DpA_XNE
   https://www.youtube.com/watch?v=OtY8DpA_XNE
   https://www.youtube.com/watch?v=OtY8DpA_XNE

2. Discuss the life cycle of the mosquito. Use the following site for a concise description of the cycle: http://www.epa.gov/mosquitocontrol/mosquito-life-cycle.



Source: U.S. Environmental Protection Agency

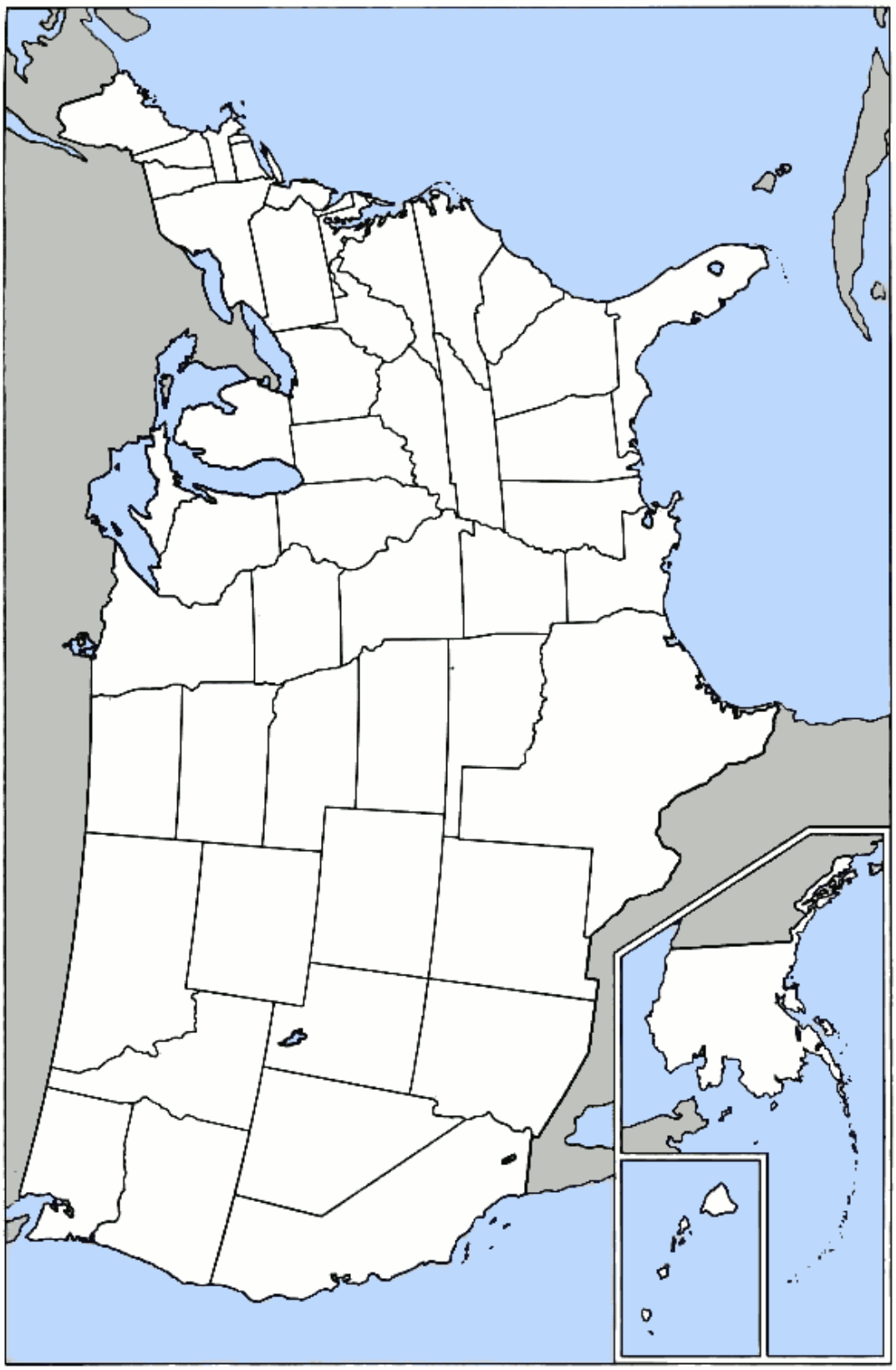
3. Ask students how climate change (Earth warming) could affect mosquitos. (Possibly increase their range north and south of the equator.)

4. Show students the NOAA website for state temperatures. Click on a state from the list (Select State button). Show what happens to the graph when you click Select Variable and when you click season. Discuss what the graph shows. An explanation of the graph is found in the section marked State Trend Charts. The annual chart shows the temperature chart for 120 years. The direction of the blue line shows the trend for those years.
   Notes:
   • The temperature scale to the left changes with the state selected and the seasons.
   • Only the lower 48 states are shown on this site.
5. Have teams of students explore the site for any states they would like to learn about. After 10 or so minutes, ask if they have seen any trends to the temperature climates of the states they looked at. Is it warmer or colder in 2015 than it was in 1895?
6. Distribute blank USA maps and markers. Have student teams look at each of the southern states, such as Florida. Have them click on Mean Temp and Annual. Is Florida a place that is currently hospitable to the *Aedes aegypti* mosquito? (Yes)
7. Have students shade in the Florida map with a color of their choice. The same color should be used for every state that is currently hospitable to the mosquito. As students move northward, some states will be too cold for the mosquito. All these states should be shaded with a different color. Have students fill in all states as either being hospitable or inhospitable to the mosquito.
8. Have students place their maps in their notebooks and answer the following questions.
   What will happen to the range of the *Aedes aegypti* mosquito if the climate continues to get warmer?
   What will happen to the spread of infectious viral diseases such as zika, dengue, chikungunya, and west Nile.

Wrap It Up

Conclude this activity by discussing student ideas for what can be done to stop the spread of mosquito-borne viruses. Some possible discussion points are as follow.

Bug spray
Removal of debris that collect water mosquito
Mosquito netting
Wear clothing that covers arms and legs
Mosquito repellant clothing
Community spraying program



Investigation 8

And Now, *It's Time for Infectious Disease Jeopardy!*

Time Needed
2-3 sessions

Before You Start
Download the game scoring spreadsheet.
Web address on bioed

What It's About
Student teams become infectious disease experts as they prepare and play a jeopardy-style quiz game.

Jeopardy! is a classic television game show that originated in 1964 and is still running today. Contestants pick game categories to view answers that they have to give a response to in the form of a question. Each statement has a dollar value that is added to their totals if they answer correctly and subtracted from their total if answered incorrectly. In this version of jeopardy, three teams of students will play against each other. They will select infectious disease categories and view statements about the disease. Any member of the team, whose turn it is, can give an answer in a question form. The team earns "$" points if correct or looses $ points if incorrect. Other teams can then try to answer the question. If no one answers correctly, the game moderator (teacher or designated student) reads the correct answer.

Infectious Disease Jeopardy! is set up for two rounds, each consisting of 5 different infectious disease categories. Each disease category has 5 answers that teams have to make up questions for. A spreadsheet, projected on the board, is used for scoring. Teams take turns selecting categories and answering prompts. When a team misses an answer, the game moves to another team. When the prompts from all five categories are selected and answered, the game ends and the team with the highest $ point total wins. A second round is played with other teams and a new set of disease categories.

To prepare for the game, team members are told what the infectious disease categories are for each of the two rounds. The teams must learn as much as possible about each of these diseases. Their primary source of information is a set of 10 Infectious Disease Info Sheets. Teams won't know what 5 categories they will get round until the game starts. The task of researching the diseases can be divided among the team members.

Materials:
- Infectious Disease INFO Sheets
- Game spreadsheet downloadable from BioEdOnline (www.bioedonline/etc..)or design your own.

Objectives
Students will learn about various infectious diseases by preparing for a fast action knowledge game.

Procedure:

Review the rules for Infectious Disease Jeopardy with your students. The game rules are similar to the television version of the game but with a few modifications. Three teams compete at a time. Teams can consist of 1 to 5 players in groups spaced around the classroom. There are sufficient questions for two complete rounds of the game.

Rules:

1. Pick the starting team by lot. From there, play always moves in the same sequence determined in advance.
2. The categories of the first round are written on the board. See the category illustration for how to set up the board.
3. Begin the game by having the first team select a category and a dollar amount square. Read the statement. Only one member of the team answers the statement and does so in a question format. Give teams up to 10 seconds to confer before answering.

   Example
   "Measles" for $200. Statement - 1963
   Answer: *In what year was the measles vaccine introduced?*

4. If the team answers the statement correctly, they are awarded the $ points in the score spread sheet. They then get to select the next square in any category they choose. If the team correctly answers that statement, they continue. After five consecutive correct answers, play moves to the next team in the agreed upon sequence.
5. Each question that has been chosen is given a check mark on the board to show teams that it has already been asked and answered.
6. If the playing team fails to answer a question correctly, they are penalized the $ points. Play moves to the next team in sequence. That team tries to answer the question. If they answer correctly, they get the $ points and play moves to them. That team gets to answer another four questions. If they miss the question, they get penalized the $ points and play moves to third team gets to try. If no team answers the statement correctly, the game moderator gives the correct answer to all teams. Play returns to the first team and they move on to the next square of their choice for up to 5 correct answers in a row.
7. The game ends when all 25 questions have been asked and answered. Scores for each team are compared and the winning team is identified. If there is a tie, one of the questions missed by the teams is asked again. The first team to answer it wins the tie.
8. The categories are changed for the second round and new teams compete.

Special Notes:

- The game moderator (teacher) has the option to accept answers that are close to the answers given in the question bank that follows. The answers in the bank provide the general information that should be included in team answers.
- As an extension, have students contribute new prompts and questions for additional rounds of the game.

Wrap It Up

Hold a class discussion on the diseases featured in the game.

Which diseases are of concern to people in the United States?

All are. Rapid international travel makes it easy for diseases to spread world wide.

Which diseases are preventable with vaccines?

Measles, Influenza, Polio, Typhoid Fever, Smallpox

How are you affected by infectious diseases, even when you do not contract them yourself?

Infectious diseases can affect the course of history. Whole countries can be decimated (and have in the past, E.g. Bubonic plague), tens of millions of people die, productivity lost, generations of young people lost, high medical costs, etc.

Why are vaccines a good thing?

Vaccines are a low-cost and safe way of stopping the spread of infectious diseases. The more people vaccinated, the harder it is for diseases to spread.

Game Spreadsheet Design

Instructions:

1. Create the game scoresheet with Microsoft Excel or other spreadsheet program.
2. Select each TOTAL in turn and enter the formula to calculate the total for Question Numbers 1-25. Doing so will permit adding and subtracting $ points.
3. Points are added or subtracted from each team's total for only the questions the teams answer or fail to answer.
4. Team column headings (A,B, C) can be replaced with team names if desired.

A game spreadsheet is available for download from www.bioedonline.....

INFECTIOUS DISEASE JEOPARDY						
TEAMS		A		B		C
Question Number						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
TOTAL		0		0		0

Game Boards Round 1 and Round 2

Malaria	HIV/AIDS	Flu	Ebola	Cholera
$ 100	$ 100	$ 100	$ 100	$ 100
$ 200	$ 200	$ 200	$ 200	$ 200
$ 300	$ 300	$ 300	$ 300	$ 300
$ 400	$ 400	$ 400	$ 400	$ 400
$ 500	$ 500	$ 500	$ 500	$ 500

Measles	Polio	Smallpox	Typhoid	TB
$ 100	$ 100	$ 100	$ 100	$ 100
$ 200	$ 200	$ 200	$ 200	$ 200
$ 300	$ 300	$ 300	$ 300	$ 300
$ 400	$ 400	$ 400	$ 400	$ 400
$ 500	$ 500	$ 500	$ 500	$ 500

Question Bank Round 1

Malaria

$100 "Plasmodium falciparum"
What is the most deadly species of malaria parasite?

$200 "Female Anopheles mosquito"
What kind of mosquito spreads malaria?

$300 "1 child every 66 seconds"
How often does malaria kill a child?

$400 "90%"
What percent of all the children that die from malaria are in Africa?

$500 "Mosquito netting"
What is one effective way of preventing malaria?

HIV/Aids

$100 "Body fluids"
How is HIV spread from person to person?

$200 '1.2 million"
What is the number of people in the U.S. living with HIV?

$300 "HIV"
What is the abbreviation for Human immunodeficiency virus?

$400 "Cancer and tuberculosis"
What are some diseases you can catch when you have AIDS?

$500 "Worse flu ever"
What are some early symptoms of an HIV infection?

Ebola

$100 "Ebola"
What is the name of the river where the first outbreaks of ebola occurred?

$200 "50%"
What are the chances of surviving an ebola infection?

$300 "2 to 21 days"
How long before a person who is infected with ebola begins to feel sick?

$400 "Chimpanzees gorillas, forest antelopes, humans"
What are some animals that can pass the ebola virus to humans?

$500 "2014"
When did the largest outbreak of ebola occur?

Flu

$100 "Influenza"
What is the full name for flu?

$200 "Sneezing and coughing"
What are ways for spreading the flu virus?

$300 "3"
How many main types of flu are there?

$400 "50 to 100 million"
How many people died from the Spanish Flu in 1918?

$500 "Vaccination, hand washing"
What are two ways to protect against the flu?

Typhoid Fever

$100 "Mary Mallon"
Who was "Typhoid Mary"?

$200 *"Salmonella Typhi"*
What is the bacteria responsible for typhoid fever?

$300 "pneumonia, pancreatitis, and kidney and bladder infections"
What can typhoid fever infections lead to?

$400 "washing hands, drinking boiled water, and only eating cooked food"
How can typhoid fever be avoided when traveling in other countries?

$500 "Southeast Asia, Africa, and South America"
Where is typhoid fever a common illness?

Question Bank Round 2

Measles

$100 "Rubeola"
What is the other name for measles?

$200 "1963"
In what year was the measles vaccine introduced?

$300 "High fever, rash"
What are symptoms of measles?

$400 "Virus"
What is the cause of measles?

$500 "Measles worldwide"
What is one of the leading causes of death in young children?

Polio

$100 "Infantile paralysis"
What is another name for polio?

$200 "Iron lung"
What device was used to help polio victims breathe?

$300 "Franklin D. Roosevelt"
What U.S. President contracted polio?

$400 "Food and water contaminate by human feces"
What is one way in which polio can be transmitted?

$500 "Afghanistan and Pakistan"
In what two countries is polio still a problem?

Smallpox

$100 "1980"
When was smallpox declared wiped out?

$200 "Latin word for spotted"
What is the smallpox symptom that give the disease it name?

$300 "Infected clothing, blankets, body fluids"
How can smallpox be spread?

$400 "1977"
When did the last known case of smallpox occur?

$500 "400,000"
How many Europeans were killed annually by smallpox in the 18th century?

TB

$100 "Consumption, Pott's Disease, white plague"
What are other names for tuberculosis?

$200 "hand shaking, kissing, or sharing toothbrushes"
What does not spread TB?

$300 "2 billion"
What is the number of people around the world who have latent TB infections?

$400 "Lungs, kidneys, spine, and brain"
What parts of the body can be affected by TB?

$500 "Drug resistance"
What happens to bacteria if a victim does not correctly take all of his or her medicine?

Cholera

$100 "Water and food contaminated with feces"
How does the cholera bacteria transmitted?

$200 "India"
In what country did cholera originate from?

$300 *"Vibro cholera"*
What is the name of the bacteria that causes cholera?

$400 "Massive diarrhea and vomiting"
What are two symptoms of cholera?

$500 "Hand washing, clean drinking water, well cooked food"
What are ways of avoiding contracting cholera?

INFORMATION SHEET 1

Disease: Measles (Rubeola)

Measles is an infectious disease that especially strikes children. The disease typically begins with high fever, cough, runny nose, and red, watery eyes. In two or three days, tiny white spots may appear inside the mouth. In three to five days, a rash breaks out. Usually, red spots appear on the face at the hairline and then spread downward to the neck, trunk, arms, legs, and feet. When the rash appears, fever may spike to 104 degrees Fahrenheit. After a few more days the fever subsides and the rash fades.

The measles virus is highly contagious. It lives in the mucus of the nose and throat of an infected person. It can spread through coughing and sneezing. The virus can live for up to two hours in the air space where an infected person has coughed and sneezed. If an uninfected person breathes the contaminated air or touches an infected surface and then touches his or her eyes, nose, or mouth, that person most likely will become infected.

Things to Know

- Measles is only spread by humans.
- Measles is so contagious that 90 percent of people, who are not immune to the virus or vaccinated will become infected when they come in contact with an infected person.
- Until 1963, when a vaccine became available, nearly all children got measles by the time they were 15. Three to four million people in the United States became infected yearly. Four to five hundred victims died, 48,000 were hospitalized, and 4,000 victims also suffered from brain swelling (encephalitis) due to their infection.
- In 1912, the United States government designated measles as a nationally notifiable disease (meaning that doctors and hospitals have to inform the government of the number of cases they treat).
- In the first ten years of measles reporting in the United States (1912-1922), an average of 6,000 children died yearly from the disease.
- Worldwide, measles is one of the leading causes of death among young children. In 2014, 114,900 died from measles (about 13 deaths per hour.
- Before 1980, when the measles vaccine was given around the world, measles killed an estimated 2.6 million children each year.

INFORMATION SHEET 2:

Disease: Poliomyelitis (polio or Infantile paralysis)

Poliomyelitis, or polio, is an infectious disease caused by the poliovirus. Victims experience muscle weakness that can result in an inability to move or even to breathe without some sort of device to help them. Usually, a serious polio infection begins with weakness in the legs. In young children, legs may fail to develop normally and become distorted, making walking difficult throughout life. Many people, who become infected, only experience minor symptoms such as fever, sore throat, headache, neck stiffness, and pains in arms and legs. These people usually feel normal again in a week or two. In 70% of polio cases, victims do not experience any symptoms at all. However, victims who experience the most severe symptoms, notably muscle weakness, may die. Up to 5% of children and up to 30% of adults die from polio infections.

Poliovirus is usually spread from person to person through infected feces entering the mouth. It can also be spread by food or water containing human feces. Proper sanitation and personal hygiene is an important way of reducing the possibility of infection. Polio can be prevented with a vaccine that is given orally through drops. The vaccine provides immunity in 95% of the children who receive it. Because the vaccine is inexpensive and easy to administer, it is used worldwide.

Things to Know

- During major polio outbreaks (1940s and 1950s), hospital wards used rows of negative pressure ventilator devices, called "iron lungs" to help victims breathe.
- Polio infections decreased by over 99% since 1988, from an estimated 350,000 cases annually, to 359 in 2014.
- Polio is still a problem in Afghanistan and Pakistan where superstition and violence have reduced the number of children there who receive the vaccine.
- Children under 5 are most at risk for getting polio.
- Post-polio syndrome may occur 35 years after a person has had polio. It may involve muscle and joint pain, difficulty breathing and swallowing, and sensitivity to cold temperatures.
- Franklin D. Roosevelt contracted polio several years before being elected President of the United States.

INFORMATION SHEET 3

Disease: Smallpox

Smallpox is a serious, contagious infectious disease that is sometimes fatal. Smallpox, also called variola, is spread by the variola virus. There are four varieties of the virus that can be contracted. One variety, variola major, is the most serious form and accounts for more than 90% of the cases.

Smallpox gets its name from the Latin word for spotted. It produces raised bumps that cover the face and body of an infected person. It is passed from person to person by direct contact with infected bodily fluids or contact with infected objects such as sheets and blankets and clothing.

The first symptoms of smallpox include fever, malaise, head and body aches, and sometimes vomiting. This is followed by a rash of small red spots on the tongue and in the mouth. The spots break open and spread the virus through the mouth and throat. At this time, the victim is most contagious. In a few days raised bumps appear around the skin and fill with fluid. Scabs form on the bumps and eventually fall off. When all scabs are gone, leaving behind pitted scars in the skin, the person is no longer contagious.

A worldwide effort to control smallpox with vaccines has eliminated the disease. The last known naturally occurring case of smallpox occurred in Somalia in 1977. Since the disease is no longer being spread, it is no longer necessary to be vaccinated against it.

Things to Know

- Smallpox is believed to have originated in human populations about 12,000 years ago.
- In the latter years of the 18th century, smallpox killed an estimated 400,000 Europeans annually.
- Smallpox was officially declared wiped out in 1980.
- There is no known treatment for smallpox. The disease just has to run its course.
- Smallpox victims rarely die from the disease but some very rare forms of smallpox can kill pregnant women and people with impaired immune systems.
- Smallpox leaves victims with severe scars on the face, arms, and legs.
- In some cases, smallpox may lead to blindness

INFORMATION SHEET 4

Disease: Cholera

Cholera is a bacterial disease that causes acute diarrheal infections that can kill the victim in a matter of hours. Between 1.4 and 4.3 million cases occur around the world every year with between 28,000 and 142,000 deaths yearly.

Cholera is caused by the bacterium *Vibrio cholerae*. Victims contract cholera by eating food and drinking water infected by the bacteria. It is a rare disease in the United States and other developed countries that have good sanitation systems. In poor countries and in areas struck by major disasters, outbreaks can occur. Disasters, like the earthquake that struck Haiti in 2010, damage or destroy water and sewer systems and made it difficult for people to obtain clean water. Since the Haitian quake, more than 700,000 Haitians have become ill with cholera and 9,000 died.

The symptoms of cholera are many – massive watery diarrhea, vomiting, low blood pressure, rapid heart beat, thirst, muscle cramps, and more. Because of the loss of fluids through diarrhea and vomiting, severe dehydration can occur and lead to death in a few hours. Fortunately, only a small proportion, 5 to 10%, of the victims have a serious infection and are risk from dying.

Cholera is easily treated. Patients are given large amounts of water or fluids with electrolytes to replace the fluids lost through diarrhea and vomiting. In a few hours, the infection (the bacteria) passes out of the body and the patient recovers.

Things to Know

- Cholera probably originated on the Indian Sub Continent (India) as early as 1000 AD. It spread around the world primarily through sailors on merchant vessels and merchants on trading caravans.
- James K. Polk, the 11th President of the United States, died from cholera a few months after his presidency term ended.
- People, even those in areas with a cholera outbreak, can protect themselves from cholera by only drinking pure water, eating well-cooked food, and hand washing.
- Cholera bacteria are usually found in water or food sources that have been contaminated by feces from a person infected by cholera.
- Two oral cholera vaccines are available but should not replace standard hygiene practices (hand washing, clean drinking water, well cooked food).
- Cholera is rare in the United States but American travelers can still contract cholera in other countries where there are outbreaks.

INFORMATION SHEET 5

Disease: Malaria

Malaria is an illness spread by mosquito bites. Only the female Anopheles mosquito can transmit malaria to people it bites. During the bite, the malaria parasite, harboring in the mosquito, enters the bloodstream of the victim. More than 100 different species of malaria are present in nature but by and large, the most deadly is the *Plasmodium falciparum* parasite that is most common in Africa.

Once a victim is infected with the malaria parasite, the parasite lodges itself in the victim's liver. There, it multiplies thousands of times. In about two weeks, the parasite bursts into the bloodstream where it infects red blood cells.

Symptoms of the malaria infection begin in 10 days to 4 weeks. The victim experience fever, headaches, and vomiting. If no drugs are available to treat the victim, the disease can cause anemia (reduced red blood cells), hypoglycemia (low blood sugar), and cerebral malaria (brain capillaries are blocked, the brain swells, and damage to the brain occurs). In the most severe cases, coma will occur, organs will fail, and death will follow. Most victims do survive malaria but some versions of the disease can lay dormant in the body for years and then suddenly reemerge to create the malaria symptoms again.

A variety of drugs are used to treat malaria. Because the parasite can become resistant to existing drugs, researchers continually look for new drugs to treat the disease. There is a worldwide effort to develop a vaccine for malaria. Developing a vaccine against a parasite is very challenging.

Things to Know

- Mosquito netting is a very effective prevention technique for Malaria. The mosquito bites at night and netting protects sleeping people.
- Malaria parasite-bearing mosquitos are most common in central South America and southern Africa.
- Malaria kills 453,000 children (90% in Africa) per year. That's 1 child every 66 seconds.
- Half the world is at risk for catching malaria.
- 198 million cases of malaria occurred worldwide in 2013
- Between 1,500 and 2,000 cases of malaria occur in the United States every year.

INFORMATION SHEET 6

Disease: HIV/AIDS

HIV stands for human immunodeficiency virus. When contracted, it weakens a person's immune system by destroying important cells that fight disease and infection. These important cells are called CD4 cells or T cells. Over time, HIV will destroy so many of these disease-fighting cells that AIDS or acquired immune deficiency syndrome occurs. A person with AIDS is at great risk for developing life-threatening diseases such as cancer, brain illnesses, and tuberculosis.

HIV is an infection that occurs when a person comes into intimate contact with fluids from another person, such as blood, that is infected with HIV. Common ways for contracting HIV include injection drug use where unsterilized needles are reused, sex, pregnancy and childbirth, blood transfusion with infected blood, and health care worker accidental exposure.

If left untreated, HIV can lead to AIDS in 10 to 15 years. With treatment using various drugs, a person infected with HIV can lead a normal life and never develop AIDS.

Symptoms of HIV infection include fever, swollen glands, sore throat, rash, fatigue, muscle and joint aches and pains, and headache. Some victims say the symptoms in the early days are like the "worst flu ever." Many victims of HIV infection do not have any symptoms and only begin to feel sick when HIV progresses towards AIDS.

Symptoms of AIDS are much worse. They include rapid weight loss, fever, night sweats, extreme tiredness, body sores, pneumonia, dark skin blotches, memory loss and eventually, death.

Things to Know

- HIV cannot be transmitted through sweat, saliva, or urine.
- HIV does not mean that person also has AIDS. That only happens if the HIV is untreated.
- More than 1.2 million people in the United States live with an HIV infection and 50,000 new infections occur every year.
- In 2014, the estimated number of people living with HIV/AIDS totaled 36.9 million.
- By 2014, an estimated 34 million people, many in Africa, have died from AIDS-related illnesses.
- Anyone can get HIV/AIDS.

INFORMATION SHEET 7

Disease: Ebola

Ebola virus disease or EVD, is a severe, often fatal illness. It is transmitted from wild animals to humans and then transmitted human to human. If contracted, the chance of dying averages 50% but in some outbreaks, the chance is as high as 90%.

Ebola virus disease first appeared in 1976 in 2 simultaneous outbreaks. One occurred in Nzara, Sudan and the other in Yambuku, Democratic Republic of Congo. All other outbreaks have occurred in central and western Africa. No outbreaks have occurred in the United States. There was one case of Ebola in the US brought here by a health worker returning home.

It is thought that fruit bats of the *Pteropodidae* family are the natural hosts for the Ebola virus. The virus is contracted by contact with blood and other fluids of animals that are sick such as chimpanzees, gorillas, monkeys, forest antelope, and porcupines. Once contracted, human-to-human contact can spread the disease.

People infected with Ebola begin to be sick 2 to 21 days later. At first, there is fever, fatigue, muscle pain, headache, and sore throat. This is followed by vomiting, diarrhea, impaired kidney and liver function, and, in some cases, internal and external bleeding.

When a person dies from Ebola, the person's body is still infectious. Burial must be done very carefully by workers protected with hazmat suits - goggles, gloves, masks, boots, and plastic clothing.

There is no proven treatment for victims suffering from Ebola. Rehydrating them with oral or intravenous fluids provides some comfort for the patient. No vaccines are yet available.

Things to Know

- There are five species of Ebola viruses. They belong to the *Filoviridae* family.
- Ebola was discovered in the Democratic Republic of the Congo near the Ebola River.
- More than two-dozen Ebola outbreaks have occurred between 1976 and 2014. Most occurred in Central and western Africa. One outbreak occurred in South Africa.
- Ebola can be avoided by washing hands with soap and water, avoiding contact with infected fluids, not handling items that may have come in contact with an infected person, and avoiding contact with bats and other animals and uncooked meat.
- The 2014 Ebola outbreak was the largest in history and affected multiple countries. The cases of Ebola detected during the outbreak totaled more than 28,000 with 11,000 deaths.

INFORMATION SHEET 8

Disease: Flu

Influenza, more commonly known as the flu, is a persistent infectious disease around the world. Every year, during the winter flu season, millions of people catch the flu virus and become sick. The flu virus infects the nose, throat, and lungs. It can cause mild to severe illness, and at times can lead to death.

The symptoms of flu are many. Victims experience fever and chills, cough, sore throat, runny and stuffy noses, muscle and body aches, headaches, fatigue, and may also have vomiting and diarrhea.

Children and the elderly are most susceptible to the flu infection and have the worst symptoms. Flu spreads when an infected person sneezes, coughs, or talks. Nearly invisible droplets of infected fluids spread through the air and are taken in by others through breathing or droplets can be transferred through handshaking or touching surfaces "sprayed" during a sneeze. Unknowingly, the flu virus is transferred to new victims by touching their own mouths, eyes, and possibly their noses.

The chances of contracting the flu each season are greatly reduced by getting a flu shot. Each flu season a different strain of the flu virus spreads rapidly. Scientists, in advance of the season try to determine which strain will strike and then custom design a vaccine to fight it. This means that people have to be vaccinated every year. Vaccination is especially important for children and elderly but, with some exceptions, nearly everyone should receive one. Different versions of the vaccine are used for people as young as 6 months. The elderly get a more potent version of the vaccine.

A flu infection can trigger other problems. It can lead to bacterial pneumonia, ear infections, sinus infections, dehydration and it can worsen other problems such as congestive heart failure, diabetes, and asthma.

Things to Know

- In 1918, a new influenza virus infected more than 500 million people around the world. Between 50 and 100 million people died from the infection. It was called the Spanish flu.
- Frequent hand washing reduces the chances of catching the flu.
- There are three main types or genus of influenza virus – A, B, C but type A has more than ten different subspecies.
- Birds and pigs (swine) can also be infected by some of the species of the Type A influenza virus.
- Influenza affects every country in the world.
- About 35 million Americans come down with the flu every year.

INFORMATION SHEET 9

Disease: Typhoid Fever

Typhoid fever is a life-threatening illness caused by the bacterium *Salmonella Typhi*. About 5,700 cases of the disease occur every year in the United States. In the developing world, typhoid affects about 22 million people annually.

The typhoid bacterium only lives in humans. A person with typhoid fever can carry the bacterium in their bloodstream and intestines. They shed the bacterium in their feces. If they are not careful with hand washing, they can spread the bacterium to others by touching. Typhoid fever can also be spread when the bacteria gets into drinking water that has been contaminated with sewage. The disease is especially prevalent in countries where hand washing is not common and sanitation systems are minimal.

The symptoms of typhoid fever begin with a sustained high fever, stomach pains, headache, weakness, and loss of appetite. Some victims may also have a skin rash. If a person has these symptoms, he or she should see a doctor immediately. Antibiotics are used to treat the disease. Even when feeling better, a person should be tested for the disease until all signs of the *Salmonella Typhi* bacterium are gone. Until that happens, the person is still able to infect others.

Typhoid fever can be avoided when traveling even in countries where the disease is common. Travelers are cautioned to frequently wash their hands and by drinking water that has been boiled and food that is thoroughly cooked. A vaccination against typhoid is available if someone is likely to come in contact with the infection.

Not all people infected with the typhoid bacterium have symptoms. Mary Mallon was a cook in New York City in the early 1900s. She worked for seven families and, in each, household members became sick with typhoid fever after she started working for them. She is thought to have infected 51 people, of which 3 died. Eventually, she was kept in isolation for 30 years to prevent further infections. People called her Typhoid Mary.

Things to Know

- Typhoid fever infections can lead to pneumonia, pancreatitis, kidney and bladder infections, heart troubles, and even mental problems.
- Typhoid fever is very common in Southeast Asia, Africa, and South America.
- Doctors can only tell if someone has typhoid fever by checking for *Salmonella Typhi* bacterium in blood and stool (feces) samples.
- In undeveloped countries, fruits and vegetables that cannot be peeled may be covered with the typhoid bacterium because they have been washed in contaminated water.
- Today, most people in the United States who contract typhoid fever do so when traveling to undeveloped parts of the world.

INFORMATION SHEET 10

Disease: Tuberculosis

Tuberculosis or TB is a bacterial disease that usually attacks the lungs but it can also attack the kidney, spine, and brain. The TB bacteria is called *Mycobacterium tuberculosis*. It is spread through the air from one person to another. An infected person will spray the air with droplets containing the bacterium through coughing, sneezing, speaking, and even singing. Nearby people will inhale the bacterium and become infected too. TB is not spread by handshaking, sharing food or drink, kissing, or even sharing toothbrushes.

The symptoms of TB are many. They include a bad cough that lasts for 3 weeks or longer, pains in the chest, coughing up blood or sputum, weakness, weight loss, chills, fever, and night sweats. To find out if the above symptoms work, doctors will take a blood sample to check for the bacteria or give a skin test.

It is estimated that 2 billion people around the world have TB but their infections are inactive. The term used is Latent TB. This means that while they have the bacteria, these people are not sick and are not experiencing any symptoms. This can change for them at the TB bacteria can become active. Monitoring of these people is important because treatment may become necessary.

TB can be treated. There are a variety of dugs that are effective. The drugs must be taken exactly as ordered for 6 to 9 months to work. Not all people who come in contact with the TB bacteria become sick. Normally healthy people's immune system will gather its antibodies and wall off the bacteria infection.

In 2014, 9.6 million people around the world became infected with TB. Because of improved treatments the mortality (death) rate has been cut almost in half. World health officials estimate that between 2000 and 2014, the lives of 43 million people were saved by diagnosis and treatment.

TB is somewhat rare in developed countries but there are concerns about its resurgence. People with AIDS have very weak immune systems and are susceptible to TB infections. Another worry is that a number of strains of tuberculosis are becoming resistant to drugs.

Things to Know

- Until a reliable treatment became available, TB was the leading cause of death in the United States.
- TB bacteria can become resistant to drugs when people do not take them regularly or do not take all of the drugs as presINFOed.
- Tuberculosis has gone under many names including consumption, pthisis, scrofula, Pott's disease, and white plague.
- Researchers are unsure of when TB first appeared. Some data indicates that TB was first acquired by humans in Africa about 5,000 years ago. It then spread around the world along trade routes. The disease may be linked to domesticated animals,
- Seals may have picked up the disease on African beaches and may have carried it across the Atlantic Ocean.