POX

SAVE THE PEOPLE

A two to four player game of disease control

Sample Lesson Plan
(high school)

“Role of vaccines in disease prevention and public health”

Subjects:
Science/Life Science/Biology

Duration:
3 45-Min Classes

Grade Level:
Grades 9 - 12

Objective:
Students will:

- Learn how communicable diseases spread and basic terminology associated with the immune system and the development of vaccines
- Brainstorm about and discuss various topics related to disease prevention and the use of vaccines.
- Learn the concept of herd immunity, or “community immunity”
- Play a game that simulates how easily diseases spread and the role vaccinations play in disease prevention and public health
- Discuss their game experience in relation to topics such as disease prevention and public health.

Materials:
POX Game Sets (up to 4 players/game)

Overview/Background Information:

The focus of this class is to introduce students to the idea of herd immunity (also known as “community” immunity). This is an important concept in science and public health policy.

Communicable diseases are infections that can be passed from one person to another. Immunity to a communicable disease means that the body has defenses against that disease, so that a person doesn’t become infected if they are exposed to the disease-causing organism. Immunity can be conferred by a past infection or by vaccination.

Herd immunity exists when people without immunity to a certain disease are protected indirectly by being surrounded by people who are immune. If a high percentage of the population is immune, the entire population is protected because the disease has little opportunity to spread. That is, an infected person is unlikely to have contact with a susceptible person and pass on the disease. If a lower percentage of the population is immune, there are more opportunities for the disease to spread.

Herd immunity works by reducing a disease’s ability to spread to others. Herd immunity can be established if enough people are vaccinated.

Creating herd immunity is an important goal because it’s never possible to vaccinate 100 percent of the population. For example, some vaccines cannot be given to pregnant women, people with weakened immune systems, or people who are allergic to components of the vaccine. Babies, too, cannot get certain vaccinations before they’re several months old. What’s more, no vaccine is 100 percent effective. Vaccinations fail to confer immunity in a small percentage of those vaccinated. Some people may also choose not to be vaccinated. Others may not have access to vaccinations, or they may not even know about vaccinations they could have. Establishing herd immunity is a vital step towards protecting people who, for any of these reasons, do not receive vaccinations.

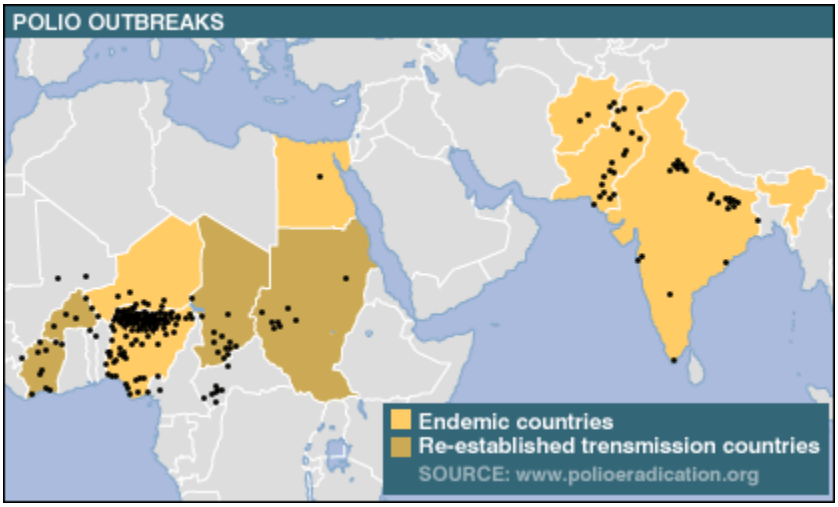
The threshold required for herd immunity to be established varies depending upon the disease. For example, to create herd immunity to measles, 83 to 94 percent of the population must be immune. Here are the estimated thresholds for some other diseases:

Diphtheria -- 85 percent
Mumps -- 75 to 86 percent
Pertussis (whooping cough) -- 92 to 94 percent
Polio -- 80 to 86 percent
Rubella -- 83 to 85 percent
Smallpox -- 80 to 85 percent

In the United States and other developed countries, immunity to these diseases is maintained at a high level by universal vaccination of the population (except for smallpox, a disease that has been globally eradicated; thus smallpox vaccination is now limited to a small number of people). As a result, these diseases, which were common in the early part of the 20th century, are now very rare or nonexistent. No one in the United States is infected with polio anymore, although

the disease is still circulating in other parts of the world where sufficient herd immunity to the disease has not been established.

Smallpox, one of the most devastating diseases in all of human history, was officially eradicated worldwide in 1980, which wouldn't have been possible without mass vaccination. Several countries have eliminated measles and polio, meaning that these diseases are no longer endemic, or constantly present, in that country. Some diseases have been entirely eradicated across the whole world. Nevertheless, we may have lost our herd immunity to pertussis, because it appears now that immunity given by childhood vaccinations has worn off over time, leaving many adults susceptible to the disease once again, and pertussis rates in the United States are on the rise.



(graphic from a link listed on CDC page, "A Polio-Free US Thanks to Vaccine Efforts". http://www.cdc.gov/Features/PolioFacts/)

Research has shown that failure to maintain herd immunity thresholds through vaccination has led to recent epidemics of measles. For example, in 2003, measles was introduced by a single infected tourist to the Marshall Islands, a small Pacific island nation, where the measles vaccination rate was only 75 percent -- well below the herd immunity threshold. More than 700 people in this country of 56,000 fell ill; dozens were hospitalized, and three died. The same year, measles was twice introduced to Mexico, which had a measles vaccination rate of 95 percent. Only 41 people in the country of more than 100 million contracted measles.

Game Overview:
POX: save the people is a turn-based game that illustrates the spread and prevention of a contagious disease in a community. Players work together to get the disease under control by vaccinating people, one by one, and curing them if necessary. But disease strikes! Players try to add pieces to the board to create conditions where no disease can spread.

By playing the game, students will begin to understand the choices in preventing communicable disease. By deciding who to immunize and who to cure, students will experiment with the implications of disease control on the community as a whole.

Procedure:
1. (45 min) For the first class, discuss herd immunity with your students and focus on the topics listed below. One way of introducing the topics for discussion is to show a short video segment on the polio epidemics, such as the Introduction from PBS's *The American Experience: The Polio Crusade* (6 min., http://video.pbs.org/video/1174115155/?starttime=2246000#). For the

next class, have students go home and talk to their relatives about polio.

1) Immunocompromised Persons

* Do you know of anyone who has chicken pox more than once, or of someone who is not immune to measles? This doesn't mean that the person has a bad immune system. It means the person has not developed full immunity to that particular antigen.

* Did you know that very young babies, those who are ill, pregnant women, and those living with immune-system compromising diseases cannot be vaccinated, even if they wished?

Very few people who are not vaccinated are that way by choice. Often circumstances such as illness, pregnancy, or parental decisions have led to their situation. This general category of persons is represented on the game board by the yellow-colored spaces.

2) The Spread of Disease

* What are some ways communicable diseases can spread through a community? (sewage in water, direct person-to-person spread in households, day care centers, and schools by coughing and hands contaminated by respiratory and gastrointestinal microbes, unprotected sex)

* Name some *communicable diseases.*
(find a large list here http://www.health.state.ny.us/diseases/communicable/)

* In contrast, name some non-*communicable diseases.* (Asthma, diabetes, stroke, heart disease)

Communicable diseases are often be caused by viruses, bacteria, and parasites:

* Viruses are tiny infectious agents that are able to replicate themselves only in living hosts. Their fundamental "purpose" is to spread genetic material. Plants can acquire a virus from insects that feed on them, such as aphids; humans and animals can be infected by viruses transmitted by insects (mosquitoes, ticks), resulting in diseases such as yellow fever, dengue, and West Nile virus encephalitis. Once a host is infected, some viruses are transmittable person - to - person. Influenza, i.e., "the flu," is spread by people coughing and sneezing. HIV is transmitted through sexual contact, through infected blood, and from mother to infant.

* Bacteria are single cell organisms that also can multiply and infect the body. Cholera is one such bacterial infection that spread through unclean water. Typhoid Fever is a bacterial infection caused by contaminated food and water.

* Humans can get the disease malaria, a protozoan parasite, via mosquito bites.

Animals and people have an immune response that usually eliminates the infecting agent. This immune response can also be induced by a vaccine against that particular disease. Some illnesses, such as HIV, have no available effective vaccine.

Infecting agents can spread among a population slowly or quickly. The POX game's Red Chips represent infections.

3) Vaccination

* What are some vaccines people typically receive in the United States? Think about pets: Rabies, Kennel Cough, distemper, and parvo.

* Babies are immunized for Hepatitis A and B, Measles, Mumps, Rubella, Polio, Diphtheria, Tetanus, Pertussis, Hemophilus influenza infections, Chickenpox, Pneumococcal infections, and others.

Vaccination is the way to stimulate a person's adaptive immunity to a particular disease. Vaccines contain a small amount of weak or dead viruses or bacteria. This material is then introduced to the body. In a sense, the body is given a sneak preview of the virus, bacteria, or pathogen, so it can react and begin to build up in advance an immunity to that particular pathogen. Vaccines can be injected, taken by mouth, or even put into the air in an aerosol or powder. Making a vaccine can take a long time. To make a batch of the influenza vaccine, for example, it can take 10 months or more. The strains have to be identified and selected. The strain is produced separately using millions of prepared chicken eggs. The fluid is then purified to make sure the virus or bacteria are killed or inactivated. Then vials are filled, packaged, and shipped. After all this, the vaccinations can occur.

The POX game's Blue Chips represent immunizations.

4) Death

* When might someone die in an outbreak of a communicable disease?

The leading *causes* of death around the world may surprise you. Infectious diseases cause 25% of all deaths in 1998. Cancer, however, ranked at 13%. Among children, the number rises. Infectious diseases accounted for 63% of all deaths among children (see: http://www.who.int/infectious-disease-report/pages/grfindx.html). According to the World Health Organization, the leading infectious killers are Pneumonia, diarrhea-related diseases, Tuberculosis, Malaria, AIDS and measles.

Infectious diseases are preventable, but children may lose one or both parents to an infectious disease, and parents may lose their children. Because they are preventable through herd immunity and vaccination, such diseases show us that when more people are immunized, fewer people die.

The POX game's Black chips represent deaths. Players can play on different levels of challenge -- from the relatively easy "chicken soup" allowing five deaths, to the very challenging "miracle" level not allowing any deaths to occur.

2. (45 min) For the 2nd class, do the following class activity

Using copies of the POX game in class:

1. Ask students to split into play and discussion groups of 2-4 players (suggested)

2. (10 min) Give a quick demo of the game (see game instructions)

3. (30 min) Within their groups, participants should collaboratively play the POX game. At the end of the time stop play regardless of where they are in game.

4. At the end of the game, give groups the list of discussion questions below and have them ready to discuss at the next class:

Discussion Questions:

- Why do different diseases have different herd immunity thresholds?
- What determines the herd immunity threshold for a particular disease?
- How important is it to save people from dying versus stopping the epidemic?
- What are the risks in choosing to vaccinate or not vaccinate?
- How might diseases spread in real life?
- Was it better to immunize or to cure?
- Could you just cure people and win the game?
- How do you understand vaccination?
- How did you interpret the message of this game?

3. (45 min) In the third class, have the students sit in with their respective groups and discuss the questions above.

1. (Approx. 30 min) Group discussion

2. (15 min) Summarize the issues discussed, using situations in POX game to illustrate issues.

Things to point out:

- Herd immunity creates a barrier around non-immune people, so viruses cannot find new hosts and end up walled in
- Clusters of non-immune people are highly susceptible to the quick spread of disease
- Herd immunity has to be extremely high to work – if the non-immune people meet up, the virus can use them like a road to get around the whole population and will continue to find new hosts and make people sick

Summary of issues related to Herd Immunity:

From a medical standpoint, it is not correct to think that if one is healthy, all will be alright. Herd immunity is the approach that protects the community and individual. The idea of herd immunity is that populations would be protected from illness if a sufficient portion of their population is immune. Many societies have been successful eradicating diseases by establishing herd immunity through immunization programs. Vaccination is an important activity to understand. The idea that we can choose to be vaccinated in fact goes beyond the individual -- it affects the community and indeed, the world's safety.

Further Information:

World Health Organization (WHO)
http://www.who.int/topics/immunization/en/

Centers for Disease Control and Prevention (CDC)
http://www.cdc.gov/vaccines/default.htm

"Viruses"
Peter Jaret, National Geographic, July 1994
Virus-related catastrophes and research triumphs are told in this illustrated article that examines viruses' vast capabilities.

Viruses
Howard and Margery Facklam, Twenty-First Century Books, 1994
This highly readable narrative of the history of viruses and vaccines features color illustrations, enlargements of microscopic images, and black-and-white historical sketches.

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