Vaccines and Herd Immunity

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Table of Contents

TEACHER GUIDE

I. Science Background

Vaccination is a vital measure in protecting against infection. It has significantly reduced the incident of illness and death caused by infectious diseases over the last one hundred years. Vaccines likely save 2 to 3 million lives per year globally. Many diseases have been eradicated from the United States as a result of national immunization programs, including diphtheria, polio, and measles. Any recently reported cases of these diseases have been attributed to people that traveled into the U.S. from countries where the diseases are still prevalent. So far, only smallpox has been globally eradicated, but polio could be next.

The goal of any effective vaccine is to produce long-lasting immunity. To do this, the vaccine must stimulate the production of effector cells to clear a pathogen and the production of memory cells that will recognize that real pathogen should it enter the body. Effective vaccines mimic natural infection, which stimulates a stronger immune response. Though many of the infections that traditionally plagued humans have been drastically reduced, there are still some diseases that are not preventable by immunization, including HIV, malaria, and tuberculosis.

It is important for individuals to get vaccinated not just to protect themselves, but to protect others that may not be able or eligible to receive vaccines due to age, health conditions, or other factors. These groups include the very young or elderly, pregnant women, and those that are immunocompromised (people with weakened, undeveloped, or non-existent immune systems). If a certain percentage of a population is protected against a contagious disease, it is difficult for a pathogen to spread within this population. Consequently, this confers protection to those members of the population that cannot be vaccinated. This concept is referred to as "herd immunity". One thing to note, highly contagious diseases require a greater percentage of the population to be vaccinated in order for this phenomenon to occur. For example, 95% of a population must be vaccinated to protect against measles, whereas only 75% of a population must be vaccinated to protect against influenza.

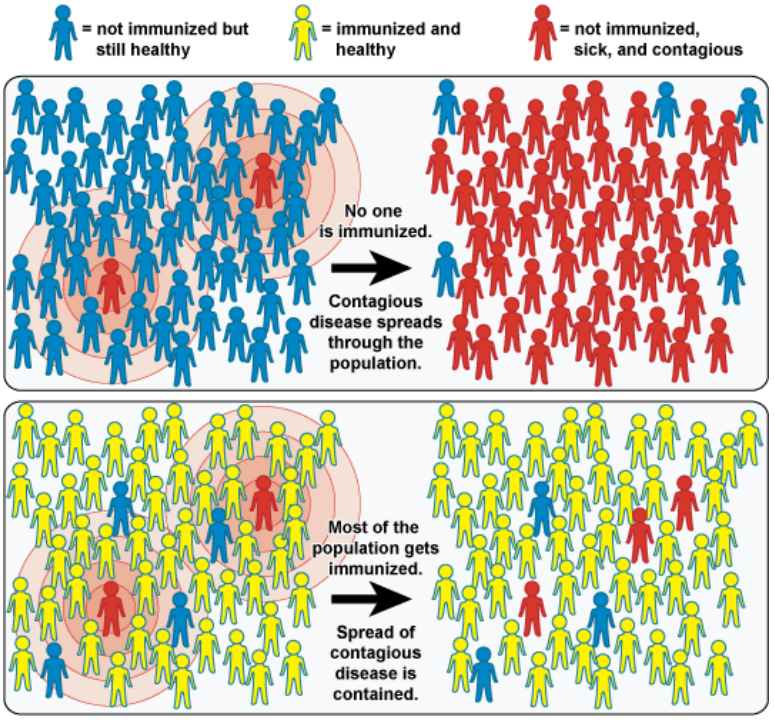

Photo Credit: National Institute of Allergy and Infectious Diseases

Adapted from Delany, I., Rappuoli, R., & Gregorio, E. D. (2014). Vaccines for the 21st century. *EMBO Molecular Medicine, 6*(6), 708-720. doi:10.1002/emmm.201403876

For an introduction or review of the immune system and cells, refer to the following resources:

- Crash Course Videos – A YouTube Playlist has been created that includes all of the videos below https://www.youtube.com/playlist?list=PLOsHKKXqO2i1u2-9YrjsJpCAuwNKHXCQS
  - Option 1: "Your Immune System" (condensed overview)
  - Option 2: "Immune System: Parts 1, 2, and 3" (detailed tutorials on innate defenses, adaptive defense, and the cell mediated response)

- Activity 32 – Immunity. In Trout, L. (Ed.). (2012). *POGIL activities for AP biology*. Flinn Scientific, Inc. https://www.flinnsci.com/store/Scripts/prodView.asp?idproduct=22433

- HHMI Biointeractive Click & Learn interactive: Cells of the Immune System (An overview of the immune system, concentrating on the roles played by B and T lymphocytes, and the antigen-presentation system.) http://www.hhmi.org/biointeractive/cells-immune-system

- 2015 AAI curricular unit developed by Amy Loewen: The Basics of Immunology through Case Studies https://www.aai.org/Education/Summer_Teachers/Docs/Archive/2015_Loewen_Immunology_Unit_Final.pdf

II. Student Outcomes

A. Science concepts covered in the unit

- A vaccine is a preparation of an innocuous *(harmless)* form of a disease-causing agent, used to stimulate the production of antibodies and provide immunity against disease.
- Vaccines help train the immune system to respond to a pathogen by mimicking infection.
- Vaccines do not cause illness, but minor symptoms can occur, such as fever. This is normal.
- With first exposure to an antigen, the immune response is usually too slow to keep people from getting sick. With second exposure to an antigen, the immune response is rapid enough to prevent the disease.
- There are many types of vaccines, each with advantages and disadvantages. These include live attenuated, inactivated, subunit, toxoid, DNA and recombinant vector vaccines.
- Herd immunity is a form of indirect protection from a disease that occurs when a significant portion of a population (or herd) is vaccinated against that disease. The proportion of vaccinated individuals required to keep the entire population safe varies by disease.
- It is important for individuals to get vaccinated not just to protect themselves, but to protect others that may not be able or eligible to receive vaccines due to age, health conditions, or other factors.

B. Next Generation Science Standards (NGSS)

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

- Disciplinary Core Ideas

  LS1.A: Structure and Function

  a. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

  b. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

- Science and Engineering Practices

  a. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

  b. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

- Cross-cutting Concepts

  a. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

  b. Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

- Common Core State Standards Connections – ELA/Literacy

  a. WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)

  b. WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)

  c. SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2)

C. Recommended course placement

This curriculum is intended for a high school college preparatory biology course, but it can be adapted for other levels.

D. Relevance

It is important for students to understand that vaccination is vital to prevent the spread infectious diseases. Diseases that were unseen for a century are returning because people are not following their recommended vaccination schedules. Why? Perceived risk of

infection is low, and people have a distorted notion of how invulnerable they are. This idea of invincibility is particularly common among teens. The media also tends to overdramatize vaccination side effects, which only affect one in one million people. Vaccination is important not only to protects individuals, but to indirectly protect those that are ineligible to receive vaccines.

III. Learning Objectives/Skills

Students will be able to

- explain how vaccines work
- describe different types of vaccines and the diseases they prevent
- create models of pathogens, antibodies, and antigen-antibody interaction
- perform simulated laboratory tests to compare the antibody levels of unvaccinated and vaccinated children who have been exposed to the bacteria that cause pertussis
- investigate how vaccination rates affect a community
- justify why vaccination is important
- research an infectious disease and its vaccine and present to classmates

IV. Time Requirements

The daily unit plans are designed around 40-minute class periods, but may be adapted as needed. Time requirements for each lesson can be found in the daily unit plans. This unit should take approximately 10-12 days to complete.

V. Advance Preparation

- Most of the advance preparation consists of making copies of student handouts for activities. See each daily unit plan for further instruction.
- Computers are required for the "Types of Vaccines" lesson, and the lesson should take one class period. Allow enough time to book a computer lab if necessary.

Science Take-Out Kit: Pathogens, Antibodies, and Vaccines

About Science Take-Out (STO): STO kits are designed by experienced science educators who understand the diverse needs of teachers and their students. All kits are thoroughly field tested to ensure that they are student friendly, teacher friendly, and meet significant learning objectives. Every effort has been made to reduce the use of hazardous chemicals in STO kits. Most kits contain common household chemicals or chemicals that pose little or no risk.

- If using pre-assembled kits, they should be ready-to-go. STO kits require essentially no prep and no lab equipment. It is suggested that reusable paper pieces of the kit are laminated. If this is something of interest, set aside time before using kits with students to laminate the immunity brochure on diphtheria, tetanus, and pertussis and the DTP vaccine; instructions and color chart for Pertussis Antibody testing; and the "Immunizations and the DTP Vaccine" brochure from each kit.
- If unassembled packs are purchased, reserve 30-60 minutes to put kits together (depending on how many are purchased). Each unassembled pack has materials to make 10 student kits.
- Teacher Instructions and a MSDS sheet are included with every Science Take-Out module. Also reserve time to read over these materials in preparation for conducting the activity with students.

VI. Materials and Equipment

- Paper to copy student handouts
- Computers for "Types of Vaccines" lesson (one per student or one per two students if needed)
- Science Take-Out Kit: Pathogens, Antibodies, and Vaccines
  - Assembled kits → $18.00 each
  - Unassembled packs → $150.00/pack (materials for 10 kits)
- Safety Goggles (for use with STO Kit)
- Colored pens/pencils (for use with STO Kit)
- A detailed MSDS sheet is included in the Teacher Information packet for the STO Kit. Goggles are required and gloves are recommended.

VII. Student Prior Knowledge and Skills

A. Knowledge

Prior to this unit, students should have a basic understanding of bacteria, viruses, antigens, antibodies, and cells of the immune system. Students would also benefit from having a basic understanding of how infections stimulate an immune response.

B. Skills

Students should be able to follow a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

C. Preconceptions

Some students think that vaccines can be used to treat disease, but vaccines are used to prevent disease. Students may also feel that vaccination is not necessary because they have not experienced the outbreaks of the past. "I don't get all of my shots, but I never get sick."

VIII. Daily Unit Plans

DAY 1 – How Vaccines Work

Prior to this lesson, review the "How Vaccines Work" interactive from the History of Vaccines website. You may want to open the interactive and the video "How we conquered the deadly smallpox virus" in the internet browser beforehand.

1. Begin the lesson by asking students to describe experiences they have had with infectious disease and vaccination.
   a. What is a vaccine? What is it used for?
   b. Why do we vaccinate?
   c. What would happen if we could no longer vaccinate against the influenza (flu)?
2. Now, begin notes using PowerPoint slides: "Introduction to Vaccines"
   a. Students will learn how a vaccine triggers a primary immune response to a pathogen, so that if the pathogen enters the body, the immune system will quickly respond to it
3. Open the interactive "How Vaccines Work" and walk students through.
4. Briefly introduce Edward Jenner's work before showing the video "How we conquered the deadly smallpox virus"
5. After viewing the video, students will answer five multiple choice questions. This can be conducted using clickers, whiteboards, multiple choice response cards, or other platform.

6. To close the lesson, have students answer the following question: "Why does a previous infection with the cowpox virus protect humans against smallpox virus infection and disease?" This can be conducted as a Think, Pair, Share or as an Exit Ticket.

DAY 2 – Types of Vaccines

This lesson requires computers (preferably one per student, but one per two students if need be). Prior to this lesson, check to make sure that the activity links are still active and the computers students will be using have the most recent update for flash player. Then, make the "Types of Vaccines" portion of the PowerPoint slides available to students. This can be done through Google Classroom, a class website, via email, etc. Also, make copies of these student worksheets: "Type of Vaccines Graphic Organizer", "NOVA – Making Vaccines"

1. To begin, students will view the "Types of Vaccines" slides. The last slide will provide them with two links, one for each of the activities.
2. 1st Activity: Types of Vaccines interactive
    a. In this activity, students will learn about the following vaccines: live attenuated, inactivated/killed, subunit, toxoid, DNA, recombinant vector
    b. They will record the following information for each vaccine in the graphic organizer: how it works, advantages, disadvantages, and examples
3. 2nd Activity: NOVA – Making Vaccines
    a. In this virtual laboratory, students will create six vaccines, using a different technique to produce each one. As they go through the virtual lab, they will answer the questions on the corresponding worksheet.
    b. Note: the procedures in this feature have been simplified. For example, the interactive shows a gene being plucked out of DNA using tweezers. This is not how it happens, and there is a note to students on their worksheet.
4. Instruct students to complete any unfinished questions for homework. Also, tell students that they should complete a 3-2-1 for today's activity (in class or for homework depending on time): (3) things they learned, (2) things they want to know more about, (1) question they have.

DAY 3-5 – Pathogens, Antibodies, and Vaccines Activity

This activity uses the Science Take-Out kit "Pathogens, Antibodies, and Vaccines" (STO-138). If purchasing unassembled kits, assemble kits and prepare plasma samples according to the Teacher Instructions from the company prior to this activity.

Teacher Information is available for viewing here: http://www.sciencetakeout.com/wp-content/themes/accelerate/images/teacher_guides/138.pdf

It is suggested that any paper materials that can be reused are laminated. Also, make copies of the student packet. Review the Advanced Preparation section of this curriculum guide.

Overview: In this activity, students will investigate how the immune response protects against diseases caused by bacteria. First, they will create models of pathogens and antibodies to review antigen-antibody interaction. Then, they will perform simulated laboratory tests to compare the antibody levels of unvaccinated and vaccinated children who have been exposed to the bacteria that cause pertussis. Each section has accompanying questions for students to

answer in their activity packet. As detailed instructions are provided with the kit, only a brief overview is provided here.

DAY 3

Part 1: Modeling Pathogens and Antibodies

a. First, students will complete a chart on three bacterial diseases using the "Immunizations and the DTP Vaccine" brochure.
b. Next, they will make models of these bacteria.
    i. Foam balls = bacteria
    ii. Adhesive jewels = antigens
c. Then, they will make a model of an antibody with antigen binding sites for pertussis.
    i. Straws held together with rubber bands = antibody
    ii. Ball of clay at the end of each straw = antigen binding site (stamped with pertussis jewel so it is specific for pertussis bacteria)

DAY 4

Part 2: Antibodies and Immunity

a. Students will graph antibody level data for the Unvaccinated Child (first exposure) on the provided sheet, and answer questions.
b. Students will graph antibody level data for the Unvaccinated Child (second exposure) on the provided sheet, and answer questions.
c. Student will perform a simulated laboratory test to collect data on antibody levels for the Vaccinated Child, graph the data on the provided sheet, and answer questions.
d. Note: it is possible to set up simulated tests for all three children, provided there are extra materials and time. Child 2 and Child 3 data are the same. Child 1 would require the following: Day 0 and Day 10 = water; Day 20 = pH 6; Day 30 = pH 10

DAY 5 (may take less than one full period)

Part 3: A Case of Pertussis (Whooping Cough)

a. Students will complete a short reading about a three-month-old baby that was affected by pertussis and answer questions.
b. Then, they will use the "Immunizations and the DTP Vaccine" brochure again to answer a few more questions. The last questions ask students to apply what they have learned about vaccination. Use this as an opportunity to have a class discussion.

DAY 6 – Herd Immunity

- Make enough role cards for each part of the activity. See below for guidelines to determine how many of each type of card are needed for the size of your class.
  - Round 1: 3 students receive an "infected" card, rest receive an "uninfected" card
  - Round 2: 3 "infected" cards, 3 "protected" cards (swap out 3 "uninfected"), rest "uninfected"
  - Round 3: 3 "infected" cards, ¾ of class "protected" cards (swap out for "uninfected"), rest "uninfected"

  Ex: For a class of 25, you would need a total of 3 "infected", 18-19 "protected", 22 "uninfected". Alternative: Make one pack of cards for each round. This will save time because you won't have to swap out cards.

- Print/copy (each 1 per student)
  - Student activity packet
  - Herd Immunity Infection Data sheet ***OR*** Provide graph paper

1. Read through the purpose and the introduction with students. Draw attention to the table in the introduction that shows the percentage decrease
2. Round 1: No one is immunized
   a. Pass out role cards to students using guidelines for Round 1. Instruct students not to share their role with classmates yet.
   b. Students should walk around the room until told to stop. Now, they will exchange roles with one person by whispering.
      - If your classmate whispers "infected", you are now infected. You must whisper "infected" during an exchange from now on.
      - However, if you are protected, you will not become infected. Continue to whisper "protected".
      - For all other exchanges (uninfected-uninfected, uninfected-protected), your role will remain the same. Continue to whisper what was on your card.
   c. Student will complete a total of 3 exchanges.
      - Finding the Index Case (optional) → In this round, they can also write down the name and role of each person they exchange with, in order to trace the disease back to the original carriers. The remaining uninfected students will act as epidemiologists to determine the index cases.
   d. They will then determine the proportion of individuals that do/do not have the disease, and then graph the data. This can be done on graph paper, or using a template sheet (make a bar graph by coloring in the appropriate number of boxes for infected [red] and uninfected [blue]). Students should also record the number of people that were vaccinated (Protected).
   e. Collect role cards before Round 2.
3. Round 2: Three people are immunized
   a. Redistribute role cards, swapping three of the "uninfected" cards with three "protected" cards. Instruct students not to share their role with classmates yet.
   b. Again, students will complete a total of three exchanges. They will then determine the proportion of individuals that do/do not have the disease, and graph the data.
   c. Collect role cards.

4. Round 3: 75% of class is immunized
    a. Redistribute role cards, swapping ¾ of the "uninfected" cards with "protected" cards. Instruct students not to share their role with classmates yet.
    b. Again, students will complete a total of three exchanges. They will then determine the proportion of individuals that do/do not have the disease, and graph the data.
    c. Collect role cards.
5. Prior to analysis questions, have students summarize the results of the activity in small groups (summarize trend in graphs from all rounds). Then discuss as a class.
6. To summarize and close the lesson, watch the two-minute video clip "What is Herd Immunity?" from Scientific American: https://www.youtube.com/watch?v=oAJDoLbrNRE

IX. Summative Assessment

Infectious Diseases Research Project (approx. 4-6 class periods plus time to work at home)

In order to become more informed about infectious diseases and the vaccines used to prevent them, students will research an infectious disease. This can be done individually, in pairs, or in groups at the teacher's discretion. Students will use the criteria provided on the student handout and the project rubric to complete this project.

- What is required:
    - Presentation (PowerPoint, Prezi, digital poster, etc.)
    - Quiz (five-question multiple choice quiz & answer key; this can be a paper quiz or a Google form)
- Suggested timeline:
    - Two to three class periods to research and work on presentation
    - Two to three periods to for students to present in class (factoring in the number of students that need to present and allowing audience to complete the quiz for each presentation)

X. Additional Activities

- NOVA Episode – *Vaccines: Calling the Shots* (Length – 53:10): This program takes viewers around the world to track epidemics, explore the science behind vaccinations, hear from parents wrestling with vaccine-related questions, and shed light on the risks of opting out. Topics include the 2013 measles outbreak in NY, vaccine history, herd immunity, Dravet syndrome, polio, vaccines and autism, and HPV. This episode can be streamed from PBS or ordered from HHMI with a free educator account.
    - Stream online: http://www.pbs.org/wgbh/nova/body/vaccines-calling-shots.html
    - Order DVD free: https://www.hhmi.org/order-materials/short-films/vaccines-calling-shots
    - ★ Two versions of a student worksheet and a teacher guide for this video have been provided within this curriculum.
- History of Vaccines Timeline: In this activity, students are divided into groups to explore a timeline related to vaccination and its history. The lesson plan includes handouts for students to record information. There are two different variations to the activity, one short (~ 35 min) and one long (~75-90 min). Two extension activities are also given: a debate about whether certain vaccinations should be required for school or college entry, and having students investigate their own vaccination history.
    - Timeline Website: http://www.historyofvaccines.org/content/timelines/all

  - Lesson Plan: http://www.historyofvaccines.org/sites/default/files/inline-pdfs/History_of_Vaccines_How_to_Use.pdf

- Illsville game: This online game takes players through historical development of a society as it fights disease and tries to develop vaccines to protect the population: http://www.historyofvaccines.org/content/illsville-fight-disease
- Online science game from Rice University called MedMyst: Animal Alert! In *MedMyst: Animal Alert!*, players learn about a mysterious disease that is affecting people in a distant tropical region. Players can choose to work as an epidemiologist, microbiologist, or veterinarian to determine what is making people sick. While role-playing as an expert, players will learn how epidemiologists, microbiologists, and veterinarians work as a team to solve infectious disease outbreaks. Each expert path has its own learning objectives.
  - Online Game: http://webadventures.rice.edu/ed/Teacher-Resources/_games/MedMyst/
  - Lesson Plan: http://educators.brainpop.com/lesson-plan/medmyst-animal-alert/?bp-topic=vaccines

XI. Teacher Answer Keys

Types of Vaccines – Teacher

Learning Objectives

- Differentiate between the different types of vaccines
- Understand how different vaccines are made

Overview

Students will complete the "Type of Vaccines" graphic organizer using information from the flash interactive found here: https://www.nwabr.org/sites/default/files/types.swf

Students will get an overview of the characteristics, advantages, and disadvantages of six different types of vaccines, as well as examples of each. Descriptions of the diseases/pathogens used as examples are included in this guide.

Note: There are additional examples included in the key the are not given in the interactive. The interactive also touches on the use of these types of vaccines for the prevention of HIV.

Once students have completed the graphic organizer, they will complete "NOVA: Making Vaccines" using the accompanying worksheet. In the activity, they will create six vaccines, using a different technique to produce each one. This activity allows students to apply the information they collected in the graphic organizer.

Flash interactive – tell students to right click on the "Launch Interactive" button and open the activity in a new tab so it opens full-size in the web browser:
http://www.pbs.org/wgbh/nova/body/making-vaccines.html

A non-flash version of the activity can be accessed from main page for the activity by clicking on the "Printable Version" button.

-- KEY --

Types of Vaccines				
Vaccine	**How it works**	**Advantages**	**Disadvantages**	**Examples**
Live, attenuated	contains a weakened version of the living microbe so it can't cause disease	• elicit strong cellular and antibody responses • often confer lifelong immunity with only one or two doses	• slight chance attenuated microbe could revert to a virulent form & cause disease • not everyone can safely receive live vaccines (immunocompromised) • usually needs to be refrigerated to stay potent	– Measles virus – Mumps virus – Rubella virus – Varicella (chickenpox) – Influenza virus (LAIV) – Polio virus (Sabin – OPV) – Tuberculosis bacterium – Yellow fever virus
Killed or Inactivated	microbe is killed or inactivated with chemicals, heat, or radiation	• Decreased risk of infection • usually don't require refrigeration • easily stored and transported in a freeze-dried form	• stimulate a weaker immune response than do live vaccines; boosters needed to maintain immunity • could cause disease if agent wasn't inactivated properly	– Polio virus (Salk – IPV) – Influenza virus (IIV) – Hepatitis A virus – Cholera bacterium – Japanese encephalitis virus – Plague bacterium
Subunit	includes only the antigens that best stimulate the immune system (i.e. surface molecules)	• easily chances of adverse reactions to the vaccine are lower – contain only the essential antigens • cannot cause disease • easy to manufacture • no culture needed	• easily identifying which antigens best stimulate the immune system is a tricky, time-consuming process • low dose of antigen = boosters	– Hepatitis B virus – Pertussis bacterium (DTa<u>P</u>) – Pneumococcal – Meningococcal – HPV

Toxoid	consists of inactivated bacterial toxins (treated with formalin)	• cannot cause disease • produces an immune reaction directly against the toxins which cause the disease	• low dose of antigen = boosters • only works for pathogens that produce toxins	– Hepatitis B virus – Diphtheria bacterium (DTaP) – Tetanus bacterium (DTaP)
DNA	genes that code for pathogenic surface proteins are isolated and directly injected into host host cells that take up pathogenic DNA manufacture antigen; stimulates immune system	• cannot cause disease • stronger immune response because host manufactures antigen (dose is higher) • inexpensive and relatively quick to produce	• potential to cause cancer (if pathogenic DNA is incorporated into host's genome) • still in experimental stages	– Malaria parasite – Influenza virus – Herpes virus – HIV
Recombinant Vector	genes that code for pathogenic surface proteins are isolated and placed inside a vector (carrier) vector delivers gene to host cells, which then manufacture antigen; stimulates immune system	• closely mimics a natural infection → stronger immune response • More efficient than DNA vaccine → greater immune response	• potential to cause cancer (if pathogenic DNA is incorporated into host's genome) • still in experimental stages	– Rabies virus – Measles virus – HIV

CHOLERA	
Pathogen	*Vibrio cholera* (bacterium)
About the disease	Cholera is an acute, diarrheal illness, meaning it has an abrupt onset and a short course. It is common in underdeveloped countries because they have poor or no water sanitation techniques. Contamination can occur if human feces are not disposed of properly. The diarrhea of an infected person contains large quantities of *V. cholera*.
Transmission	Ingesting contaminated food or water
Symptoms	• profuse watery diarrhea, sometimes described as "rice-water stools," • vomiting • dehydration • low blood pressure • acute renal failure • severe electrolyte imbalance • coma If untreated, severe dehydration can rapidly lead to shock and death in hours.
Statistics	• Affects 3-5 million people annually and kills about 100,000 to 120,000 people among those affected • 1 in 10 (5-10%) infected persons will have severe cholera

Read more: http://www.cdc.gov/cholera/index.html

DIPHTHERIA	
Pathogen	*Corynebacterium diphtheriae* (bacterium)
About the disease	Diphtheria is an upper respiratory tract infection. When *C. diphtheriae* attach to the lining of the respiratory system, they produce a toxin. There are several combination vaccines for diphtheria, tetanus and pertussis (e.g. DTaP).
Transmission	From person to person through respiratory droplets by coughing or sneezing (more common) or by touching open sores (rare)
Symptoms	• Weakness • Sore throat • Fever • Swollen glands in the neck • Pseudomembrane (buildup of dead respiratory tissue)
Statistics	• Before there was treatment for diphtheria, up to half of the people who got the disease died from it. • There were less than 5 reported cases of diphtheria in the U.S. in the last 10 years.

Read more: http://www.cdc.gov/diphtheria/index.html

HEPATITIS A	
Pathogen	Hepatitis A virus (HAV)
About the disease	Hepatitis A is a highly contagious liver infection. The infection usually clears on its own in about 2 months once the body has produced enough antibodies, though 10%–15% of people have prolonged or relapsing disease for up to 6 months.
Transmission	From person to person through the fecal-oral route, occasionally foodbourne
Symptoms	• Fever • Fatigue • Vomiting • Abdominal pain • Dark urine • Clay-colored bowel movements • Joint pain • Jaundice (yellow color in the skin or the eyes) Young children are usually asymptomatic.
Statistics	• Hepatitis A rates in the U.S. have declined by 95% since the Hepatitis A vaccine first became available in 1995. • More than 80% of adults with Hepatitis A have symptoms. • Antibodies for HAV give lifelong immunity.

Read more: http://www.cdc.gov/hepatitis/hav/index.htm

HEPATITIS B	
Pathogen	Hepatitis B virus (HBV)
About the disease	Hepatitis B is a contagious liver infection that is an acute illness for some. However, it can become a long-term, chronic infection in others. Chronic Hepatitis B can lead to cirrhosis or liver cancer.
Transmission	From person to person through blood, semen, or other body fluid
Symptoms	• Fever • Fatigue • Vomiting • Abdominal pain • Dark urine • Clay-colored bowel movements • Joint pain • Jaundice (yellow color in the skin or the eyes) About 15%–25% of people with chronic Hepatitis B develop serious liver conditions, such as cirrhosis (scarring of the liver) or liver cancer.
Statistics	• Hepatitis B rates in the U.S. have declined by 82% since the Hepatitis B vaccine first became available in 1991. • Globally, chronic Hepatitis B affects approximately 240 million people and contributes to an estimated 786,000 deaths worldwide each year.

Read more: http://www.cdc.gov/hepatitis/hbv/index.htm

HERPES	
Pathogen	herpes simplex virus → HSV-1 or HSV-2
About the disease	The herpes simplex virus causes contagious sores, frequently around the mouth (cold sores) or on the genitals. Though HSV-1 or HSV-2 can cause sores in either location, HSV-1 usually is associated with oral herpes while HSV-2 is associated with genital herpes. Genital herpes is an STD. The virus remains as a latent infection in the ganglion (HSV-1 resides in the trigeminal ganglion; HSV-2 resides in the sacral ganglia). Even if there are no symptoms present, a person with herpes can still be contagious and spread the virus with asymptomatic shedding.
Transmission	From person to person through blood, semen, or other body fluid
Symptoms	Blisters appear on the lips and the roof of the mouth (oral herpes) or on or around the genitals or rectum (genital herpes). <u>Before blisters appear</u> • pain, itching, or tingling, before blisters • sore throat, or swollen glands in neck <u>After blisters appear</u> • blisters break open, leak clear infectious fluid, then crust over (last 2–24 days)
Statistics	• It is estimated that 50%-80% of American adults have the oral herpes virus and 20% have the genital herpes virus. • Once the virus has entered and infected the body, it remains as a latent infection and there is no cure. • Genital herpes has reached epidemic proportions in the U.S.; 500,000 are diagnosed each year, but only a third knows they have the virus.

Read more: http://www.herpes.com/index.html

HIV	
Pathogen	human immunodeficiency virus
About the disease	HIV attacks the body's immune system, specifically the CD4 T cells. As more CD4 T cells are destroyed, it is more difficult for the immune system to fight off infections. When opportunistic infections (tuberculosis) or cancers (invasive cervical cancer) take advantage of a very weak immune system, this signifies that the person has AIDS. Infected persons are usually prescribed medicine for antiretroviral therapy (ART) to prevent the virus from progressing.
Transmission	From person to person through contact with mucosal membrane or damaged tissue (semen, pre-seminal fluid, rectal fluids, vaginal fluids, breast milk) OR be directly injected into the bloodstream (needle/syringe → blood)
Symptoms	<u>Stage 1: Acute HIV infection</u> • 2 to 4 weeks after infection, may experience a flu-like illness, but most people are unaware they have been infected <u>Stage 2: Clinical latency (HIV inactivity or dormancy)</u> • HIV reproduces at low levels until end of this stage, so people are usually asymptomatic • Time in this stage varies; can be a decade or more if on ART <u>Stage 3: Acquired immunodeficiency syndrome (AIDS)</u> • Compromised immune system (usually very low CD4 T cell count) • Prone to opportunistic infections
Statistics	• An estimated 1.2 million persons aged 13 and older were living with HIV infection in the U.S., plus more with undiagnosed infections. • Sub-Saharan Africa accounts for 66% of all new HIV infections.

Read more: http://www.cdc.gov/hiv/basics/index.html

HPV	
Pathogen	human papillomavirus
About the disease	HPV is a group of several related viruses, and each type can infect different parts of the body. They are named for the warts (papillomas) some types can cause. Other types can lead to cancer, especially cervical cancer.
Transmission	From person to person through intimate skin-to-skin contact (oral, vaginal, anal sex)
Symptoms	HPV usually goes away on its own and does not cause any health problems. If it persists, it can cause • Genital warts • Cervical cancer • Other HPV-related cancers, including oropharynx (cancers of the back of the throat, including the base of the tongue and tonsils)
Statistics	• HPV is the most common sexually transmitted infection (STI). • HPV is so common that nearly all sexually active men and women get it at some point in their lives.

Read more: http://www.cdc.gov/hpv/index.html

INFLUENZA	
Pathogen	influenza virus
About the disease	Influenza is a contagious respiratory illness that can range from mild to severe. There are two types of flu viruses (Type A and B). These viruses can change slightly when small alternations in their genes occur, but the antigenic properties usually remain the same. Therefore, the immune system can recognize a virus that is closely related to one it was previously exposed to. Flu viruses (Type A only) can also undergo drastic changes in their genes, resulting in new hemagglutinin and neuraminidase proteins that infect humans. These proteins are used to name viruses (e.g. H1N1). When drastic changes occur, most people have little or no protection against the new virus. There are several approved vaccines: live, attenuated influenza vaccine (LAIV) [nasal spray]; inactivated influenza vaccine (IIV), recombinant influenza vaccine (RIV) [injections]. The influenza virus evolves enough seasonally that a modified vaccine is necessary every year. The vaccine is a cocktail of the strains predicted to spread (generally 3 or 4) that year.
Transmission	From person to person likely through droplets when people cough, sneeze or talk
Symptoms	The flu usually comes on suddenly and can induce some or all of the following: • Fever and/or feeling feverish/chills • Cough • Sore throat • Runny or stuffy nose • Muscle or body aches • Headaches • Fatigue (tiredness) • Complications could arise, including pneumonia, bronchitis, sinus/ear infections
Statistics	• Flu activity peaks between December and February, but can last as late as May. • Over 31 seasons between 1976 and 2007, estimates of flu-associated deaths in the U.S. range from a low of about 3,000 to a high of about 49,000 people.

Read more: http://www.cdc.gov/flu/about/disease/index.htm

JAPANESE ENCEPHALITIS (JE)	
Pathogen	Japanese encephalitis virus (flavivirus)
About the disease	Japanese encephalitis is prevalent in Asia and the western Pacific. It persists as part of a cycle between vector (mosquito) and host (pig, wading bird). A small percentage of humans that are infected by mosquito bite develop encephalitis (inflammation of the brain). There is no specific treatment for JE, but the disease is preventable by vaccination.
Transmission	From infected mosquito to human via bite
Symptoms	• Less than 1% of people infected develop clinical illness. • Initial symptoms often include fever, headache, and vomiting. • Mental status changes, neurologic symptoms, weakness, and movement disorders might develop. • Seizures are common, especially among children.
Statistics	• Among patients who develop encephalitis, 20% - 30% die. • 30%-50% of survivors continue to have neurologic, cognitive, or psychiatric symptoms.

Read more: http://www.cdc.gov/japaneseencephalitis/

MALARIA	
Pathogen	*Plasmodium* (protozoan)
About the disease	Malaria is a disease caused by one or more of several species of parasitic *Plasmodium*. Symptoms can range from mild to severe. *P. falciparum* causes red blood cells to adhere to vessel walls, so they do not freely circulate in the blood. If this phenomenon occurs in the vessels of the brain, it can cause cerebral malaria, which is associated with high mortality. Malaria is curable if diagnosed and treated promptly and correctly. However, relapses may occur. *P. vivax* and *P. ovale* can lay dormant in the liver for months or years before reactivating.
Transmission	From infected *Anopheles* mosquito to human via bite
Symptoms	• Fever • Chills • Sweats • Headaches • Nausea and vomiting • Body aches • General malaise (general feeling of discomfort, illness, or uneasiness) • Infections may cause organ failures or blood/metabolism abnormalities—this is considered "severe malaria"; severe symptoms could lead to death
Statistics	• About 1,500 cases of malaria are diagnosed in the U.S. each year; most cases are people returning from countries like sub-Saharan Africa and South Asia. • The WHO estimates that malaria caused 198 million clinical episodes and 500,000 deaths worldwide in 2013.

Read more: http://www.cdc.gov/malaria/about/index.html

MEASLES	
Pathogen	Measles virus (*Morbillivirus*)
About the disease	Measles is a contagious respiratory illness in humans. It is so contagious that 90% of susceptible people in proximity to an infected person will also become infected. Symptoms appear about 7 to 14 days after infection. Children <5 years of age and adults >20 years of age are more likely to suffer from measles complications. The measles vaccine is frequently given in combination with mumps and rubella (MMR).
Transmission	From person to person through droplets when people cough or sneeze; also airborne for up to two hours
Symptoms	• Initial symptoms: high fever, cough, runny nose, and red, watery eyes • Day 2-3: tiny white spots (Koplik spots) may appear inside the mouth • Day 3-5: rash (flat red spots), raised bumps, fever Headaches • Complications: ear infections that result in permanent hearing loss, pneumonia, encephalitis
Statistics	• Measles is no longer endemic (constantly present) in the United States. • Two doses of measles vaccine as a child confer lifetime protection (no booster). • The herd immunity threshold for measles is 92%-95% (percent of people that need to be vaccinated in order to protect the community as a whole).

Read more: http://www.cdc.gov/measles/index.html

MENINGOCOCCAL DISEASES	
Pathogen	*Neisseria meningitides* (bacteria)
About the disease	Meningococcal disease can refer to any illness caused by *N. meningitidis*. Illnesses are often severe and include infections of the lining of the brain and spinal cord (meningitis) and bloodstream infections (bacteremia or septicemia). Meningococcal meningitis must be treated immediately. If fatal, death can occur in as little as a few hours. If non-fatal, one can be left with permanent disabilities, including hearing loss and brain damage.
Transmission	From person to person through exchanging respiratory/throat secretions, during close contact (coughing or kissing), or lengthy contact (live in same household)
Symptoms	*Symptoms vary with illness.* A common meningococcal disease is meningitis. This disease causes the protective membranes covering the brain and spinal cord (meninges), become infected and swell. This causes: • sudden onset of fever, headache, stiff neck • nausea, vomiting • photophobia (increased sensitivity to light) • altered mental status (confusion)
Statistics	• About 1 out of 10 people have this type of bacteria in the back of their nose and throat with no signs or symptoms of disease • 10 to 15 out of 100 people infected with meningococcal disease will die. About 11 to 19 out of every 100 survivors will have long-term disabilities.

Read more: http://www.cdc.gov/meningococcal/

MUMPS	
Pathogen	Mumps virus (*Paramyxovirus*)
About the disease	Mumps is a contagious disease characterized by puffy cheeks and a swollen jaw. Some cases of mumps are asymptomatic—infected persons do not know they have the disease. Most people with mumps recover completely in a few weeks. Mumps can be prevented with MMR vaccine.
Transmission	From person to person through saliva or mucus from the mouth, nose, or throat
Symptoms	• Fever • Headache • Muscle aches • Tiredness • Loss of appetite • Swollen and tender salivary glands under the ears on one or both sides (parotitis) Mumps can occasionally cause complications, particularly in adults.
Statistics	• Two doses of the vaccine are 88% (range: 66-95%) effective at preventing mumps • Within less than 40 years of the first vaccine, mumps rates declined by more than 99% thanks to high two-dose vaccination coverage among children.

Read more: http://www.cdc.gov/mumps/about/index.html

PERTUSSIS	
Pathogen	*Bordetella pertussis* (bacteria)
About the disease	Pertussis is a highly contagious respiratory disease. It is commonly referred to as whooping cough—this is because violent and rapid coughing causes a lack of air that forces one to inhale with a loud "whooping" sound. *B. pertussis* attach to the cilia that line the upper respiratory track, and release toxins that cause damage and swelling. Recovery from pertussis can happen slowly, as coughing fits can return for months after the initial infection. The best way to protect against this disease is by getting vaccinated. However, children must be at least two months old to be eligible. This is why pertussis is particularly dangerous for newborns, though the disease can affect people of all ages.
Transmission	From person to person through coughing, sneezing, sharing breathing space for extended periods of time
Symptoms	Early symptoms can last for 1 to 2 weeks and usually include: • Runny nose • Low-grade fever (generally minimal throughout the course of the disease) • Mild, occasional cough • Apnea – a pause in breathing (in babies) Later stages (after 1 to 2 weeks): • Paroxysms (fits) of many, rapid coughs followed by a high-pitched "whoop" • Vomiting (throwing up) during or after coughing fits • Exhaustion (very tired) after coughing fits Mumps can occasionally cause complications, particularly in adults.
Statistics	• There has been an 80%-90% decrease in cases since the introduction of the mumps vaccine in the 1940s. • About half of babies younger than 1 year old who get pertussis need care in the hospital, and 1 out of 100 babies who get treatment in the hospital die.

Read more: http://www.cdc.gov/pertussis/about/index.html

PLAGUE	
Pathogen	*Yersinia pestis* (bacteria)
About the disease	There are multiple plague diseases, including bubonic, pneumonic, and septicemic. The bacterium is maintained in a vector (flea) host (rodent) cycle, but it can infect other mammals, including humans.
Transmission	Flea bites; Contact with contaminated fluid or tissue from a plague-infected animal; From person to person through coughing (infectious droplets)
Symptoms	**Bubonic plague:** fever, headache, chills, weakness; swollen, painful lymph nodes (called buboes). **Septicemic plague:** fever, chills, extreme weakness, abdominal pain, shock, and possibly formation of a hematoma. Skin and other tissues may turn black and die, especially on fingers, toes, and the nose. **Pneumonic plague:** fever, headache, weakness; pneumonia with shortness of breath, chest pain, cough, and sometimes bloody or watery mucous. The pneumonia may cause respiratory failure and shock.
Statistics	• It occurs in both men and women, though historically is slightly more common among men, probably because of increased outdoor activities that put them at higher risk. • Almost all cases reported occur in small towns and villages or agricultural areas.

Read more: http://www.cdc.gov/plague/index.html

PNEUMOCOCCAL DISEASES	
Pathogen	*Streptococcus pneumoniae* (bacteria)
About the disease	Pneumococcus can cause many types of illnesses, including ear infections and meningitis.
Transmission	From person to person by direct contact with respiratory secretions, like saliva or mucus
Symptoms	*Symptoms vary with illness.* A common pneumococcal disease is pneumonia, which causes: • Fever and chills • Cough • Rapid breathing or difficulty breathing • Chest pain • Confusion or low alertness (adults)
Statistics	• People can have this type of bacteria in the back of their nose and throat with no signs or symptoms of disease (referred to as "carriage"). • It is estimated that about 900,000 Americans get pneumococcal pneumonia each year and about 5-7% die from it.

Read more: http://www.cdc.gov/pneumococcal/about/index.html

POLIO (POLIOMYELITIS)	
Pathogen	poliovirus
About the disease	Polio is a crippling and potentially fatal infectious disease because it can cause paralysis and other serious symptoms. There is currently a global health initiative in progress to eradicate polio. This can best be achieved by vaccination. There are two forms of the vaccine: oral polio vaccine (OPV - Sabin) and inactivated polio virus (IPV – Salk). Though both forms are used worldwide, only the IPV is currently used in the United States.
Transmission	From person to person through contact with the feces of an infected person (common) or respiratory droplets (less common)
Symptoms	About 1 out of 4 people will have flu-like symptoms: • Headache, sore throat, stomach pain • Fever • Tiredness • Nausea A small proportion of people could develop serious symptoms, including paresthesia (feeling of pins and needles in the legs), meningitis, or paralysis (may lead to permanent disability).
Statistics	• Four regions of the world are certified polio free—the Americas, Europe, South East Asia and the Western Pacific. Therefore, 80% of the world's people now live in polio-free areas.

Read more: http://www.cdc.gov/polio/

RABIES	
Pathogen	Rabies virus (*Lyssavirus*)
About the disease	The rabies virus infects the central nervous system, ultimately causing disease in the brain and death. After being introduced into a new host, it travels within nerves to the brain. Once there, the virus multiplies, causing the first symptoms of rabies.
Transmission	From infected animal to uninfected animal through saliva, usually by means of a bite
Symptoms	• Initially: flu-like symptoms; discomfort/itching at the wound site • As disease progresses: cerebral dysfunction, anxiety, confusion, agitation, delirium, abnormal behavior, hallucinations, and insomnia • Once clinical signs of rabies appear, the disease is nearly always fatal.
Facts	• Rabies can kill unless you receive a series of rabies shots before you have symptoms.

Read more: http://www.cdc.gov/rabies/index.html

RUBELLA	
Pathogen	Rubella virus *(Rubivirus)*
About the disease	Rubella (a.k.a. German measles) is no longer constantly present in the United States and was therefore deemed eliminated from the U.S. in 2004. All recent cases resulted from living or travelling outside of the U.S. It is important that you disclose with friends, family, childcare provider, etc. if you have/had rubella because an infected person is contagious for up to one week after the rash disappears. The MMR vaccine is administered as a preventative measure.
Transmission	From person to person through coughing or sneezing; a pregnant woman can pass the virus to her unborn child
Symptoms	Rubella is usually mild, with a red rash as the first sing of infection. Other symptoms may include: • low-grade fever • headache • mild pink eye • swollen and enlarged lymph nodes • cough, runny nose However, there may be serious complications in some people (e.g. miscarriage in pregnant women).
Statistics	• Less than 10 people in the U.S. report rubella each year • 25% to 50% of people infected with rubella do not develop a rash or have any symptoms

Read more: http://www.cdc.gov/rubella/about/index.html

TETANUS	
Pathogen	*Clostridium tetani* (bacteria)
About the disease	*C. tetani* produce a toxin that causes muscles to tighten. This can be quite painful, and is sometimes called "lockjaw" because the tightening prevents a person from opening his/her mouth. The DTaP or Tdap vaccines are used to prevent infection.
Transmission	Occurs through broken skin due to injuries from contaminated objects
Symptoms	• Headache • Jaw cramping • Muscle tightening/spasms (often in the stomach) • Painful muscle stiffness all over the body • Trouble swallowing • Jerking or staring (seizures) • Fever and sweating • Complications may arise
Statistics	• Tetanus is uncommon in the U.S. Most cases are in people that have never been vaccinated or have missed the 10-year booster.

Read more: http://www.cdc.gov/tetanus/index.html

TUBERCULOSIS	
Pathogen	*Mycobacterium tuberculosis* (bacteria)
About the disease	*M. tuberculosis* can infect many parts of the body. Pulmonary TB (lungs) is most common. Some people may have a latent TB infection, in which they do not present symptoms. However, the bacteria can become active and cause infection.
Transmission	Airborne from person to person
Symptoms	Though TB usually infects the lungs, symptoms depend on what part of the body is infected with the bacteria. • bad cough (3 weeks or longer) • chest pain • coughing up blood or sputum (phlegm deep inside lungs) • weakness or fatigue • weight loss • fever/chills
Statistics	• One third of the world's population is infected with TB. • TB is a leading killer of people who are HIV infected.

Read more: http://www.cdc.gov/tb/topic/basics/default.htm

VARICELLA (CHICKENPOX)	
Pathogen	varicella-zoster virus (VZV)
About the disease	Chickenpox is high contagious. Anyone who hasn't had chickenpox or gotten the chickenpox vaccine can get the disease. For most people, getting chickenpox once provides immunity for life. However, for a few people, they can get chickenpox more than once, although this is not common. Chickenpox can be serious, especially in babies, adults, and people that are immunocompromised with weakened immune systems.
Transmission	From person to person, usually touching or breathing in the virus particles chickenpox blisters
Symptoms	• Face/body rash that turns into itchy, fluid-filled blisters; eventually turn into scabs • fever • tiredness • loss of appetite • headache
Statistics	• The number of chickenpox cases has fallen by as much as 90% over a 10 year period. • The rash causes between 250 and 500 itchy blisters.

Read more: http://www.cdc.gov/chickenpox/about/index.html

YELLOW FEVER	
Pathogen	Yellow fever virus (*Flavivirus*)
About the disease	Yellow fever virus is related to the JE virus. The yellow fever virus is found in tropical and subtropical areas in South America and Africa. It persists as part of a cycle between vector (mosquito) and host (primate—human or non-human).
Transmission	From infected mosquito to human via bite
Symptoms	Most infected people have no illness or mild symptoms. Symptoms include: • Fever/chills • Severe headache • Back/body aches and pain • Nausea/vomiting • Fatigue/weakness • About 15% of cases progress to a more severe form of the disease
Statistics	• Among those who develop severe disease, 20–50% may die.

Read more: http://www.cdc.gov/yellowfever/index.html

-- KEY --

NOVA: Making Vaccines

Directions: Use the information provided within the interactive to complete the questions below.
Note: *The procedures in this feature have been greatly simplified. For example, a gene cannot be plucked out of DNA using tweezers, and there's no device called a purifier that can extract materials.*

Go to: http://www.pbs.org/wgbh/nova/body/making-vaccines.html
Right click on "Launch Interactive" and open the activity in a new tab to view it full-size

1. To create a vaccine that will protect you against a pathogen, you usually begin with a pathogen and alter it in some way. Explain how the process of making the smallpox vaccine is different.

   To make the smallpox vaccine, you begin with another virus that is similar to the smallpox virus, yet different enough not to bring on the smallpox disease once it enters your body. This similar virus is cowpox.

2. When preparing a live-attenuated vaccine, to what degree (how much) should the pathogen be modified? Why?

   The pathogen needs to be modified enough so that it will still invade cells in the body. It must be similar enough to the original measles virus to stimulate an immune response, but not so similar that it brings on the disease itself.

3. What is the goal when creating a killed vaccine?

   The goal in creating a killed vaccine is to disable a pathogen's replicating ability (its ability to enter cells and multiply) while keeping intact its shape and other characteristics that will generate an immune response against the actual pathogen.

4. Name a couple of ways bacteria and viruses can be inactivated.

   Bacteria and viruses can be inactivated by using heat, radiation, or chemicals like formaldehyde.

5. Why do vaccines that are not live require booster shots?

   Vaccines that are not live (like subunit vaccines) require boosters because they will not produce a full immune response.

6. What is the goal when creating a toxoid vaccine?

   The goal when creating toxoid vaccines is to condition the immune system to combat a toxin produced by an invading virus or bacteria rather than the pathogen itself.

7. Name a couple of chemicals that are used to neutralize toxins for toxoid vaccines.

   Some chemicals that can neutralize toxins are formaldehyde and aluminum salts.

8. How are the subunits produced for use in subunit vaccines?

   Genetic engineering techniques are used to make subunit vaccines. A piece of DNA from the pathogen is extracted and inserted into the genome of a yeast cell (or bacteria). As the cell grows, it transcribes and translates the pathogenic DNA and produce the protein it codes for.

9. What is the goal when creating genetic vaccines (DNA vaccines)?

   The goal when creating DNA vaccines is to use a gene from a pathogen to generate an immune response.

10. What does PCR stand for? What is PCR used for?

    PCR stands for polymerase chain reaction. PCR is used to make many copies of a specific gene.

11. What is a vector?

    A vector is an agent that is able to enter and instruct cells to create proteins based on the vector's DNA code.

12. What are restriction enzymes? What are they used for when creating DNA vaccines?

    Restriction enzymes are agents that cut DNA sequences at known locations. Restriction enzymes are used to cut open vectors and trim the ends of copied genes in order to splice them together.

Herd Immunity Activity – TEACHER

Learning Objectives

- Investigate how vaccination rates affect a community
- Justify why vaccination is important

Introduction

Just as a herd of cattle or sheep uses sheer numbers to protect its members from predators, herd immunity protects a community from infectious diseases due to the sheer numbers of people immune to such diseases. The more members of a human "herd" who are immune to a given disease, the better protected the whole population will be from an outbreak of that disease. This concept is referred to as herd immunity.

Early human communities were relatively small and isolated. Therefore, the spread of a disease was greatly limited by geography. But today, various modes of transportation allow humans to traverse the globe, essentially linking us all into one vast, interactive human herd. Increased interaction has resulted in increased disease transmission. The only thing that can break a chain of transmission is a disease-resistant link. By increasing the number of vaccinated individuals in a population, even those most vulnerable to disease can be protected by herd immunity.

For a comparison of annual morbidity resulting from childhood diseases in the pre- and post-vaccination eras, see Table 13-1 in Malone and Hinman (2003, p. 266).

Malone, K.M., and Hinman, A.R. 2003. Vaccination mandates: The public health imperative and individual rights. In *Law in Public Health Practice* (pp. 262–84). New York: Oxford University Press. Retrieved August 8, 2016 from http://www.cdc.gov/vaccines/imz-managers/guides-pubs/downloads/vacc_mandates_chptr13.pdf

Preparation

- Print/copy enough role cards (see below) for each part of the activity. For each part of this activity, students will receive a role card. In addition to the role, "uninfected" cards have one of the many reasons why people do not get vaccinated.
  - Round 1: 3 students receive an "infected" card, rest receive an "uninfected" card
  - Round 2: 3 "infected" cards, 3 "protected" cards (swap out 3 "uninfected"), rest "uninfected"
  - Round 3: 3 "infected" cards, ¾ of class "protected" cards (swap out for "uninfected"), rest "uninfected"

  Ex: For a class of 25, you would need a total of 3 "infected", 18-19 "protected", 22 "uninfected"

- Print/copy (each 1 per student)
  - Student activity packet
  - Herd Immunity Infection Data sheet ***OR*** Provide graph paper

Procedure (Overview)

There are three different roles:

- ***Infected*** – You can pass on the infection to anyone that is not protected by vaccination.
- ***Uninfected*** – You can become infected if you come into contact with an infected individual.
- ***Protected*** – You have been vaccinated against the infection and are therefore protected. You will not contract the infection if you come into contact with an infected individual.

Round 1
There are always 3 infected individuals in the class. In this round, no one is immunized.

After walking around the room a bit to mix students up, they will be told to stop and whisper their role to a student nearby. They will complete a total of three exchanges. In this round, they can also write down the name and role of each person they exchange with, in order to trace the disease back to the original carriers. The remaining uninfected students will act as epidemiologists to determine the index cases. They will then determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data. This can be done on graph paper, or using a template sheet. Collect role cards before Round 2.

Round 2
There are always 3 infected individuals in the class. In this round, three people are immunized. Redistribute role cards, swapping three of the "uninfected" cards with three "protected" cards.

Again, students will complete a total of three exchanges. They will then determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data.

Round 3
There are always 3 infected individuals in the class. In this round, three-fourths of the class is immunized. Redistribute role cards, swapping ¾ of the "uninfected" cards with "protected" cards.

Again, students will complete a total of three exchanges. They will then determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data.

Prior to analysis questions, have students summarize the results of the activity in small groups. Then discuss as a class.

Discussion/Analysis

1. What is herd immunity?

   Herd immunity refers to the increased protection of a whole population from a disease when more individuals of that population are immune to the disease.

2. How does herd immunity protect people who are unvaccinated?

   Herd immunity protects people who are unvaccinated by decreasing the likelihood that susceptible people will come into contact with the disease. Herd immunity prevents disease outbreak by breaking the chain of transmission (prevents spreading).

3. The herd immunity threshold refers to the number of people that should be vaccinated in order for everyone to be relatively safe. Highly contagious diseases have a higher threshold than less contagious ones. For example, measles is much more contagious and has a higher herd immunity threshold (95%) than influenza (75%). Based on the data you collected during the activity, what is the herd immunity threshold for the infection? Explain.

   Answers will vary, but should suggest 75% or higher. Students should note that during the first two rounds, vaccination rate was low or non-existent. In the last round, the disease was not able to spread as easily due to an increased proportion of vaccinated individuals.

4. List 3 specific reasons why some people cannot or do not get vaccinations?

   These responses can come from the cards students had during the activity. They should be specific in their answers. Ex: Students should list more than just "medical exemption" → A cancer patient should forego vaccination because he or she has a compromised immune system.

5. Vaccine exemption laws vary from state to state, but all states have exemption legislation in place. How does taking a vaccine exemption for oneself affect others?

   By taking a vaccine exemption, you increase the chances of spreading infectious diseases to others. The very young or elderly, pregnant women, and the immunocompromised are more likely to suffer from severe symptoms or complications from infectious diseases. Though your body may be able to fight off the disease, individuals from any of these groups may not be able to do so.

Uninfected

Medical exemption:
Severe allergic reaction to vaccine component

You had a severe reaction the last time you received this immunization and had difficulty breathing.

Uninfected

Medical exemption:
Acute illness (moderate or severe)

You have recently been diagnosed with strep throat and are taking medicine for it. This is temporary and your doctor will vaccinate you once you are well.

Uninfected

Medical exemption:
Compromised immune system

Your body is weakened from cancer treatment and you cannot be immunized now.

Uninfected

Medical exemption:
Immunosuppressive therapy

You are taking medicines after an organ transplant and cannot be immunized now.

Uninfected

Medical exemption:
Age (too young for first immunization)

You are younger than 2 months.

Uninfected

Medical exemption:
Severe allergic reaction to vaccine component

You had difficulty breathing and broke out in hives soon after you received this immunization the last time.

Uninfected

Philosophical exemption in one of the states that permit this:

When you were younger, your parents made the decision not to have you immunized.

Uninfected

Religious exemption:

When you were younger, your parents refused immunization for religious reasons.

Infected

You have contracted a communicable infection. It is easily spread when you come into contact with other people.

Infected

You have contracted a communicable infection. It is easily spread when you come into contact with other people.

Infected

You have contracted a communicable infection. It is easily spread when you come into contact with other people.

Protected

You have been vaccinated against the infection, and are therefore protected from contracting the disease.

Protected

You have been vaccinated against the infection, and are therefore protected from contracting the disease.

Protected

You have been vaccinated against the infection, and are therefore protected from contracting the disease.

Protected

You have been vaccinated against the infection, and are therefore protected from contracting the disease.

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Protected

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TEACHER NOTES ON VIDEO SEGMENTS – VACCINES: CALLING THE SHOTS

The Invisible Threat

Our lives are connected—this can pose invisible threats and allow transmission of pathogens
Diseases unseen for a century are returning. People are dying in the developed world
Some parents are electing not to vaccinate their children. Why?
All parents want healthy children; this is becoming an expectation.
90% of parents vaccinate children. Children receive 28 immunizations in their first 2 years.
There are many vaccine-related concerns (how many given at one time, when they should be done)
1% of parents don't vaccinate at all—why and what are the consequences?
Video presents a 7 week old baby with whooping cough (infection caused by *Bortadella persussis*)
- Infected before he was allowed to be vaccinated (age-related reason)
- Has nasty bronchitis, lots of coughing, and could stop breathing
- 1 in 100 infants with whooping cough will die
- No cure for whooping cough, but antibiotics can help prevent the spread of infection
- Was rarely seen in developed countries, but now its's back—50,000 cases in 2012, 20 died
- Vaccine can wear off after a few years, so older children are vulnerable

Measles Outbreak

2011—30,000 measles cases in Europe
2012—2,000 cases in the UK
2013—unvaccinated orthodox community was hit in New York and spread quickly. In 3 months, 3,500 people were exposed, 58 were infected (all unvaccinated)
Measles are droplet spread, but can also survive in the air. It can remain for 2 hours.
90% of people who are exposed but aren't immune get the disease
Measles was declared to be eradicated in the U.S. in 2000.
Worldwide, there are some mainstream pockets of populations that choose not to vaccinate
Some parents worry about vaccines causing side effects (e.g. seizures)
Exemptions can be issued for personal or religious beliefs (do not apply nationwide for all reasons)
It's ok to question vaccines—worthy being concerned about
1955 first polio vaccine was announced
People used to see cases of infectious diseases in first hand, so vaccination seemed more pressing.
- Now that infection rates are lower, people are not as enthusiastic about vaccination.

The History of Vaccines

500 years ago, 1 in 3 children died before age of 5 as the result of as a result of disease.
1,000 years ago—vaccines evolved from traditional Indian medicine (Brahmin healers). Death by smallpox was prevented by rubbing scabs from a smallpox survivor in a fresh scratch on a healthy individual. Though the person would get sick, they would recover and be protected from future infections.
1721—400,000 people would die from smallpox every year in England. The Brahmin technique was introduced in England by Lady Mary Wortley Montagu. The smallpox death rate dropped from 30% to 2%.
1796—Edward Jenner demonstrated that intentional infection with cowpox would prevent smallpox. He named his invention vaccine after vaca (cow)
Immunity is the body's natural defense system. It depends on white blood cells to fight against disease. If they recognize something as foreign, the white blood cells attack, replicate, and tag pathogens with antibodies to be disposed of. They also leave behind memory cells, which can look for invaders and sound alarm if they return.
Pathogens have coevolved to evade our immune system. If an infection spreads too quickly for the immune system to eradicate, we can get sick. A vaccine sends in a weakened or dead form of a pathogen to make it easier for the immune system to eliminate it quickly. Different vaccines can be combined to reduce the number of injections kids need.
Younger people have the weakest immune systems. However, vaccination is very successful as a whole, so few parents worry about losing kids to infectious disease.

Herd Immunity
Measles outbreak did not spread much past the orthodox community in NY because a majority of people exposed were vaccinated.
The less a disease exists among groups of people, the safer each person is. [Idea of herd immunity]
For highly infectious diseases (measles), we need at least 95% of community to be vaccinated for it to work well. Ex: In 2008, only 89% of France was vaccinated against measles. Measles was brought in by a girl returning from holiday in Austria. Come 2011, there were 15,000 cases.
Why don't people get vaccinated? Risk tolerance is low, and people have a distorted notion of how invulnerable they are. Low vaccination can be amplified by mistrust and amplified by media.

Dravet Syndrome
Video presents a boy that had seizures after getting vaccinated. They thought it was due to the vaccine. After much investigation and seeing many doctors, they found out he had Dravet syndrome (rare form of epilepsy that begins at infancy). The vaccine caused a mild infection, which lead to a fever. The fever triggered the seizure, not the vaccine. The parents have chosen to forego vaccination to avoid triggering more seizures. They now rely on other people vaccinating themselves and their children to keep their son safe.

Polio
In the 1950s, tens of thousands of U.S. children were paralyzed from polio and thousands died
1955—polio vaccine (Salk, injection; Sabin, oral) rates plummeted by 99%
In extremely rare cases, the oral polio vaccination leads to infection because the virus may mutate.
In 2000, the oral form was replaced by safer injectable form

Science of Autism
Sometimes vaccines are blamed for causing harm without any concrete evidence
Autism—1 in 70 children are diagnosed on spectrum—unsure of cause
Correlation doesn't imply causation—though some argue that vaccination could cause autism, there are dozens of studies that do not link the two.
Autism can run in families. Scientists are investigating genes that lead to autism, as well as environmental factors. It is likely that autism begins in the womb—10 and 24 weeks—fetal origin.

HPV
Gardasil is a vaccine that protects against HPV (human papilloma virus) and cervical cancers
HPV is the most common cancer-causing virus.
Around 80% of Americans will catch it at some point in their lives. For some, it will cause cancer.
Some see as lifesaving vaccine, but others are concerned that they do not have the info to decide.
It is key to vaccinate boys and girls before they could contract the virus (before sexually active)
Some parents link the HPV vaccine with encouraging sexual activity

Weighing Risk
Risks surround us every day—not just in vaccines.
Vaccines aren't risk free. There are known side effects, but only 1 in 1 million will have a life-threatening reaction. Some worry about that 1 in 1 million, and make their decision about vaccination based on this fear.
More people vaccinated = increase protection for everyone
Ethics → greater good for greater number of people

Adapted from: http://communities.naae.org/servlet/JiveServlet/downloadBody/15335-102-1-17039/NOVA%20Vaccines%20Calling%20the%20Shots.docx

NOVA: Vaccines—Calling the Shots

Discuss each statement with a partner before watching the film, and decide whether the statement is true or false. Then, circle either T or F in the column labeled "Before." After watching the film, discuss the statements with your partner again, and circle either T or F in the column labeled "After."

Actual	Statement
False	**1)** Approximately ~~70%~~ **90%** of parents choose to vaccinate their children.
True	**2)** Vaccines can wear off after a few years, so some require booster shots to provide the appropriate immunity.
False	**3)** Approximately ~~50%~~ **90%** of people exposed to measles that are not immune actually get sick from the virus.
True	**4)** Families can claim religious exemption to avoid having their children get the required vaccinations to attend school.
False	**5)** In the 1500s, ~~1 in 10~~ **1 in 3** children died before the age of 5.
False	**6)** Vaccines got their name from the word for ~~sheep~~ **cow**.
True	**7)** Vaccines contain weakened or dead parts of antigens, making it easier for immune system to win quickly.

MATCHING

B Pertussis	A. Causes small puss filled bumps on skin, infection of cowpox created immunity against this virus
C Measles	B. Inflammation of the lungs, lots of coughing, commonly affects infants and young children
A Smallpox	C. Causes fever and red rash on the skin, US declared free of this virus in 2000 but has returned, very infectious
D Polio	D. Affects the spinal cord leaving many infected individuals paralyzed, infection rate dropped by 99% when vaccine was introduced in 1955

Define and provide an example of/purpose for THREE of the following terms:

Eradicate Herd Immunity Immunocompromised Virulent

Eradicate—to get rid of; Ex: Measles was declared to be completely eradicated from the US in 2000.

Herd immunity—refers to a means of protecting a whole community from disease by immunizing a critical mass of its populace; Ex: If 95% of a community is vaccinated against measles, unvaccinated people are protected because the likelihood of the disease appearing is very small.

Immunocompromised—people with weakened, undeveloped, or non-existent immune systems; Ex: Individuals infected with HIV/AIDS, young and elderly, those undergoing cancer treatments, etc.

Virulent—denotes a pathogen that can cause disease; Ex: The viruses that cause measles and polio are considered to be extremely virulent because they cause severe and potentially harmful symptoms.

AGREE OR DISAGREE with the following statements and EXPLAIN WHY:

The threat of contagious disease is underappreciated.

AGREE—Vaccines have prevented disease outbreaks that were typical in the past. Consequently, the general public is no longer affected by widespread losses caused by disease. Therefore, people have a distorted notion of how invulnerable they are without vaccination.

Vaccines cause autism.

DISAGREE—One study presented in the video showed a correlation between vaccines and autism, but the results have not been replicated. Even though subjects were diagnosed as being autistic after they received vaccines, this does not mean that the vaccines CAUSED the autism. (correlation does not imply causation). Genetics point to early developmental processes, meaning that autism may be of fetal origin (10 and 24 weeks of gestation).

Vaccines cure cancer.

DISAGREE—The HPV vaccine can prevent many types of cervical and related cancers by protecting against the virus that can cause these cancers. However, it does not protect against all HPV virus strains (some of which are cancer-causing), and it cannot be used to treat cancer.

Vaccination—and any associated risk—is better than not vaccinating at all.

AGREE—Most of the side effects of vaccines are minimal and occur at a very low frequency (1 in 1 million).

DISAGREE—Those that are immunocompromised may not be able to vaccinate because side effects could be more dangerous. They have to depend on herd immunity to stay protected.

XII. Student Worksheets

Name: _____ Date: _____ Per. _____

To complete this activity, go to: http://learn.genetics.utah.edu/content/science/viruses/types.swf

Types of Vaccines				
Vaccine	**How it works**	**Advantages**	**Disadvantages**	**Examples**

Vaccine	Description	Advantages	Disadvantages	Examples

When finished, complete tutorial: http://www-tc.pbs.org/wgbh/nova/assets/swf/1/making-vaccines/making-vaccines.swf

Name: _____ Date: _____ Per._____

NOVA: Making Vaccines

Directions: Use the information provided within the interactive to complete the questions below.
Note: *The procedures in this feature have been greatly simplified. For example, a gene cannot be plucked out of DNA using tweezers, and there's no device called a purifier that can extract materials.*

Go to: http://www.pbs.org/wgbh/nova/body/making-vaccines.html
Right click on "Launch Interactive" and open the activity in a new tab to view it full-size

1. To create a vaccine that will protect you against a pathogen, you usually begin with a pathogen and alter it in some way. Explain how the process of making the smallpox vaccine is different.

2. When preparing a live-attenuated vaccine, to what degree (how much) should the pathogen be modified? Why?

3. What is the goal when creating a killed vaccine?

4. Name a couple of ways bacteria and viruses can be inactivated.

5. Why do vaccines that are not live require booster shots?

6. What is the goal when creating a toxoid vaccine?

7. Name a couple of chemicals that are used to neutralize toxins for toxoid vaccines.

8. How are the subunits produced for use in subunit vaccines?

9. What is the goal when creating genetic vaccines (DNA vaccines)?

10. What does PCR stand for? What is PCR used for?

11. What is a vector?

12. What are restriction enzymes? What are they used for when creating DNA vaccines?

Name: _____ Date: _____ Per._____

Herd Immunity Activity

Purpose: To understand how vaccination rates affect a community

Introduction

Just as a herd of cattle or sheep uses sheer numbers to protect its members from predators, herd immunity protects a community from infectious diseases due to the sheer numbers of people immune to such diseases. The more members of a human "herd" who are immune to a given disease, the better protected the whole population will be from an outbreak of that disease. This concept is referred to as herd immunity. Early human communities were relatively small and isolated. Therefore, the spread of a disease was greatly limited by geography. But today, various modes of transportation allow humans to traverse the globe, essentially linking us all into one vast, interactive human herd. Increased interaction has resulted in increased disease transmission. The only thing that can break a chain of transmission is a disease-resistant link. By increasing the number of vaccinated individuals in a population, even those most vulnerable to disease can be protected by herd immunity.

Procedure

For each part of this activity, you will receive a card that identifies your role.

There are three different roles:

- ***Infected*** – You can pass on the infection to anyone that is not protected by vaccination.
- ***Uninfected*** – You can become infected if you come into contact with an infected individual.
- ***Protected*** – You have been vaccinated against the infection and are therefore protected. You will not contract the infection if you come into contact with an infected individual.

Round 1

1. After receiving your card, secretly look at your role. ** At this point, DO NOT share this information with anyone. **

2. When told to do so, walk around the room amongst your classmates randomly. When given the signal, stop and whisper your role to one person nearby. *If there is an odd number of students, one person will not exchange roles with a classmate this time.*

   - If your classmate whispers "infected", you are now infected. You must whisper "infected" during an exchange from now on.
   - If you are protected, you will not become infected. Continue to whisper "protected".
   - For all other exchanges (uninfected-uninfected, uninfected-protected), your role will remain the same. Continue to whisper what was on your card.

3. Write the name of the person and what he or she whispered in the space below.

Exchange	Name of Classmate	Role
#1		
#2		
#3		

4. Repeat this process two more times for a total of three exchanges, each with a different classmate. When finished, return to your seat.

5. You will now trace the course of the infection to discover the original carriers. Anyone that was infected at the end of Round 1 should stand, but remain quiet unless asked a question by the epidemiologists. The remaining uninfected students will now act as epidemiologists to determine the index case(s). If you get stuck, ask your teacher for help/hints.

6. Determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data. Below the graph, note the number of vaccinated individuals in this round.

Round 2

1. After receiving your card, secretly look at your role. *Your role may be different than Round 1.* At this point, do not share this information with anyone.

2. When told to do so, walk around the room amongst your classmates randomly as in Part 1. When given the signal, stop and whisper your role to one person nearby. Same rules apply.

3. Repeat this process two more times for a total of three exchanges. When finished, return to your seat.

4. Determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data. Below the graph, note the number of vaccinated individuals in this round.

Round 3

1. After receiving your card, secretly look at your role. *Again, your role may be different.* At this point, do not share this information with anyone.

2. When told to do so, walk around the room, completing the three exchanges as in the first two rounds. When finished, return to your seat.
3. Determine the proportion of infected, uninfected, and protected individuals in the class, and then graph the data. Below the graph, note the number of vaccinated individuals in this round.

Discussion/Analysis

Write out and answer the following questions on a separate sheet of paper.

1. What is herd immunity?

2. How does herd immunity protect people who are unvaccinated?

3. The herd immunity threshold refers to the number of people that should be vaccinated in order for everyone to be relatively safe. Highly contagious diseases have a higher threshold than less contagious ones. For example, measles is much more contagious and has a higher herd immunity threshold (95%) than influenza (75%). Based on the data you collected during the activity, what is the herd immunity threshold for the infection? Explain.

4. List 3 specific reasons why some people cannot or do not get vaccinations?

5. Vaccine exemption laws vary from state to state, but all states have exemption legislation in place. How does taking a vaccine exemption for oneself affect others?

Name: _____ Date: _____ Per._____

Herd Immunity Infection Data

Color in the boxes to represent the number of people that were infected (RED) and the number of people that were uninfected (BLUE). Write the number of people that were vaccinated in the space provided.

Part 1

35	
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8	
7	
6	
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4	
3	
2	
1	
Infected	**Uninfected**
# Vaccinated: _____	

Part 2

35	
34	
33	
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8	
7	
6	
5	
4	
3	
2	
1	
Infected	**Uninfected**
# Vaccinated: _____	

Part 3

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8	
7	
6	
5	
4	
3	
2	
1	
Infected	**Uninfected**
# Vaccinated: _____	

Name: _____ Date: _____ Per._____

NOVA: Vaccines—Calling the Shots

Discuss each statement with a partner before watching the film, and decide whether the statement is true or false. Then, circle either T or F in the column labeled "Before." After watching the film, discuss the statements with your partner again, and circle either T or F in the column labeled "After."

Before	After	Statement
T / F	T / F	**1)** Approximately 70% of parents choose to vaccinate their children.
T / F	T / F	**2)** Vaccines can wear off after a few years, so some require booster shots to provide the appropriate immunity.
T / F	T / F	**3)** Approximately 50% of people exposed to measles that are not immune actually get sick from the virus.
T / F	T / F	**4)** Families can claim religious exemption to avoid having their children get the required vaccinations to attend school.
T / F	T / F	**5)** In the 1500s, 1 in 10 children died before the age of 5.
T / F	T / F	**6)** Vaccines got their name from the word for sheep.
T / F	T / F	**7)** Vaccines contain weakened or dead parts of antigens, making it easier for immune system to win quickly.

Name: _____ Date: _____ Per. _____

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T / F	T / F	**6)** Vaccines got their name from the word for sheep.
T / F	T / F	**7)** Vaccines contain weakened or dead parts of antigens, making it easier for immune system to win quickly.

AGREE OR DISAGREE with the following statements and EXPLAIN WHY:

The threat of contagious disease is underappreciated.

Vaccines cause autism.

Vaccination—and any associated risk—is better than not vaccinating at all.

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Name: _____ Date: _____ Per._____

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T / F	T / F	**7)** Vaccines contain weakened or dead parts of antigens, making it easier for immune system to win quickly.

MATCHING

_____ Pertussis	E. Causes small puss filled bumps on skin, infection of cowpox created immunity against this virus
_____ Measles	F. Inflammation of the lungs, lots of coughing, commonly affects infants and young children
_____ Smallpox	G. Causes fever and red rash on the skin, US declared free of this virus in 2000 but has returned, very infectious
_____ Polio	H. Affects the spinal cord leaving many infected individuals paralyzed, infection rate dropped by 99% when vaccine was introduced in 1955

Define and provide an example of/purpose for THREE of the following terms:

Eradicate Herd Immunity Immunocompromised Virulent

AGREE OR DISAGREE with the following statements and EXPLAIN WHY:

The threat of contagious disease is underappreciated.

Vaccines cause autism.

Vaccines cure cancer.

Vaccination—and any associated risk—is better than not vaccinating at all.

Infectious Diseases Research Project

In order to become more informed about infectious diseases and the vaccines used to prevent them, you will research an infectious disease. Use the criteria below to guide your research. You will then create a 5 minute presentation to present this information to your classmates. You will also be required to create a five-question multiple choice quiz for classmates to take. The quiz should be straightforward and include only information within your presentation. You will be graded by a rubric, which will be provided to you in advanced.

Procedure for choosing an infectious disease:

After you have decided upon an infectious disease, you will sign up with the teacher. Each student will research a different disease. The links below list vaccine-preventable disease, and include a list of pipeline vaccines (vaccines in development for various diseases).

- From the CDC: http://www.cdc.gov/vaccines/vpd-vac/vpd-list.htm
- From the WHO: http://www.who.int/immunization/diseases/en/

Address the following:

1. Name of infectious disease
2. Causative agent
    a. What pathogen causes the disease?
    b. Is it a bacterium or a virus?
3. Mode of transmission (Describe how a person can contract this disease)
4. Symptoms
    a. Typical symptoms
    b. Severe symptoms/complications
5. Treatment/Cure
6. Prevention
    a. Vaccine
        i. What type of vaccine is available (live attenuated; inactivated; toxoid; multiple types)?
        ii. How effective is the vaccine (one dose, boosters, etc.)?
        iii. Restrictions – are there certain groups that should not/cannot be vaccinated?
        iv. If there is not a vaccine available, what measures have been taken to create one, and what problems have been encountered?
    b. Other ways to prevent infection
7. Three facts/statistics
    a. Examples
        i. How many cases are reported annually in the U.S.? Worldwide?
        ii. How does the latest number of reported cases compare with the number before the vaccine was available?
8. Bibliography
9. Quiz (five multiple choice questions and answer key)

Suggested Resources:

- Centers for Disease Control → http://www.cdc.gov/
- MicrobeWiki → https://microbewiki.kenyon.edu/
- World Health Organization → http://www.who.int/en/

Name: _____ Date: _____ Per._____

Rubric for Infectious Disease Project

Elements of Project	3	2	1	0
Name of disease			Includes name	Does not include name
Causative agent		Identifies the name and type of pathogen that causes the disease	Identifies either the name or type of pathogen that causes the disease, but not both	Does not identify the name or type of pathogen that causes the disease
Mode of transmission		Provides a complete, detailed explanation of how people can contract the disease	Provides an incomplete explanation of how people can contract the disease	Transmission of the disease is not mentioned
Symptoms of disease		Provides a complete, detailed explanation of the symptoms	Provides an incomplete explanation of the symptoms	Symptoms of disease are not mentioned
Treatment/Cure	Provides a complete, detailed explanation of treatment/cure	Provides a satisfactory explanation of treatment/cure, but does not elaborate	Provides an incomplete explanation of treatment/cure	Do not include an explanation of treatment/cure
Prevention	Provides a complete, detailed explanation of vaccine information and other preventative measures	Provides a satisfactory explanation of vaccine information and other preventative measures	Provides a minimal explanation of vaccine information and other preventative measures	Do not include an explanation of vaccine information or other preventative measures
Facts/Statistics	Includes 3 relevant facts/statistics	Includes 2 relevant facts/statistic	Includes 1 relevant fact/statistics	Does not include any facts/statistics
Layout of presentation	The layout is visually pleasing and contributes to the overall message with appropriate use of headings and white space	The layout shows good structure, contributes to the message with occasional appropriate use of heading and white space	The layout shows some structure, but appears cluttered and busy or distracting with large gaps of white space or a distracting background	The layout is cluttered, confusing, and does not use spacing and headings to enhance or increase readability
Use of pictures, links, and/or video clips		Pictures, links, and/or video clips are used to support your research; they are not used “in place” of the research	Pictures, links, and/or video clips are partially support your research; you rely on them as your research frequently	Pictures, links, and/or video clips are not used or are used to “be” the research, not to “support” research
`Bibliography			Includes a bibliography	Does not include a bibliography
Quiz Questions/ Answers	Questions greatly reflect the material learned from presentation	Question somewhat reflect the material learned from presentation	Questions minimally reflect the material. Answers are not provided.	Questions do not reflect the material or are not present

Submit to teacher for grading **Total: _____ / 25**