Reducing Disease Threats through Vaccination

How Vaccination Protects Populations Against Disease

COVID HACKS
Healthy Actions • Community Knowledge • Science

FOR GRADES
3–5 6–8

OVERVIEW

Student learn how vaccination can protect populations against disease by working through three simulations of the spread of an imaginary infectious disease, called "yuckyitis." They relate this knowledge to the COVID-19 vaccination efforts.

LEARNING OBJECTIVES

Students compare the rates of disease spread among populations and calculate how illnesses spread more slowly in populations in which most individuals have been immunized.

SCIENCE, HEALTH AND MATH SKILLS

- Observing
- Comparing
- Quantifying
- Predicting
- Interpreting

NGSS SCIENCE AND ENGINEERING PRACTICES

- Developing and using models
- Analyzing and interpreting data

TIME

- Set Up: 15 minutes
- Activity: 60 minutes

MATERIALS FOR SCIENCE INVESTIGATION

Teacher will need:

- Device and projection capability depending on teaching situation.

Students will need:

- Copies of the three Fairhaven USA pages for each student. Alternately, project the images from the accompanying slide deck and conduct a class discussion while modeling each scenario.
- Markers and crayons, if conducted in class. Or, students may complete the sheets as homework in paper or electronic formats.
- Clean spray bottle (such as an empty window cleaner bottle) filled with plain water.

SET UP AND TEACHING TIPS

This activity may be conducted in class or online as a synchronous session. Or, you may assign the three simulations depicted on the Fairhaven USA student pages as asynchronous work to be completed ahead of class. Students should work separately on their own set of handouts, or as part of physically distanced teams, in which students take turns completing one of the scenarios.

PROCEDURE

ENGAGE

1. Ask students, *Has anyone ever received a vaccine?* Discuss student responses. Typical immunizations received by school age children include MMR (measles, mumps, rubella), DTaP® (tetanus and whooping cough) and Flu (influenza).
2. Briefly review what is meant by the term, "vaccine." Typically, a vaccine contains the same germs or fragments of germs as the ones that cause a particular disease. But the material in the vaccine has been either killed or weakened. Some vaccines, such as the newest ones being developed for COVID-19, contain only a part of the microbe that causes the disease. Exposure to the killed or weakened germs or germ fragments helps the immune system create a memory of the invaders. This memory enables the immune system to be ready and act quickly if the body encounters the same germ again.

   COVID-19 is caused by a virus called SARS-CoV-2. The name is an acronym for Severe Acute Respiratory Syndrome Coronavirus Number 2. It is the second coronavirus that has been found to cause serious infections of the respiratory system. Recent research has shown that SARS-CoV-2 can infect other parts of the body, such as the nervous system and gastrointestinal system, in addition to the respiratory system.
3. Individuals who receive a vaccine develop immunity (or protection) to a disease, without having to be infected with it first. Refer to students' earlier responses related to common childhood vaccines. As appropriate, discuss different vaccinations given to children and vaccination schedules. The following site is a good source for information on vaccination schedules (www.cdc.gov).
4. Explain that vaccines teach the body's immune system to defend against a particular microbe—even when the person hasn't actually had the disease.

EXPLORE

5. Depending on your teaching situation, give each student the first of three Fairhaven USA sheets, or project each sheet for students to view. If students are working with paper copies, provide a red marker or red crayon. You also may distribute the sheets electronically.
6. Tell students to imagine that someone in the town of Fairhaven USA has contracted the dreaded infectious disease, "Yuckyitis," caused by the "Yucky" virus. If you wish, make up a few "yucky" symptoms for this imaginary disease. Have students note that there are more than 60 residents in the town and that straight lines indicate the people with whom each individual has contact every day.
7. Point out that the profiles at the top represent different people.
   - The uncolored profile represents someone who is healthy but unprotected with a vaccine.
   - Green represents someone who is healthy and unprotected with a vaccine, but immune to the microbe that causes "Yuckyitis" because they already have had the disease.
   - It's possible for a person to be infected with COVID-19 and not feel sick, but still spread the virus to other people.
   - Blue represents someone who is protected with the "Yuckyitis" vaccine.
   - Red represents people who have become infected with the "Yucky" virus that causes "Yuckyitis."
8. Tell teams to randomly pick one healthy, unprotected person on the page and color that person red to indicate that she or he has acquired "Yuckyitis." The simplest way to do this is to have the student close their eyes and touch the paper with the pointer finger. If you are using slides, simply click to the next slide and one image will appear in red.
9. Tell students that the infected person now passes the virus that causes "Yuckyitis" to each person with whom they come in close contact during the next day. You may want to create a criterion for close contact, such as the one used for COVID-19 (within 6 feet for 15 minutes or more). Color the people who have acquired the virus red. (The scenario is based on the assumption that "Yuckyitis" is 100% contagious, unless an individual has immunity.)

10. Continue by following the network of contacts and coloring red all of the individuals who eventually contract "Yuckyitis." At the end, teams should count the total number of people in Fairhaven who have been infected with "Yuckyitis" and write the number at the bottom of the page.

11. Note: If you are conducting this as a demonstration while teaching online, use a whiteboard function to color the infected individuals—or simply use the edit mode in PowerPoint to add a red dot or X on each person who becomes infected.

12. Distribute or project the third Fairhaven USA sheet. On this sheet, many of the town's residents have been vaccinated against "Yuckyitis." Again, pick one healthy, unprotected person, and color that person red, along with all the other healthy unprotected people who catch "Yuckyitis." Write the total number of infected people at the bottom.

EXPLAIN

13. Have students answer the questions below in their science notebooks, and then discuss their responses in class. Review the concept of vaccination. Have teams explain how vaccination helps reduce the incidence of disease in a population, using their Fairhaven sheets as evidence.

    - How do vaccines help prevent the spread of disease?
    - In which scenario were the residents of Fairhaven most protected from "Yuckyitis"? Explain your answer
    - Suppose that a person has a weakened immune system or an allergy to the vaccine and can't be immunized against "Yuckyitis"? In which scenario would that person be least likely to become infected?

    Discuss the concept of herd immunity. Herd immunity means that most members of a population have immunity to a particular infection and it is difficult for the disease to spread from one person to another. Thus, the more people who get vaccinated, the harder it is for an infectious disease to spread.

EXTEND

14. Ask, *How is this information about herd immunity relevant to the COVID-19 pandemic?*
    Accept all responses.

    Discuss how the current vaccination efforts against COVID-19 are aimed to help our population reach herd immunity status. The percentage of a population that must develop immunity depends on how contagious a disease is. Measles, for example, is highly contagious, so about 95% of the individuals in a group have to have immunity in order to eliminate the disease. Many experts believe that 70-85% of the population will have to be immune in order to contain the spread of COVID-19.

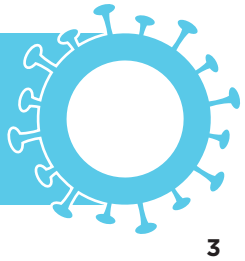
15. Mention the new COVID-19 vaccines that now are available. Ask students what they know or have heard about the vaccines.

    Explain that several different vaccines are available or being studied to prevent infection by SARS-CoV-2. At least two of these vaccines rely on messenger RNA, or mRNA. The mRNA vaccines are a new kind of vaccine to protect against infectious diseases. The COVID-19 mRNA vaccines teach our cells how to make proteins—or even just a piece of a protein—to trigger an immune response inside our bodies. The biotechnology to create these new vaccines has been under development for decades.

    Importantly, mRNA vaccines do not use the live virus that causes COVID-19. In addition, they do not affect or interact with our DNA in any way.

    People who are vaccinated with this type of vaccine gain protection without ever having to risk the serious consequences of getting sick with COVID-19.

Typically, a vaccine contains the same germs or fragments of germs as the ones that cause a particular disease. But the material in the vaccine has been either killed or weakened. Some vaccines, such as the newest ones developed for COVID-19, contain only a part of the microbe that causes the disease.



You and your students can find more information about the COVID-19 mRNA vaccines here:

- https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/mrna.html

The CDC website provides complete information about all of the vaccines that are approved or under development to prevent COVID-19.

- https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/mrna.html

EXTEND

16. As an extension, have teams repeat the Fairhaven activity with one more sheet. Tell teams in this scenario, the "Yucky" virus only infects half (50%) of the people who are exposed through close contact. In other words, only half of the people (every other person) who come in contact with the initial sick person get the disease.
17. Have students flip a coin to identify whether each individual will be infected or not. Use a different marker color to indicate people who do not get sick. How do these results compare to the other Fairhaven sheets?
18. Have teams compare their Fairhaven charts to the Herd Immunity Diagram provided by the National Institute of Allergy and Infectious Diseases (included in the slide deck).
19. Have students read the accompanying essay, *Vaccines: An Important Protection Against Diseases*.

WORDS TO KNOW

Herd Immunity	Protection from infectious disease provided to a large group of people through immunization of its members.
Immunization	The process by which a person is made immune or resistant to a particular disease through a vaccine.
Transmission	Passing on an infectious disease through direct or indirect contact.
Vaccine	A biological preparation (usually a liquid), most often administered through an injection, that provides active acquired immunity to a particular disease.

THE SCIENCE

Vaccines are used to stimulate a person's immune system to produce antibodies against disease. They are made from weakened or killed microbes, or parts of the disease -causing microbe. Vaccines enable the immune system to create a memory of the microbe so when the microbe enters the body it is recognized and the body can respond quickly to defend itself against it.

The antibodies that are produced help you develop an immunity to the disease without having to get the disease first. Vaccines prevent disease. If enough people are vaccinated against a disease, it is harder for the disease to spread among the members of a population.

RESOURCES

- Building Trust In Vaccines, Anthony Fauci, MD. https://www.nih.gov/about-nih/what-we-do/science-health-public-trust/perspectives/science-health-public-trust/building-trust-vaccines.
- Redford G. 2021. Is herd immunity closer than we think? AAMC News. https://www.aamc.org/news-insights/herd-immunity-closer-we-think.
- Vaccines: The Basics. https://www.cdc.gov/vaccines/vpd/vpd-vac-basics.html.
- Zhang Y, Geng X, Tan Y, Li Q, Xu C, Xu J, Hao L, Zeng Z, Luo X, Liu F, Wang H. 2020. New understanding of the damage of SARS-CoV-2 infection outside the respiratory system. Biomedicine & Pharmacotherapy (127):110195. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7186209/pdf/main.pdf.

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Healthy Actions • Community Knowledge • Science

COVID HEALTHY ACTIONS, COMMUNITY KNOWLEDGE AND SCIENCE

A SCIENCE-BASED CURRICULUM FOR THE COVID-19 PANDEMIC

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STUDENT PAGE A

Fairhaven USA Assignment

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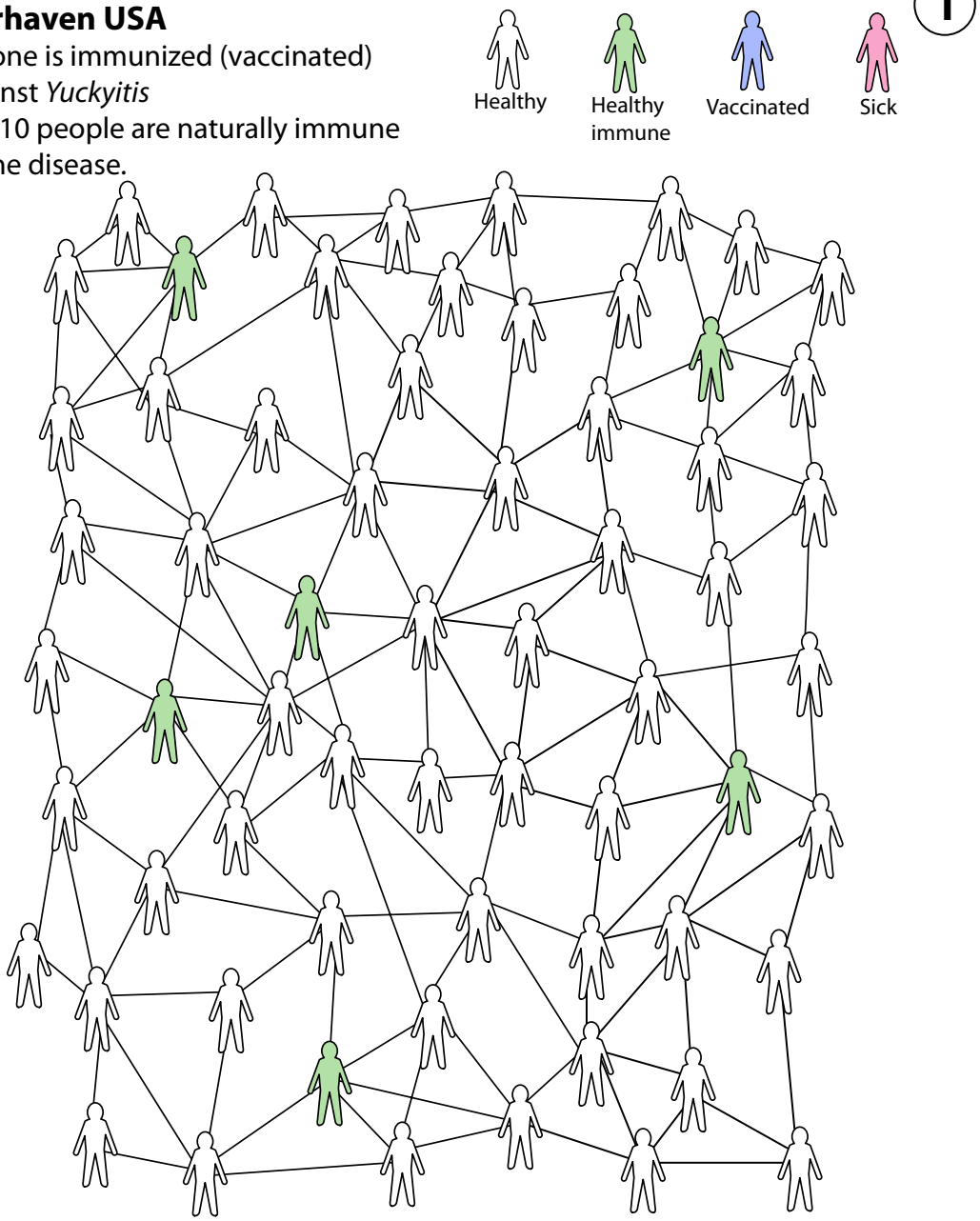
1

Fairhaven USA

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

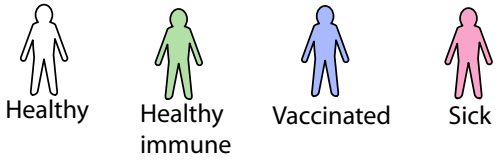


One citizen of Fairhaven comes in contact with a carrier (person infected with Yuckyitis) in another town. Pick one healthy person at random and color that person red for being infected. Follow all the lines from this person. Those people become infected too. Color them red. Trace the lines from those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

Sick People of Fairhaven _____

Fairhaven USA

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



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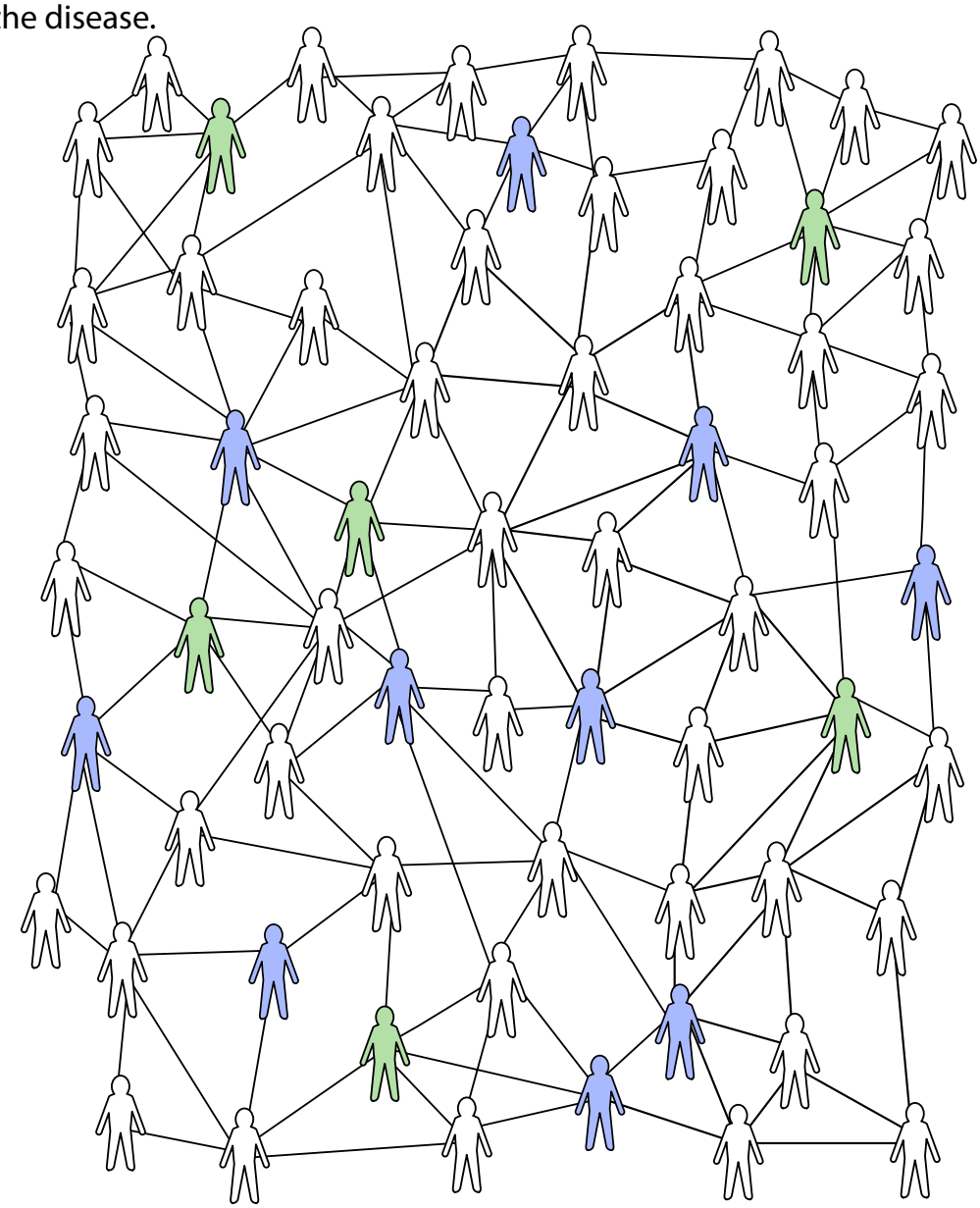

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Sick People of Fairhaven _____

Fairhaven USA

Many citizens are immunized (vaccinated) against *Yuckyitis.*
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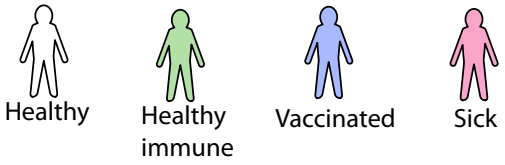

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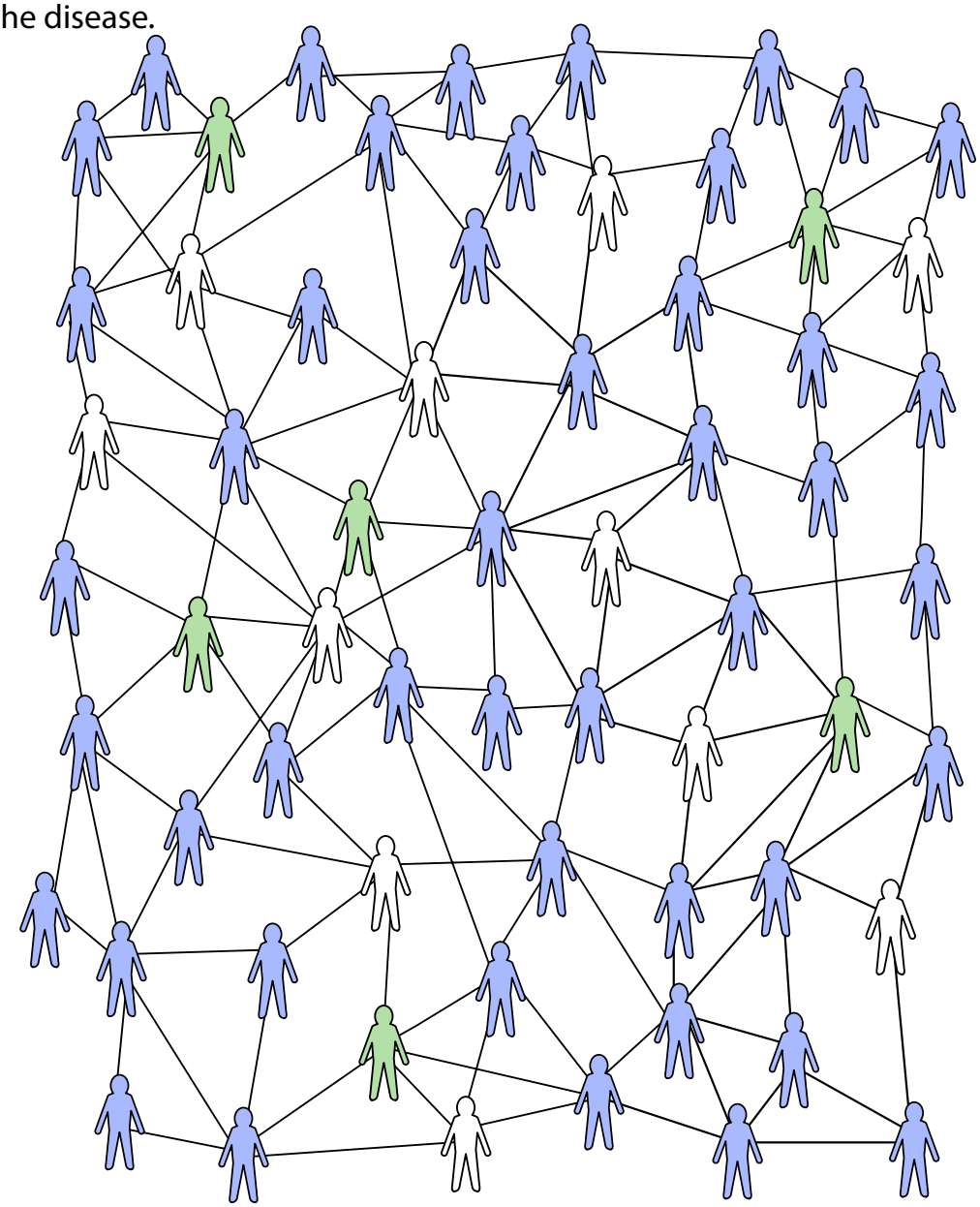

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Sick People of Fairhaven _____

Vaccines: An Important Protection Against Diseases

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Your immune system allows your body to fight illness. The immune system has several tools to protect against infection, including cells that swallow germs, and proteins called antibodies that can disable invaders, and other defensive cells. Fortunately, the immune system creates a memory of any invaders, enabling it to act quickly if the body encounters the same germ again. A person can develop immunity from a previous infection or by receiving a vaccine. The process of giving a vaccine to stimulate the immune system against a particular microbe is called immunization.

Figure 1. A health care provider placing a bandage on the injection site of a child, who had just received a seasonal influenza vaccine.

Vaccines help develop immunity by imitating an infection by a particular microbe. Vaccines usually rely on subunits of a virus or bacterium, or an inactivated or killed version of the microbe. The vaccine causes the immune system to produce defensive cells and antibodies against the microbe. After vaccination, the body has the cellular weapons it needs to recognize and defend against the disease-causing microbe if it ever becomes necessary. With some illnesses, such as seasonal influenza (flu), changes in the strains of virus require people to be immunized every year.

Immunity in populations can be created by vaccination or by natural means. Herd immunity means that so many individuals in a community are immune that a microbe cannot easily spread from one person to another. Herd immunity helps to protect people who are unable to be vaccinated, sometimes because of other health conditions. The best way to achieve herd immunity is through vaccination. The only other path to herd immunity is for large numbers of individuals become infected.

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Vaccines: An Important Protection Against Diseases

Student Reading

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