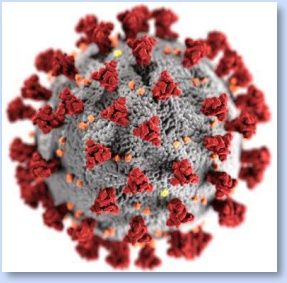
COVID-19 Vaccination

COVID-19 is a dangerous disease that spreads mainly from person to person through respiratory droplets. COVID-19 vaccination is an important tool to help stop the COVID-19 pandemic.

Terms to Know

Coronavirus	a family of viruses characterized by a crown of spikes on the outside; examples are respiratory diseases like MERS and SARS, including SARS-CoV-2
mRNA	messenger RNA (**mRNA**) is the blueprint for making proteins; **mRNA** naturally forms in the nucleus of a cell when DNA is copied during transcription
Population immunity	when an entire population is resistant to a disease because of high levels of previous infection or vaccination amongst its members
Reproduction number (R_0)	the average number of people that one person with SARS-CoV-2 is likely to infect in a population without any immunity or interventions
Effective reproduction number (R_t)	estimate of the average number of people that one person with SARS-CoV-2 is likely to infect in a population with mitigation measures and immunity factors in place
Vaccine confidence	the trust that patients, their families, and providers have in recommended vaccines including development, licensing, manufacturing, and administration
White cells/ Immune cells	cells that fight infection; some examples include macrophages that fight germs and lymphocytes that produce antibodies and attack infected cells

What is COVID-19?



Coronaviruses are a large family of viruses that can infect people and many animals, including camels, cattle, cats, and bats. There are many types of **coronaviruses**, including some that give people a common head or chest cold. Other **coronavirus** diseases like severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) are extremely dangerous but are much less widespread than colds and COVID-19.

COVID-19 most often causes respiratory symptoms that can feel much like a cold, a flu, or pneumonia, but COVID-19 can also harm other parts of the body. Most people who catch COVID-19 have mild symptoms, but some people become severely ill. Older adults and people who have certain underlying medical conditions are at increased risk of severe illness from COVID-19. Hundreds of thousands of people have died from COVID-19 in the United States. Vaccines against COVID-19 are safe and effective.

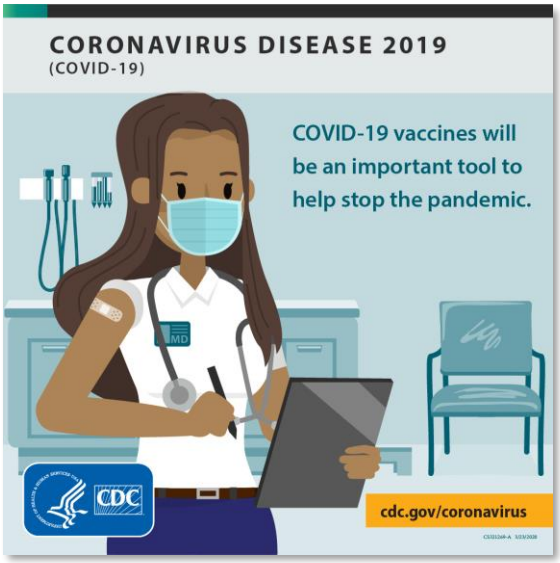
Think About It

1. How do you think vaccines prevent illness?
2. What are some reasons that a person might get a COVID-19 vaccine?
3. How safe and effective are vaccines against COVID-19?

COVID-19 Vaccination and the Centers for Disease Control and Prevention

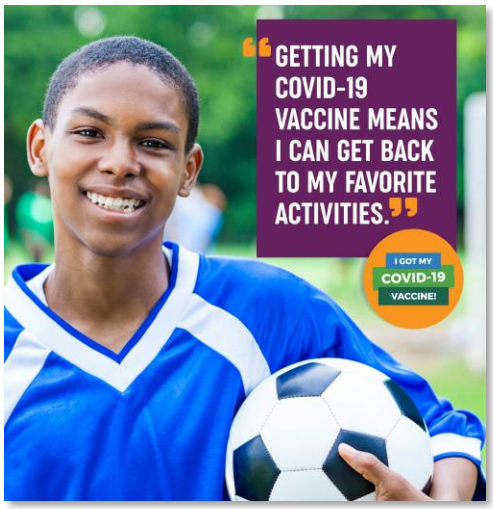
When germs, such as the virus that causes COVID-19, invade our bodies, they attack and multiply. This invasion, called an infection, is what causes illness. Blood contains **white** or **immune cells**, which fight infection. The first time a person is infected with the virus that causes COVID-19, it can take several days or weeks for their body to make and use all the germ-fighting tools needed to get over the infection. After the infection, the person's immune system remembers what it learned about how to protect the body against that disease. COVID-19 vaccines help our bodies develop immunity to the virus that causes COVID-19 without us having to get the illness.

CDC's National Center for Immunization and Respiratory Diseases (NCIRD) works to prevent disease, disability, and death from viral diseases through immunization and other prevention measures. CDC collects information about the vaccines and outbreaks and helps healthcare professionals and health departments develop vaccination programs. CDC also monitors vaccine safety using the v-safe tool to report side effects.



COVID-19 vaccines are safe and effective. Millions of people in the United States have received COVID-19 vaccines, and these vaccines have undergone the most intensive safety monitoring in U.S. history. This monitoring includes using both established and new safety monitoring systems to make sure that COVID-19 vaccines are safe. Results from these monitoring efforts are reassuring. While some people don't have any side effects after getting a COVID-19 vaccine, many people will have mild side effects after COVID-19 vaccination, like pain or swelling at the injection site, a headache, chills, or fever. These reactions are normal and show the vaccine is working. A small number of people have had a severe allergic reaction (called "anaphylaxis") after vaccination, but this is extremely rare and when it does happen, vaccination providers have medicines available that they can use to effectively and immediately treat the reaction.

COVID-19 vaccination is an important tool to help stop the COVID-19 pandemic. COVID-19 vaccination helps protect people from getting sick or severely ill with COVID-19 and might also help protect people around them. Some people who are fully vaccinated against COVID-19 will still get sick because no vaccine is 100% effective. Experts continue to monitor and evaluate how often this occurs, how severe their illness is, and how likely a vaccinated person is to spread COVID-19 to others. CDC recommends you get a COVID-19 vaccine as soon as one is available to you. To receive the most protection, people should receive all recommended doses of a COVID-19 vaccine.



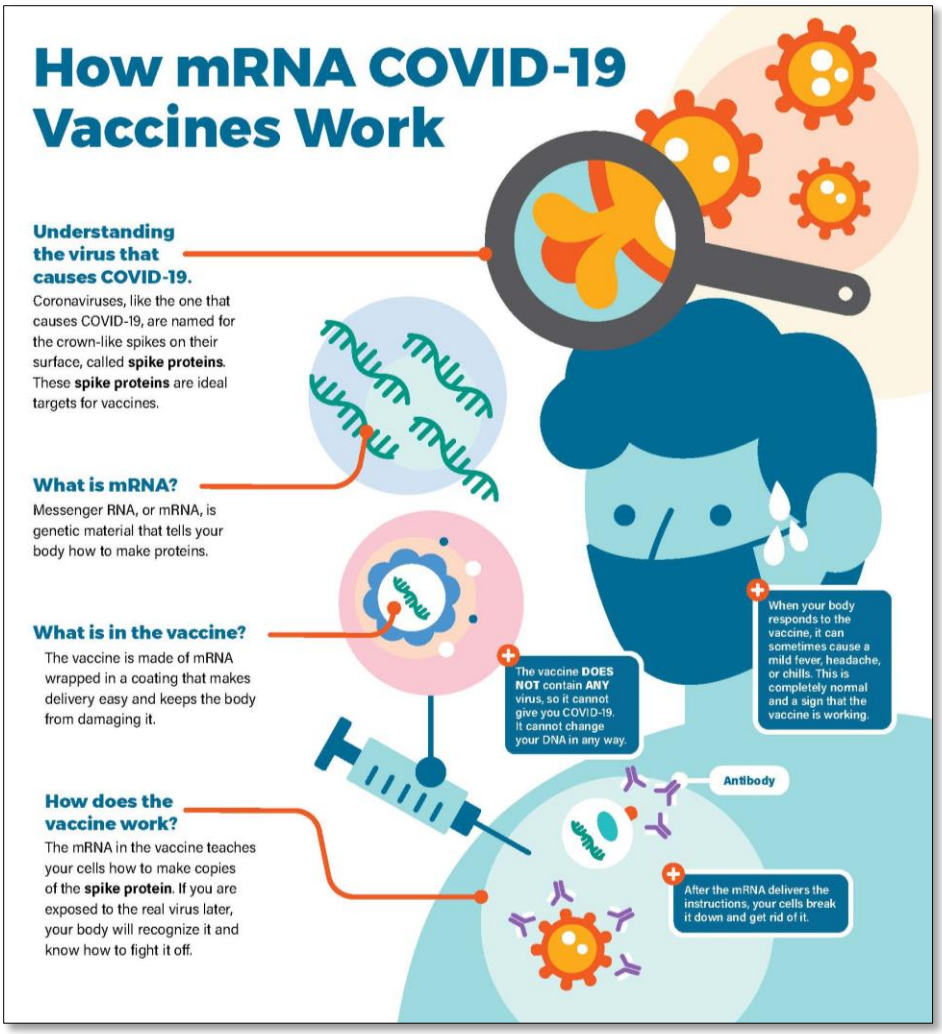
How do mRNA vaccines work?

Messenger RNA vaccines—also called **mRNA** vaccines—are some of the first COVID-19 vaccines authorized for use in the United States. The vaccines from Moderna and Pfizer-BioNTech are examples. **mRNA** vaccines are a new type of vaccine to protect against infectious diseases. To trigger an immune response, many vaccines put a weakened or inactivated germ into our bodies. Not **mRNA** vaccines. COVID-19 **mRNA** vaccines give instructions for our cells to make a harmless piece of what is called the "spike protein." The spike protein is found on the surface of the virus that causes COVID-19.

First, COVID-19 **mRNA** vaccines are given in the upper arm muscle. Once the instructions (**mRNA**) are inside the muscle cells, the cells use them to make the protein piece. After the protein piece is made, the cell breaks down the instructions and gets rid of them.

Next, the cell displays the protein piece on its surface. Our immune systems recognize that the protein doesn't belong there and begin building an immune response and making antibodies, like what happens in natural infection against COVID-19.

At the end of the process, our bodies have learned how to protect against future infection. The benefit of **mRNA** vaccines, like all vaccines, is those vaccinated gain this protection without ever having to risk the serious consequences of getting sick with COVID-19.



Future **mRNA** vaccine technology may allow for one vaccine to provide protection for multiple diseases, thus decreasing the number of shots needed for protection against common vaccine-preventable diseases.

Check out this video from Vaccine Makers Project for a more detailed explanation of the components of the immune system that make vaccines work: https://vimeo.com/579667076

Think About It

1. How is CDC supporting the efforts to vaccinate all Americans against COVID-19?
2. Why is getting a COVID-19 vaccine important?
3. How are **mRNA** vaccines different from most other vaccines?

From the Experts:

The National Forum on COVID-19 Vaccine occurred in Feb 2021 as vaccine efforts in the United States were starting to accelerate. The virtual conference aimed to inform public health officials about effective strategies for a data-driven implementation of the nation's COVID-19 response strategy. Watch the finale video to hear from a variety of public health officials about how to build trust in the vaccines, use data to drive implementation, and optimize access for groups who are most at risk for infection. https://youtu.be/EH_qjp5u030

Call to Action

In order to understand the importance of COVID-19 vaccination, it is essential that people understand how it affects others in their community. You can help people by following these three steps:

1. Build a model for population immunity. Some individuals are unable to get vaccinated due to age, allergies, immune diseases, or other medical conditions. Build a model and use it to show how **population immunity** impacts unvaccinated individuals.

2. Publish your vaccine story. Vaccine hesitancy puts everyone at risk as new infections allow mutations to occur, creating new variants. Share your personal stories of how COVID-19 has changed your life and how vaccination may mean a return to normalcy.

3. Share your findings. One of the ways CDC communicates information is through social media. Your story can help CDC communicate the work they have done and are doing to improve the rate of COVID-19 vaccinations across the globe.

Why Participate? A Message from CDC

Vaccine confidence is the trust that patients, their families, and providers have in recommended vaccines, providers who administer vaccines, and processes and policies that lead to vaccine development, licensure or authorization, manufacturing, and recommendations for use. Many factors influence vaccine decision-making, including cultural, social, and political factors; individual and group factors; and vaccine-specific factors.

Most people in the United States are planning to get vaccinated against COVID-19, but some may want more information before seeking vaccination. They may want to know more about COVID-19 vaccines, including the process for developing and authorizing these vaccines and information about their safety and effectiveness. People may also have previous experiences that affect their trust and confidence in the health system, which could affect their decision to get vaccinated.

By taking time to listen to their concerns and answer their questions, you can help people become confident in their decision to get vaccinated. Also, when you decide to get vaccinated and share the reasons why you did, you can have a powerful influence on your family and community. Strong confidence in the vaccines within communities leads to more people getting vaccinated, which leads to fewer COVID-19 illnesses, hospitalizations, and deaths.

Think About It

1. Why is it important to identify vulnerable populations when administering vaccines?
2. Who are trusted community members who help people make vaccine decisions?
3. Why are vaccines our best defense against **coronavirus**?

Engineering Design Process Overview

The engineering design process allows engineers to develop and test solutions to problems. You can use the process to design a campaign to inform people about why vaccination against COVID-19 is important for them and their communities.

Define the problem	Describe the problem you are trying to solve. There are several questions you could use to guide your investigation: • What are some reasons for getting a COVID-19 vaccine? • Why are some people reluctant to get COVID-19 vaccines?
Do background research	Find information about the problem. • Use resources provided or your own search of credible sources to find more information about COVID-19 vaccines.
Specify requirements	Determine what your solution needs to have to succeed. • What information do people need to feel confident in the decision to get a vaccine against COVD-19?
Brainstorm, choose and develop solutions	For each part of your design, ask yourself the following: • How has COVID-19 affected you? • Why is getting the vaccine important?
Build a prototype	Design and build your model. • Share your COVID-19 story and vaccination plea. • Have vaccine conversations with friends and family.
Test and redesign	Test the prototype you made. • Evaluate the talking points in your vaccine conversations for effectiveness and adjust for future conversations.
Communicate results	Sharing the information you collect is key! • Share your information using social media with the CDC accounts listed.

Build a Model for Population Immunity

Population immunity means that enough people in a community are protected from getting a disease because they've already had the disease or because they've been vaccinated. **Population immunity** makes it hard for a disease to spread from person to person. It even protects those who cannot be vaccinated, like newborns or people who are allergic to a vaccine. The percentage of people who need to have protection to achieve **population immunity** varies by disease. We are still learning how many people have to be vaccinated against COVID-19 before the population can be considered protected.

1. Print out the vaccine tiles and gameboard on the next two pages. If you don't have printer access, any double-sided objects (ex: coins, buttons, game pieces) or two different colors of objects will also work (ex: colored paper, building blocks, beads). A checkerboard or chess board works well as a background for this activity.
2. Cut out all 64 of the vaccine tiles.

Round 1: 50% of the Population is Vaccinated

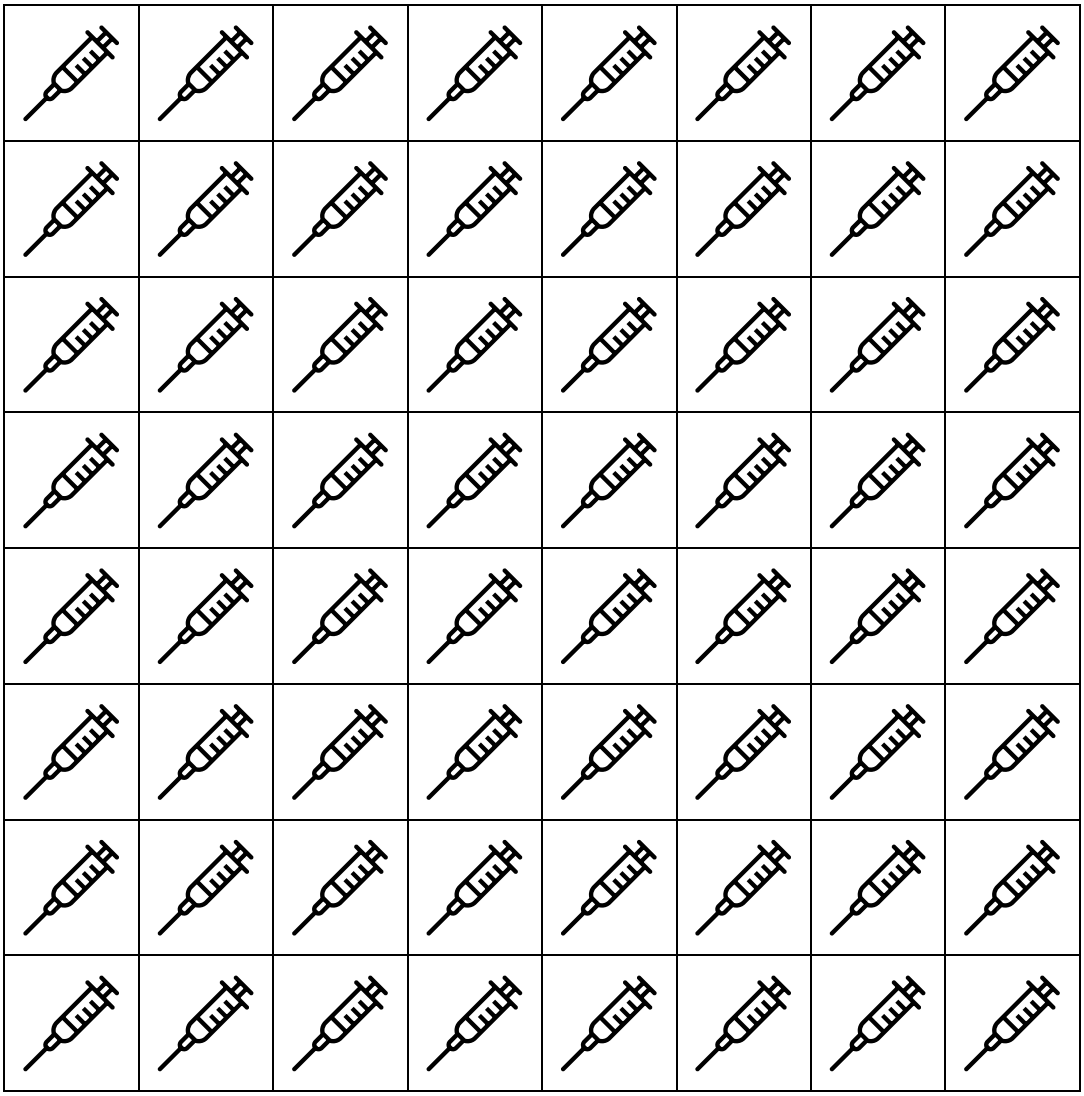
3. For Round 1, we will assume that 50% of the population is fully vaccinated. On your gameboard, randomly lay out 32 tiles with the vaccine syringe showing. This represents 32 people who are vaccinated. Lay out the other 32 tiles with the vaccine syringe facing down to represent 32 people who are unvaccinated. Make sure you are using a random distribution of vaccines, not a clump.
4. Uh-oh! A disease outbreak has occurred. Let's see what happens to our population. Remove one of the unvaccinated tiles somewhere near the middle of the board. This missing tile represents a person who has been infected.
5. In this game, any unvaccinated tile that is directly touching an infected tile will also be infected. Remove any unvaccinated tiles touching the top, bottom, left, or right of the infected tile. No diagonal tiles should be removed.
6. Continue spreading the disease and removing tiles until it can no longer spread.
7. Count your results and record them in the data table.
    a. How many people were infected?
    b. Of the uninfected people, how many were not vaccinated? This is a measure of the **population immunity** in a community.
8. Repeat the experiment 2 more times to see how your results compare.
9. Calculate the average % infected and % of unvaccinated people who were NOT infected.

Round 2: 75% of the Population is Vaccinated

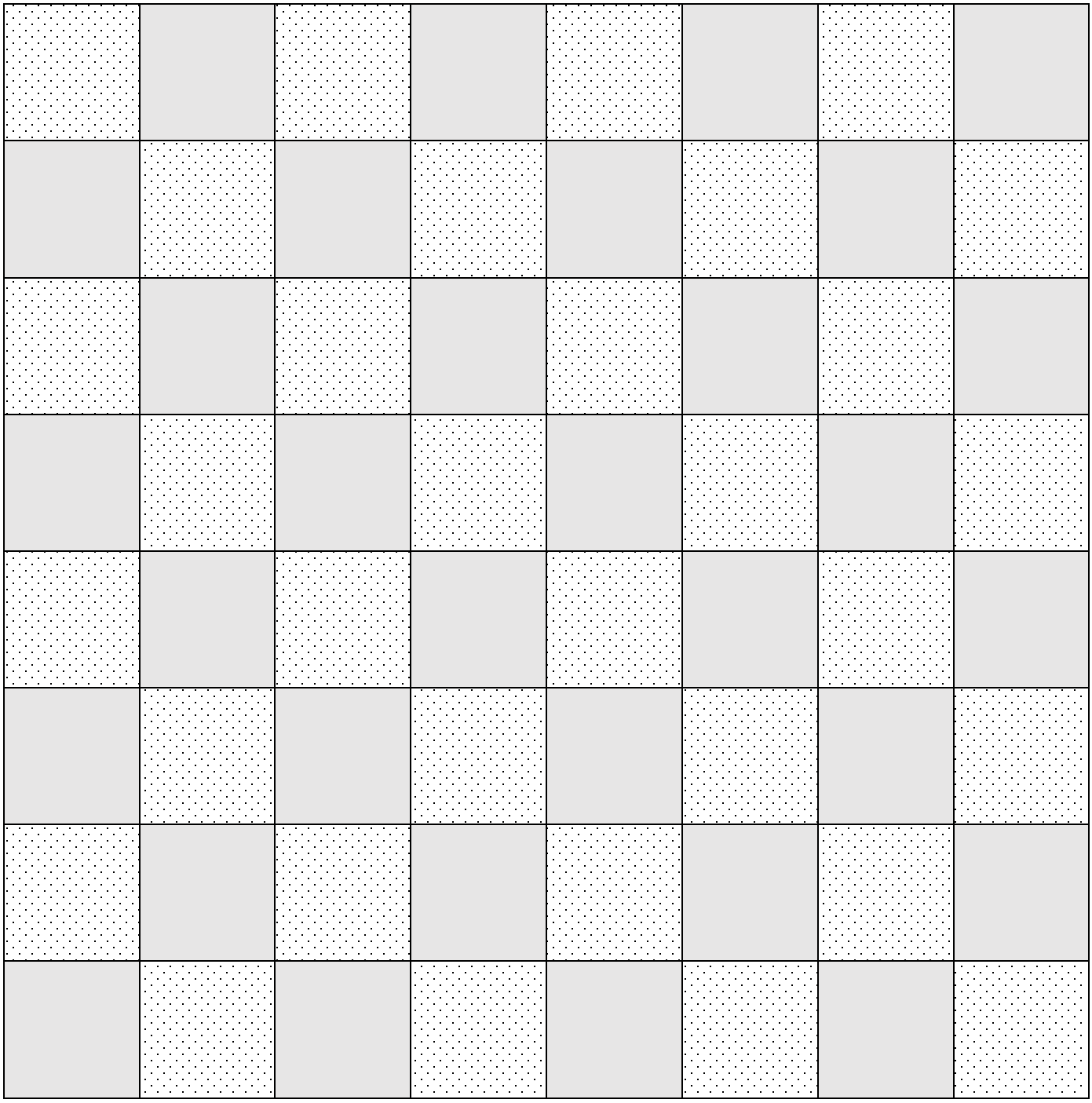
10. For Round 2, we will assume 75% of the population is vaccinated. Reset your board so that 48 tiles are showing the vaccine syringe and 16 are not. This represents 48 vaccinated people and 16 unvaccinated people.
11. Choose an unvaccinated person near the middle of the board and start a new epidemic, following the same rules as before for transmission and removal of tiles.
12. Count your results and record them in the data table.
13. Repeat the experiment 2 more times to see how your results compare. Calculate averages.

In this game, the disease has a **reproduction value** (**R_0**) of 4 because each infected person would infect 4 other people on average without vaccines. When factors like immunity from vaccination/prior infection or other factors like masks and social distancing are added in, the reproduction rate decreases. This value is known as the effective reproduction value (**R_t**). When **R_t** is less than 1, case numbers will decrease. When it is greater than 1, they increase.

Tip: To make these tiles easier to see against the gameboard, print this page on colored paper.



Population Immunity Gameboard



Round 1 Data

# vaccinated	____ / 64 = ____ % vaccinated
# unvaccinated	____ / 64 = ____ % vaccinated

Trial 1	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 32 = ____ % infected
Trial 2	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 32 = ____ % infected
Trial 3	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 32 = ____ % infected
Average	% infected	_____ %	% of unvaccinated who were not infected	_____ %

Round 2 Data

# vaccinated	____ / 64 = ____ % vaccinated
# unvaccinated	____ / 64 = ____ % vaccinated

Trial 1	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 16 = ____ % uninfected
Trial 2	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 16 = ____ % uninfected
Trial 3	# infected	____ /64 = ____ % infected	# of unvaccinated who were not infected	____ / 16 = ____ % uninfected
Average	% infected	_____ %	% of unvaccinated who were not infected	_____ %

Based on the rules of this game, how many of the 64 people would be infected if there were no vaccinated individuals in the sample? _____

As the number of people who were vaccinated increased from 50% to 75%, how did the number of people infected in the outbreak change?

_____

_____

How did your $\mathbf{R_t}$ compare to your $\mathbf{R_0}$ in each round?

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How do unvaccinated individuals benefit from others in their community who are vaccinated?

_____

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_____

Some people are unable to be vaccinated due to age, allergies, or other medical reasons. Why is **population immunity** so important to this group of people?

_____

_____

_____

Publish Your Vaccine Story

COVID-19 has affected all of us in some way. We all want to get back to some sort of normal as quickly as possible, and vaccines are a path to that. Sometimes we get overwhelmed by the sheer magnitude of the COVID-19 pandemic, and it's easy to forget that real people are being affected.

Decide how you want to share your story. You can make a website, video, digital book, social media post, or any other format that you feel comfortable using. The key feature is to make it personal. This is not about a pandemic that affects the whole world. It's just about you and your story.

1. Tell your COVID-19 story.
   How has this pandemic affected you personally? What are the mental, physical, and social effects that you have experienced firsthand?
2. Describe how the vaccine has impacted you.
   What does the vaccine mean to you? How has the vaccine changed things? Have your family members been vaccinated? Have you?
3. Convince others to get vaccinated.
   Why is it important to you that others get vaccinated? Keep it hopeful and positive!

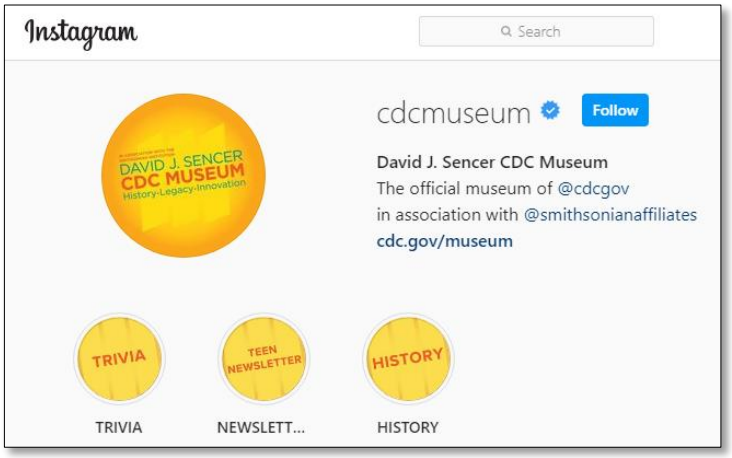
Share your story with people you know. Have vaccine conversations with friends, family members, classmates, and others in your life who are unvaccinated. Here are some helpful resources:

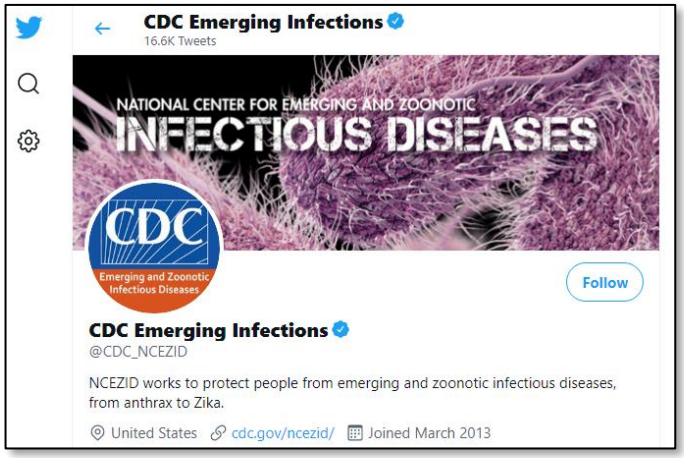
- Information about COVID-19 vaccines from CDC:
  https://www.cdc.gov/coronavirus/2019-ncov/vaccines/index.html
- Tips from CDC for talking to others about COVID-19 vaccinations:
  https://youtu.be/1Mf3ZWmK1wM
- How do we know that COVID-19 vaccines are safe?
  https://youtu.be/7bBmQaX2k4w
- Locating a COVID-19 vaccination site:
  https://www.vaccines.gov/
- Myths and facts about COVID-19 vaccines
  https://www.cdc.gov/coronavirus/2019-ncov/vaccines/facts.html
- Examples of vaccination campaigns:
  https://youtu.be/oH6dCTtgxbY
  https://youtu.be/_JB8IEPqd1o
  https://youtu.be/a7Zz4SxhhvA

Share Your Findings

The David J. Sencer CDC Museum uses award-winning exhibits and innovative programming to educate visitors about the value of public health and presents the rich heritage and vast accomplishments of CDC. Your results could be a valuable contribution! Share your demonstration with the CDC Museum on Instagram using **@CDCmuseum**.

The National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) works to protect people at home and around the world from emerging and zoonotic (diseases that are transferrable from animals to people) infections ranging from A to Z—anthrax to Zika. We are living in an interconnected world where an outbreak of infectious disease is just a plane ride away. Connect with them on Twitter **@CDC_NCEZID.**





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Reflections

Now that you have completed this investigation, think about what you learned from your research. Answer the questions below.

1. Can getting the vaccine give you COVID-19? Explain your answer.

_____

_____

2. Explain two safety measures that CDC and the FDA have taken to ensure vaccine safety.

_____

_____

_____

3. COVID-19 is a zoonotic disease, meaning it can be transmitted from non-human animals to humans. Why does that make it hard to control?

_____

_____

_____

4. Use the COVID Data Tracker from CDC or other data source to analyze the number of fully vaccinated individuals in your area versus the rest of the country. What do you see? How do you think your state is progressing with vaccinations?

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_____

_____

_____

5. Use the Trends in COVID-19 Vaccine Confidence visualizer to see current trends in vaccination intent across the United States and broken down by state. What trends or patterns do you notice? What surprised you? What do you want to know more about?

_____

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_____

6. What are your personal strategies for inspiring **vaccine confidence** in others?

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