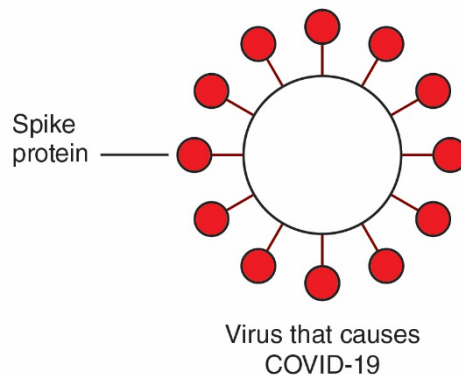


How Do mRNA Vaccines Work?

Some people are hesitant to get a COVID-19 vaccine because they do not understand how the new mRNA vaccines work. You will make models and take photos that could be used to help people understand how mRNA vaccines work. You will take pictures of the models and then create a slide show that could be used to educate the community about mRNA vaccines.

A. Model of the Virus that Causes COVID-19

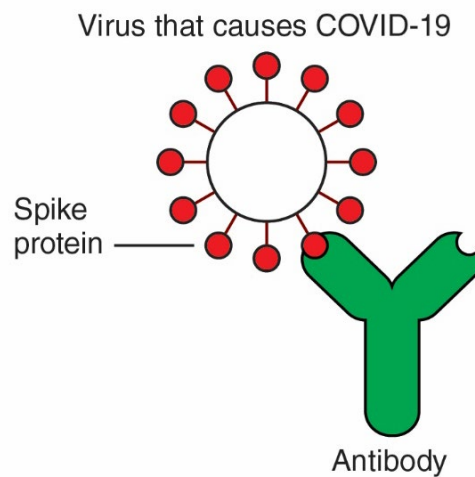
The surface of the virus that causes COVID-19 is covered with spike proteins. The spike proteins attach to receptors on the surface of cells in the lungs. This allows the virus to attach to and invade lung cells.



1. Use a foam ball and 6 red pins to create a model of a virus that can infect cells and cause COVID-19.
Use your cell phone to take a picture of this model.

B. Model of Antibodies that Fight the COVID-19 Virus

If your cells are infected by the virus that causes COVID-19, the cells will make many new viruses and you will get sick. You can get better because your immune system learns how to produce antibodies to fight the viruses. These antibodies are Y-shaped molecules with a specific shape that allows them to attach to spike proteins on the COVID-19 virus. When antibodies attach to the COVID-19 virus, they keep the spike proteins on the virus from attaching to receptors and infecting cells.



Once you have had COVID-19, you are less likely to get the illness again because your immune system has already learned how to make antibodies to fight the COVID-19 virus.

2. Use a small piece of green clay and 1 green bead to make 1 antibody molecule that can attach to spike proteins. *Hint: attach two tiny balls of green clay to the "arms of the Y" as shown in the picture below. Use your cell phone to take a picture of your model.*



3. When COVID-19 viruses invade your body, your body produces antibodies to prevent COVID-19 viruses from infecting cells. How could these antibodies prevent the COVID-19 viruses from infecting your cells?

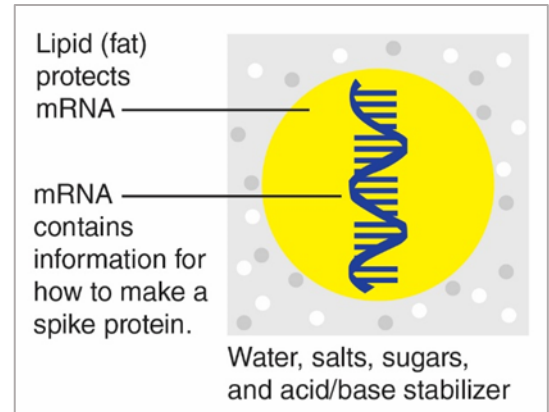
C. Model of an mRNA Vaccine

Getting sick with COVID-19 can be unpleasant and even dangerous. There is a safer way to become immune to COVID-19. Vaccines are a much safer and more effective way prevent COVID-19 illness. A vaccine protects you by teaching your immune system to make antibodies to fight the COVID-19 viruses.

7. An effective COVID-19 vaccine causes your _____ system to produce _____ to protect against the COVID-19 virus.

To fight COVID-19, scientists developed new kinds of vaccines called mRNA vaccines. The *Pfizer* and *Moderna* vaccines that are commonly used are both mRNA vaccines.

What are the ingredients in an mRNA vaccine? mRNA vaccines do not contain any living or killed viruses. The main ingredient of mRNA vaccines is mRNA molecules that carry information to tell a cell how to make spike proteins. The mRNA is inside a lipid (fat) coating that protects the mRNA and carries it into the cell. The vaccine also contains small amounts of other ingredients such as water, salts, sugar, and acid/base stabilizers that protect the delicate mRNA molecules.

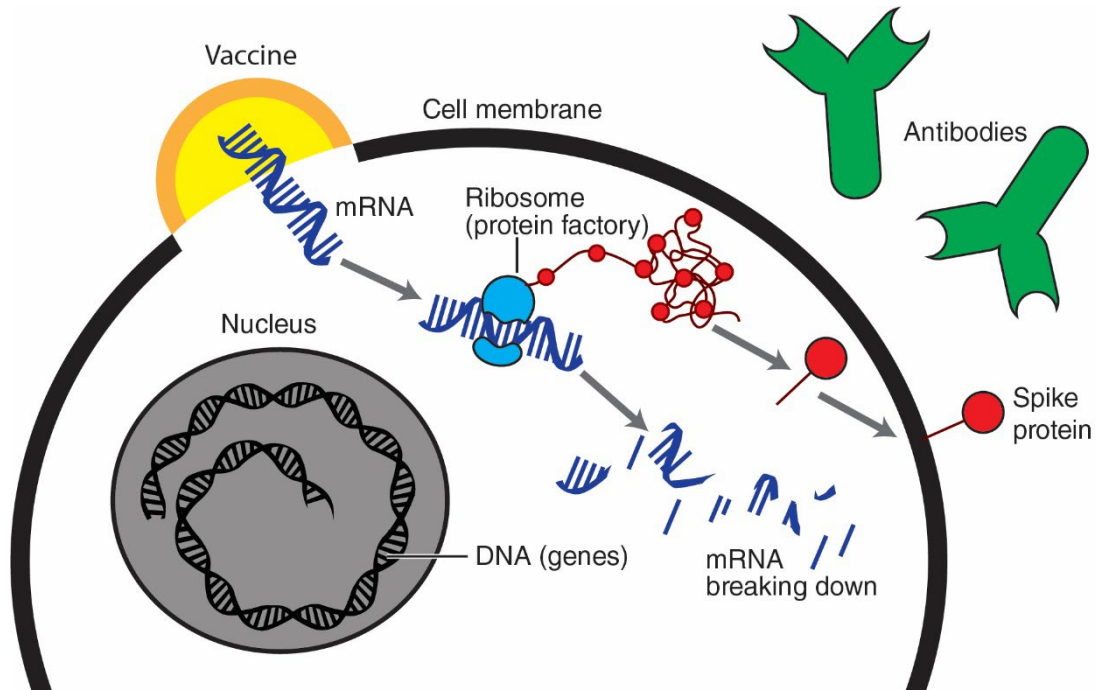


Ingredients in an mRNA Vaccine

8. Use the small plastic cup and the blue sparkly wire to model the lipid and mRNA parts of an mRNA vaccine. **Use your cell phone to take a picture of this model.**
9. What does the sparkly wire represent? _____
10. What does the small cup represent? _____
11. Some people claim that mRNA vaccines **can** cause infection with the virus that causes COVID-19. Explain why this is not possible.
12. Some people claim that mRNA vaccines contain harmful substances such as preservatives, antibiotics, medicines, food proteins (eggs, gluten, nuts), metals, and latex. Is this claim supported by the information in the text and the diagram above? Explain why or why not.

D. Model of Vaccination

COVID-19 vaccines are given in the muscle of the upper arm or upper thigh, depending on the age of the person who is being vaccinated. After vaccination, the mRNA enters cells in the muscle. The diagram below shows what happens to cells in your muscle when you get a COVID-19 vaccine.



13. Use the **Cell in Muscle** diagram and your model of an mRNA vaccine to show mRNA being delivered to a cell in a muscle. **Use your cell phone to take a picture of this model.**

E. Model of mRNA Producing Spike Proteins

Once inside the cell, the mRNA remains in the cytoplasm. It does not enter the nucleus. The mRNA enters the cell's ribosomes (protein factories) and begins producing spike proteins. After the spike proteins are made, the cell breaks down the mRNA and it leaves the body as waste.

14. Insert the mRNA into a blue bead. What does the blue bead represent?

15. Add some spike proteins to the cell. What did you use to represent the spike proteins that are produced when the ribosome uses the mRNA information?

16. ***Use your cell phone to take a picture of this model*** that shows the mRNA attached to a ribosome and producing spike proteins.

17. Some people are concerned that mRNA is going to change their DNA (genes). Based on your model and the information the text above, is it possible for mRNA to change people's genes? Explain why or why not.

F. Model of the Immune System Making Antibodies

The spike proteins that are made inside the cell will then move through the cell membrane and attach to the outer surface of the cell. Your immune system will recognize that the spike proteins do not belong there, because the surface of human cells does not have spike proteins. This will teach your immune system to produce antibodies to fight off what it thinks is an infection.

18. Make a model to show the spike proteins on the cell surface and three antibodies that are produced by the immune system after a vaccination. ***Use your cell phone to take a picture of this model.***
19. What did you use to represent antibodies?
20. What triggered the production of these antibodies—spike proteins on viruses or spike proteins produced by cells?
21. Explain how these antibodies protect against invading COVID-19 viruses.
22. Traditional vaccines contained weakened or killed viruses or parts of viruses. How is an mRNA vaccine different from a traditional vaccine?

G. Model of Antibodies Protecting from COVID-19 Illness

With the COVID-19 vaccine, your body learns how to protect itself against future infection from the virus that causes COVID-19. Any side effects from getting the COVID-19 vaccine are normal signs that your body is building protection against the virus.

The benefit of the COVID-19 vaccine is that people get this protection from a vaccine, without ever having to risk the potentially serious consequences of getting sick with COVID-19.

23. Make a model to show how the antibodies protect a person if a COVID-19 virus enters their body.
Use your cell phone to take a picture of this model.

24. What are some side effects of COVID-19 vaccinations?

25. Which is more dangerous, getting sick with COVID-19 or having side effects of a COVID-19 vaccination? Explain your answer.

26. Use the seven pictures that you took to create a slide show presentation to help people understand how mRNA vaccines work.

Each slide in the slide show should include:

- One of the pictures that you took
- Labels for the picture
- A caption (description) that explains the picture

