



Exploring Polio

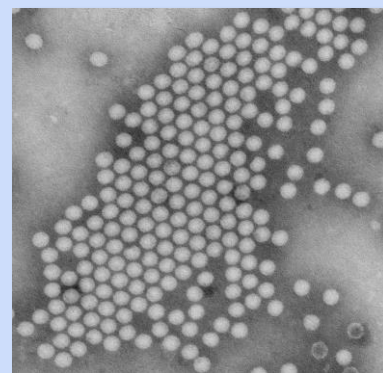
Poliomyelitis, also known as **polio**, is a disabling and life-threatening disease caused by the **poliovirus**. The **virus** spreads from person to person and can infect a person's brain and/or spinal cord, causing **paralysis**. A targeted vaccination program has dramatically reduced the cases worldwide.

Terms to Know

Virus	type of microbe (organisms too small to be visible to the naked eye) that causes infectious diseases; has a core of genetic material but no way to reproduce on its own; uses infected cells' reproductive machinery
Infectious	likely to be transmitted to people and organisms through the environment
Poliovirus	virus that infects people and causes poliomyelitis, polio for short
Polio	disabling and potentially life-threatening disease caused by poliovirus infection
Sanitation	the act or process of making or keeping things free from filth, infection, or other dangers to health
Paralysis/ Paralyzed	the loss of the ability to move (and sometimes to feel anything) part or most of the body; typically caused by illness, poison, or injury
Phrenic nerve	a nerve that runs from the neck to the diaphragm and controls breathing

Understanding Polio

Polio is a crippling and potentially fatal **infectious** disease caused by the **poliovirus**. It is very contagious and spreads through person-to-person contact. The **virus** enters the human body through the mouth and exits via the digestive system. For most, this **virus** passes through undetected but, for others the **virus** can cause nerve damage, resulting in **paralysis**. It enters the body through the mouth and spreads through contact with the feces (poop) of an infected person or droplets from a sneeze or cough of an infected person. **Polio** can contaminate food and water in unsanitary conditions where access to proper **sanitation** is unavailable.



Think About It

1. What microbe causes **polio**?
2. How is **polio** spread in a community?
3. Why do some communities lack access to clean water and sewage sanitation?



Polio and the Centers for Disease Control and Prevention (CDC)

Polio was the great equalizer as fear swept through the U.S. for the first half of the 20th century. Little was known about how the disease spread, leading to closed pools in summer and empty playgrounds as parents tried to protect their children from falling ill. Though most people will show no symptoms of **poliovirus** infection, 1 in 4 will experience a few days of flu-like symptoms (sore throat, fever, tiredness, nausea, headache, and stomach pain). Some of these infected people will experience tingling in the legs or infection of the spinal cord and/or brain. In about 1 of every 200 **poliovirus** infections, **paralysis** will occur and can be fatal. When paralytic infection occurs, the disorder is called poliomyelitis, or **polio** for short. Oftentimes this paralysis included the **phrenic nerve**, a nerve that runs from the neck to the diaphragm and controls breathing.

The iron lung was developed to help people with upper body paralysis. The machine gets the name iron lung because it is made of metal and helps people breathe. A patient lies on a roll-out bed tray and sticks their head outside the machine through an opening on one end of the bed. A small motor in the machine pumps a lever on the far end of the iron lung near the patient's feet to change the air pressure inside the sealed machine. When the pressure decreases in the iron lung, the patient inhales. When the pressure increases in the iron lung, the patient exhales. There is a mirror angled over the headrest so the patient can interact with others. Because it was an expensive machine, a family often could not afford to have a machine at their house and had to send sick children to hospitals far away.



In 1955, Barton Hebert (pictured left) contracted **polio** in Covington, Louisiana when he was 15 years old. He recovered from the devastating **virus** but was left **paralyzed** from the waist up and confined to an iron lung. Nonetheless, Mr. Hebert returned to school to finish his high school degree. After a close friend told him, "Forget about physical conditions—work on your brain. The body is nothing but a life-support system for the brain," Hebert went on to earn a degree in finance and to enjoy a successful career as a stockbroker and investment counselor. At work he used a portable respirator, but he was most comfortable breathing in his iron lung.

The widespread fear of **polio** prompted President Franklin D. Roosevelt, in 1938, to ask his counsel Basil O'Connor to form and oversee the [National Foundation for Infantile Paralysis](#). Today, this organization is known as the [March of Dimes](#). This organization collected money for **polio** research, which made possible funding for the first **polio** vaccine, developed by Jonas Salk in the early 1950s. CDC is working with other agencies across the world to eradicate, or completely remove, **polio**. Thanks to mass vaccination campaigns, the last case that originated in the United States was in 1979. Today, **polio** only occurs naturally in two countries- Pakistan and Afghanistan. Only a few hundred cases are reported yearly worldwide, down from approximately 350,000 when the [Global Polio Eradication Initiative](#) was launched in 1988.



Think About It

1. What symptom is required for a person to be considered to have **polio**?
2. What types of discrimination do people with physical disabilities experience?
3. What are the disadvantages of iron lung treatment?



From the Expert

Watch this clip to hear Dr. Walter Orenstein, former director of CDC's National Immunization Program and current Associate Director of the Emory Vaccine Center, discuss the dangers of **polio** for children in the 1950s. Find out more about the symptoms of the disease, how it spreads, and the specific ways in which the nervous system is affected, leading to paralysis.

<https://youtu.be/C6Weidit5Wo>

Call to Action

In order to understand how **polio** causes difficulty breathing, it is essential that people understand how the lungs function. You can help people by following these three steps:



1. Create a lung model. When we breathe, we use multiple parts of the body, including the lungs and the diaphragm. Building a model will give you a visual representation of how those parts work together to keep us breathing and how **polio** disrupts respiration.



2. Conduct a breathing demonstration. This will allow you to see the importance of the diaphragm and what it does. Some people with **polio** are **paralyzed** and they are not able to breathe on their own. The iron lung (today a respirator) works as their diaphragm.



3. Share your findings. One of the ways CDC communicates information is through social media. Your demonstrations can help CDC communicate the work they have done and are doing to improve access to **polio** vaccinations across the globe.



Why Participate? A Message from CDC

Successful vaccination efforts by CDC in the 1950s reduced **polio** cases in the U.S. from 15,000 annually to zero within 30 years. The [Global Polio Eradication Initiative](#) (GPEI) began in 1988 with the goal of eradicating **polio** worldwide and has dropped the infection rate by over 99.9%.

You can help support these efforts by raising awareness about the importance of routine vaccinations in your community. While endemic (naturally occurring) **polio** has been eradicated (eliminated) in much of the world, unvaccinated people are still vulnerable to infections that are brought in from other areas. It is important that people understand and follow the recommended CDC [immunization schedule](#) for their own health and that of their communities.

For more information about the **polio** vaccine and eradication efforts, check out the [STEM lesson](#) Eradicating Polio.



Think About It

1. What are the dangers associated with **polio**?
2. Why is it important for everyone to understand the dangers of **polio**?
3. How can your efforts support the efforts of CDC?



Design a Working Model of the Lungs

The engineering design process allows engineers to develop and test solutions to problems. You can use the process to help determine the best way to inform the public about **polio** eradication efforts.

Define the problem

Describe the problem you are trying to solve. There are several questions you could use to guide your investigation:

- What is the **poliovirus** and how does it spread?
- How does **poliovirus** infection cause **polio**?

Do background research

Find information about the problem.

- In what countries can **poliovirus** still be found?
- What are the symptoms and side effects of **polio**?

Specify requirements

Determine what your solution needs to have to succeed.

- Can you build a model that shows how the lungs work?
- Can you show how **polio** affects a person's breathing ability?

Brainstorm, choose and develop solutions

For each part of your design, ask yourself the following:

- How do your lungs breathe?
- What is the importance of the diaphragm for breathing?

Build a prototype

Design and build your lung model.

- Build a model lung using a plastic bottle, balloons, & straws to show how the diaphragm makes the lungs function.

Test and redesign

Test the prototype lung model you have made.

- Once you have tested your prototype, consider how diaphragm **paralysis** might affect a person's breathing.

Communicate results

Sharing the information you collect is key!

- Share your information using social media with the accounts listed.



Create a Lung Model

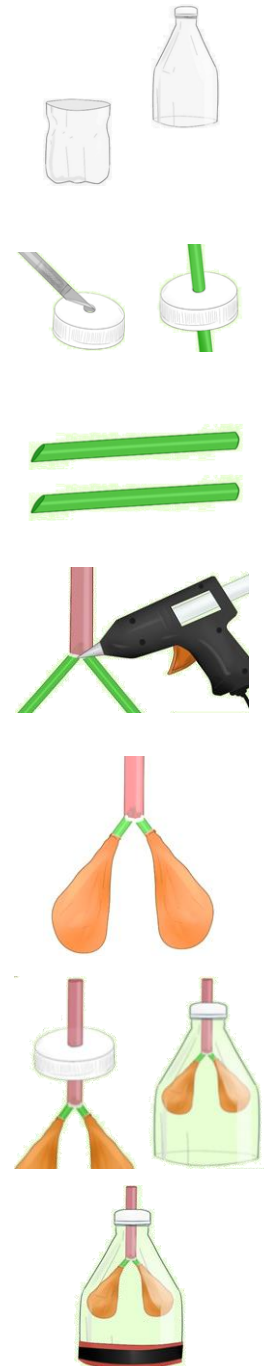
Tools of the Trade

Your model will give viewers an idea of how the respiratory system works. You will need these parts to construct your model:

- Plastic bottle (20oz or larger)
- 2 plastic straws
- 3 balloons
- Tape
- String or yarn (optional)
- Scissors
- Utility knife
- Hot glue gun

Safety First! If you feel unsure or uncomfortable with any of these instructions, ask an adult for help!

- 1 Cut the bottle into two pieces horizontally with your scissors.**
Use a utility knife to make a small cut in the side of your plastic bottle, 4–5 inches (10–13 cm) above the bottom. The incision should be horizontal. Insert one of the scissor blades into the incision that you made. Hold the bottle firmly and cut all the way around the side of the bottle with your scissors so that you end up with two halves—one half with the bottle cap and one half with the base. You can recycle the bottom half of the plastic bottle.
- 2 Use your utility knife to cut an opening in the bottle cap for the straw.**
Hold the bottle cap in place and carefully puncture the top of the bottle cap with the tip of your utility knife. Carve a small circle into the cap by holding the knife at an 80-degree angle. Take a plastic straw and try to squeeze it through your bottle cap. If the straw fits and doesn't fall out of the opening, your bottle is ready to go. It's okay if the straw is a little snug inside the hole. A tighter fit is going to be easier to work with than a looser fit. *Tip: You may also use a drill bit to puncture your hole if the bottle cap is too thick for a utility knife.*
- 3 Cut a plastic straw into thirds with your scissors.**
Cut the straw into even thirds. Cut at an angle that's perpendicular to the straw so that the places where you cut are even and flat. Then use your scissors to cut one end of two of the straw sections at a 45-degree angle to make them pointy.
- 4 Slide the pointed edges of two pieces of straw into the bottom of a larger straw.**
Squeeze the tip of each straw and slide each inside the same opening at the bottom of an uncut straw. The two smaller sections that you already cut will rely on the tension inside the opening to keep them in place. Make sure the sections of straw are at a 45° angle to one another and are symmetrical. Glue the junction where your three straws meet with a hot glue gun. This will ensure that no air escapes when you're using your lung. Wait 2-3 minutes to let the hot glue dry.
- 5 Add hot glue to the inside lip of two balloons and put them on the straws.**
Put a drop of hot glue inside each balloon near the top of each balloon's opening. Slide them over each of the branching straws so that the longer length of straw is still open. Squeeze the section where you added hot glue against each straw for 15-30 seconds so that they're sealed over the opening of each straw. Blow into the open end of your straw to test it. If the balloons expand, you're ready to continue. If you hear air coming out, identify the leak and cover it with hot glue. You can also use tape to help with leaks.
- 6 Slide the open end of your straw through the bottle cap.** You may need to pinch the opening of your straw to fit it through the hole as you slide it up through the bottle cap. Slide it until each balloon is inside the case of your bottle. Screw the bottle cap tight and seal the area where your length of straw and bottle cap meet with hot glue. *Optional: Cut a 12" long piece of string or yarn. Fold it in half and dangle the 2 ends into the hole before inserting your straw. This represents the **phrenic nerve**, which starts in the neck and runs down to the diaphragm to control breathing.*
- 7 Stretch another balloon over the bottom of the bottle.**
Cut the balloon about 1.5 inches (3.8 cm) from the top near the section where the balloon's neck begins to get wider. Slide the balloon that you cut over the bottom of your bottle. Stretch it evenly over the bottom of the bottle. It may take a couple attempts since the plastic and the balloon are both flexible. Use a rubber band or tape to tightly secure the balloon to the bottle by wrapping it around the area where they meet.





Conduct a Breathing Demonstration

The diaphragm is a muscle located beneath the lungs. As it expands and contracts, the pressure inside your lungs changes, causing respiration to occur. In the model you built, the balloon on the bottom of the bottle represents the diaphragm. Pull on the skin of the balloon at the bottom of the bottle to use your lung and observe the changes that occur.



What happens to the pressure in the bottle when you pull down on the balloon?

What happens to the size of the lungs when you pull down on the balloon?

What happens to the pressure in the bottle when you release the balloon?

What happens to the size of the lungs when you release the balloon?

If the **phrenic nerve** is damaged due to **polio**, thus **paralyzing** your diaphragm, how would this affect your breathing?

Record your demonstration. Be sure to explain the importance of the diaphragm for respiration and how pressure changes the size of the lungs. Explain why people with **polio** who are **paralyzed** in this area of the body, need an iron lung to help them breathe. You may write your script below.

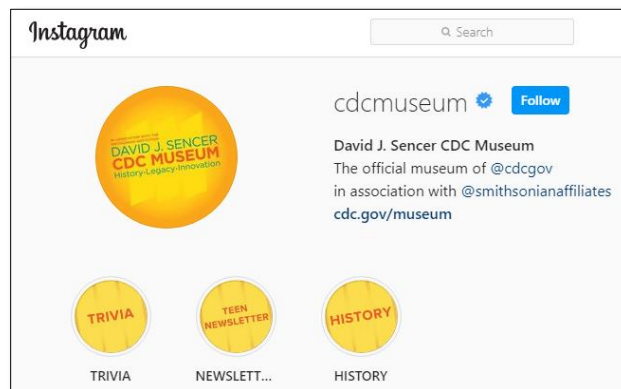


Share Your Findings

CDC plays a critical role in eradicating **polio** by providing scientific leadership and guidance at the global, regional and country level to implement evidence-based strategies. Since 1988, CDC, ministries of health, and Global Polio Eradication Initiative (GPEI) partners have worked together across these areas to reach every community and vaccinate every last child.

CDC's Center for Global Health (CGH) works 24/7 around the globe to stop health threats at their source. As a citizen scientist, you can help CDC's CGH by sharing your demonstration on their Twitter or Facebook pages to show the importance of **polio** vaccination using **@CDCGlobal**.

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 demonstration could be a valuable contribution! Share your demonstration with the CDC Museum on Instagram using **@CDCMuseum**.





Reflections

Now that you have built a model and shared your findings, think about what you learned about polio. Answer the questions below.

1. What is the **poliovirus** and how is it transmitted?

2. What are the symptoms and consequences of **polio**?

3. What are some challenges communities might experience in accessing proper **sanitation** and vaccination?

4. Health equity is achieved when every person has the opportunity to attain his or her full health potential and no one is disadvantaged from achieving this potential because of social position or other socially determined circumstances. What are some of the health equity issues surrounding **polio**?

5. Before he was president, Franklin D. Roosevelt was diagnosed with **polio** in 1921 at the age of 39, resulting in permanent paralysis of his legs. He founded the National Foundation for Infantile Paralysis in 1938 to study the disease. How do you think this changed history?

6. Why is it important to raise awareness about global public health?
