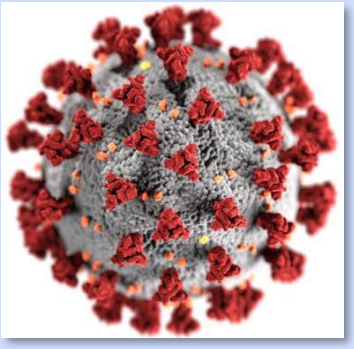
Masks Against COVID-19

COVID-19 is a dangerous disease that spreads mainly from person to person through respiratory droplets. Wearing a mask in public spaces is a safe, easy, and effective strategy to stop the spread of **coronavirus**. Given this, what makes for the best face mask to protect yourself and others?

Terms to Know

Coronavirus	a family of viruses characterized by a crown of spikes on the outside; this includes respiratory diseases like MERS and SARS, including **SARS-CoV-2**
Efficacy	how well something works; how effective something is
Pandemic	a disease outbreak that has spread over several countries or continents
SARS-CoV-2	the virus that causes COVID-19 disease
Vaccine/ Vaccination	a **vaccine** provides a trigger to help the immune system build immunity to a disease; **vaccines** allow the immune system to recognize a virus as a threat
Variant	different forms of the **SARS-CoV-2** virus that occur as a result of random mutations; examples include B.1.351 (Beta), B.1.617.2 (Delta)

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 can wearing a mask help stop the spread of viruses?
2. Are some types of masks better than others? Explain your answer.
3. What are some steps you could take to protect yourself and your community from COVID-19?

COVID-19 and the Centers for Disease Control and Prevention (CDC)

COVID-19 is a dangerous disease caused by a **coronavirus** discovered in December 2019 in Wuhan, China. It is very contagious and has quickly spread around the world. On February 11, 2020, the World Health Organization announced an official name for the disease: **coronavirus** disease 2019, abbreviated COVID-19. 'CO' stands for 'corona,' 'VI' for 'virus,' and 'D' for disease. The virus that causes COVID-19, **SARS-CoV-2**, is a **coronavirus**. The word corona means "crown" and refers to the appearance that **coronaviruses** get from the spike proteins sticking out of them like a crown.

COVID-19 spreads mainly from person to person through respiratory droplets. Respiratory droplets travel into the air when you cough, sneeze, talk, shout, or sing. These droplets can then land in the mouths or noses of people who are near you, or they may breathe these droplets in.

Masks are a simple barrier to help prevent your respiratory droplets from reaching others. Studies show that masks reduce the spray of droplets when worn over the nose and mouth. You should wear a mask, even if you do not feel sick. This is because several studies have found that people with COVID-19 who never develop symptoms (asymptomatic) and those who are not yet showing symptoms (pre-symptomatic) can still spread the virus to other people. Wearing a mask helps protect those around you in case you are infected but are not showing symptoms.

It is especially important to wear a mask when you are indoors with people you do not live with and when you are unable to stay at least 6 feet apart, since COVID-19 spreads mainly among people who are in close contact with one another.

There are two common types of masks for use by the general public.

- Cloth masks can be made from a variety of fabrics, and many types of cloth masks are available. The best cloth masks are made of multiple layers of tightly woven, breathable fabric, have a nose wire, and block light when held up to a bright light source.

- Disposable face masks are widely available. Common types are surgical, KN95, and N95. The best disposable masks include a description indicating multiple layers of non-woven material, contain a nose wire, and are designed and tested to ensure they perform at a consistent level to prevent the spread of COVID-19. N95 masks should be reserved for healthcare professionals.

The best protection against infection is **vaccination**. COVID-19 **vaccination** reduces the risk of COVID-19 and its potentially severe complications. All COVID-19 **vaccines** currently authorized for use in the United States helped protect people against COVID-19, including severe illness, in clinical trial settings. Millions of people in the United States have received COVID-19 **vaccines** since they were authorized for use by the Food and Drug Administration (FDA).

Think About It

1. What is the primary way that the **SARS-CoV-2** virus spreads from person to person?
2. If a person's mask drops below their nose, what happens to their respiratory droplets?
3. What are some reasons that people might have to choose masks instead of **vaccination** to protect them from COVID-19?

From the Expert:

Project Firstline is a video series from CDC to explain the basics of infection control to healthcare personnel. In this episode, listen to CDC infectious diseases doctor Dr. Abby Carlson explain the ways in which COVID-19 spreads. https://youtu.be/1LZZz1yMGvY

Call to Action

In order to understand COVID-19 prevention, it is essential that people understand some simple ways to keep themselves safe. You can help people by following these three steps:

1. Test face masks. How do face masks affect how air is released through respiration? Conduct a simple experiment to see the difference between air movement with and without a face mask.

2. Design a better face mask. The fit of a face mask is a critical aspect that determines how effective it is against the virus. Can you use the engineering design process to create a mask that is comfortable, effective, and suitable for long term use?

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 mask use to help fight COVID-19.

Why Participate? A Message from CDC

Your research and designs are important to help you and others understand the role face masks play in stopping the COVID-19 **pandemic**. Correct and consistent mask use is a critical step everyone can take to reduce their risk of getting and spreading COVID-19. Masks work best when everyone wears them, but not all masks provide the same protection. How well a mask fits, how well it filters the air, and how many layers it has are all important to consider when choosing which mask to wear. Wearing a mask around people who do not live with you or when someone in your house is sick is now even more critical with the increased spread of new COVID-19 **variants**, some of which appear to spread more easily and quickly than the original virus that causes COVID-19.

For more information about mask types, fitting, and **efficacy** studies, check out this report from CDC: https://www.cdc.gov/mmwr/volumes/70/wr/mm7007e1.htm

Think About It

1. According to Dr. Carlson, what are other ways besides respiratory droplets that **SARS-CoV-2** can be spread from person to person?
2. What are some problems you have encountered while wearing a face mask that you might want to fix in your design?
3. As new variants of COVID-19 emerge, the **efficacy** rates of **vaccines** may decrease. How will this affect communities? How might we respond to this change?

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 face mask that is effective at blocking respiratory droplets but also comfortable to wear for long time periods.

Define the problem

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

- Why are face masks necessary to stop viral spread?
- What material blocks respiratory droplets best?
- What mask material is the most comfortable to wear?

Do background research

Find information about the problem. You can use any credible sites for your research. Here are some suggestions:

- https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html
- https://youtu.be/9fca7M5STEA

Specify requirements

Determine what your solution needs to have to succeed.

- Perform the candle test to see how different face mask materials affect air movement through a mask.
- Identify other factors that make a face mask more effective or comfortable to wear.

Brainstorm, choose and develop solutions

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

- Which face mask material blocks respiratory droplets best?
- What features are needed for greatest safety?
- What features are needed for comfort?

Build a prototype

Design and build your model.

- Build a mask that effectively seals and blocks respiratory droplets that is comfortable for long-term wear.

Test and redesign

Test the prototype you made.

- Test your prototype using the candle test.
- Reflect on the comfort and effectiveness.
- Redesign prototype if needed.

Communicate results

Sharing the information you collect is key!

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

Test Face Masks

There are many different types of masks available, but some are more effective than others. To test the **efficacy** of mask materials, you will try to extinguish a candle flame while wearing masks made from different materials.

Tools of the Trade

- Several different masks and/or fabrics
- Candle
- Matches or lighter
- Ruler

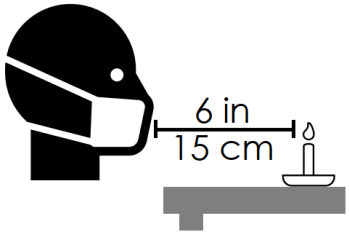
SAFETY FIRST!
Since this experiment involves open flame, make sure that you have adult permission or supervision before beginning.

Here are some suggestions for face masks/materials that you might have at home:

- Surgical mask
- Cloth face mask
- Bandana
- Cotton fabric
- KN95 or N95 mask
- T-shirt
- Neck gaiter
- Polyester fabric

Consider trying a single layer of cloth, then folding it to make double or triple layer masks to see how the number of layers affects the results. Try using a variety of materials to capture the full spectrum of effectiveness and to see if your predictions are correct.

Test Your Mask Materials



1. Place a candle 6 inches (15 centimeters) from the edge of a table or counter. Make sure the area around and above the candle is clear of any flammable materials. Light the candle.
2. Without a face mask, perform these 3 tasks in front of the candle:
    a. Read a paragraph from a book. (Make sure to keep the book clear of the flame!)
    b. Sing a verse of a song. ("Twinkle, Twinkle, Little Star," "Happy Birthday," etc.)
    c. Purse your lips and try to blow the candle out.
3. Record your results in the data table. Relight the candle in between tasks if it goes out.
4. Put on one of your face masks, repeat the tasks, and record results in the table.
5. Switch to a different face mask and repeat until you have tested all materials.

BONUS EXPERIMENT: If you have access to a pulse oximeter device, measure your oxygen saturation levels while wearing each of the different mask types.

DATA COLLECTION TABLE

Mask Material	# of Layers	Reading Test	Singing Test	Blow Test
No Face Mask	0	Did candle go out? *Yes No* Candle Movement: *0 1 2* Observations:	Did candle go out? *Yes No* Candle Movement: *0 1 2* Observations:	Did candle go out? *Yes No* Candle Movement: *0 1 2* Observations:
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Candle Movement Key:

0 = no movement   1 = slight movement   2 = significant movement

Design a Better Face Mask

Beyond choosing a material that effectively blocks respiratory droplets, other factors contribute to the effectiveness of a mask. A good fit is important not only for sealing in respiratory droplets, but also because people don't like wearing masks that are uncomfortable. An effective mask that doesn't get worn is useless!

Here are some additional things you might want to consider when designing your face mask:

- Does the mask completely cover your nose and mouth?
- How tightly does the mask fit against the sides of your face?
- How does the mask fit over the bridge of your nose?
- When you talk, does the mask stay in place or slip down off your nose?
- Does the mask hurt your ears after a long period of wearing it?
- Do glasses fog up when you are wearing this mask?

Suggested Resources:

- CDC guide to masks: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html
- Watch this video guide from the World Health Organization about how to find a mask that fits your face the best. https://youtu.be/aNUPVdJHeAQ
- FDA guide to masks: https://www.fda.gov/medical-devices/coronavirus-covid-19-and-medical-devices/face-masks-including-surgical-masks-and-respirators-covid-19

Design Your Face Mask

Select your face mask material. You can start from scratch with cloth or try to improve the design of an existing disposable mask to improve comfort and fit. Draw a diagram of your face mask below. Label the materials used and any special features you will be adding for comfort or fit.

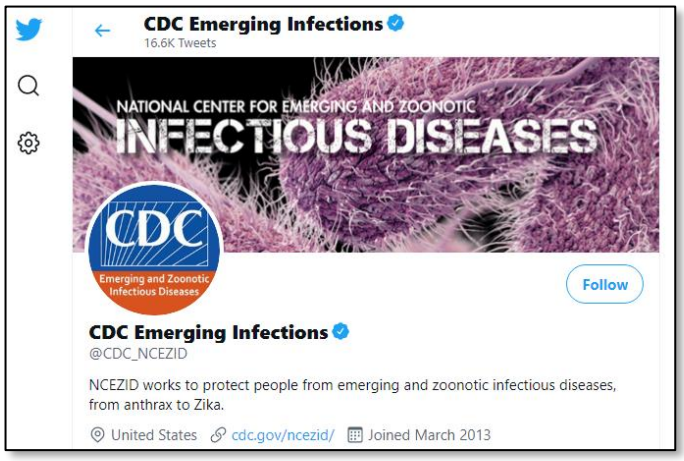
Test Your Face Mask

1. Perform the candle test with your mask to ensure that you cannot blow out the candle.
2. Check the fit of your mask. Look for gaps around the nose, chin, or sides of the face. Blow out air and feel for significant leaks around the edges.
3. Evaluate the comfort of the mask. Is it scratchy, tight, or otherwise uncomfortable?
4. Redesign your prototype if needed. Make sure it conforms to CDC guidelines before wearing it out in public. No mask is perfect against **coronavirus** but wearing one will significantly reduce your risk of catching or transmitting the virus.

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 can be spread 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 NCEZID on Twitter **@CDC_NCEZID.**



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Reflections

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

1. How do masks help stop the spread of the virus that causes COVID-19?

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2. What is the single best way to protect yourself from COVID-19?

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3. The **SARS-CoV-2** virus is only about 100 nanometers in diameter. The holes in your standard cloth or surgical mask are much larger than the size of a **coronavirus**. Given the way the virus is transmitted, why are masks still so effective at stopping transmission of the virus?

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4. Carbon dioxide and oxygen molecules are more than 3,000 times smaller than a **SARS-CoV-2** virus particle. Based on the information given in the previous question, how effective are masks at blocking these tiny gas molecules from entering/exiting? Explain your answer.

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5. Describe the results of your candle tests and how you used them to select the material for your mask design.

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6. Why might some people be reluctant to wear masks? What might you say to convince them that wearing masks is the right thing for them and their communities?

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