

DIY MASK MANUAL

Due to the COVID-19 pandemic, our loved ones, public-facing workers and healthcare professionals are at risk of contracting coronavirus.

This manual outlines the need to wear masks to protect those around us, and offers an evidence-based mask-making tutorial. By taking responsibility for our own bodies and health, we can save lives.



Table of Contents

Last updated 4/27/20 <https://covidstudentresponse.org/campaigns/ppe/mask-making/>

A Call to Action: Why We Should All Wear Masks	3-5
Mask-making tutorial	6-23
• Overview	6
• Safety and Hygiene	7
• Full coverage mask	8-11
• Filter pocket mask	12-19
• Simple coverage	20-21
• CDC No-sew coverage	22-23
What we know about COVID-19	24-31
• The Basics	24-25
• Spread	25-28
• Symptoms	29
• Prevention	30
• Treatment	31
• The Bigger Picture	31
What the research tells us about home-made masks	32-42
• Do Handmade Masks Work in a Pandemic?	32
• Materials	33-36
• Which Mask Should I Make?	37
• Evidence-based mask making	38-40
• The controversy around HEPA filters	41-44
Innovations in home-made masks and new materials	45-59
• Maker Mask: Cover and Surge	43-53
• University of Florida: Prototype 1 and Prototype 2	54-63
• Homemade Mask for Deaf and Hard of Hearing	64
N95s and False Claims of Protection	
• The Making of an N95	65
• Carbon Filters: The False Claims of N95/N99 Protection	66-71
Guidance for sewers and physicians on clinical homemade mask use	72
Donations, Resources & Advocacy	73-74
Contact information	75

This is an open-access resource for free of charge distribution. [Link](#) the guide if used.

Thank you for your service & mutual aid!

A Call to Action: Why we should all wear masks

As of 4/3/20, the United States [CDC officially recommends](#) national cloth mask use.

The mixed messaging around masks

COVID-19 has been marked by a storm of media coverage. With doctors, news anchors, policy-makers and politicians all giving different advice, it has been difficult to know what the public can do to help flatten the curve for this global pandemic other than stay home and practice good hygiene.

During the first phases of this pandemic, the messaging in the United States was clear: don't wear masks. The intention was to save surgical masks and N95s for healthcare providers and hospital staff in contact with COVID-19 patients. As the situation has escalated, mask supplies have dwindled in the U.S. and the CDC has begun recommending the use of [scarves, T-shirt masks and bandanas](#) to help prevent the spread of COVID-19 when medical-grade masks are unavailable. The conversation around the public wearing masks has been minimal, [until now](#).

Masks protect the people around you

The good news: by being responsible for our own bodies, we can protect those around us and alleviate the burden of disease carried by the elderly, the immune compromised, healthcare workers, and the essential workforce.

What can science tell us about making masks? This short answer is: it's complicated. Cloth masks vary in design, maker's skill, type of cloth / filters used, and the wearer's hygiene.

[This study](#) demonstrated that all handmade masks tested showed ability to protect against airborne viruses. Mixed cloth demonstrated high filtration of 70-75% compared to surgical masks which both [block respiratory droplets](#), and block [aerosolized](#) particles less than 1.25 microns (1250 nm) up to [96%](#).

[Research](#) published 4/3/20 in Nature stated that surgical face masks could prevent transmission of human coronaviruses from symptomatic individuals. However, as much as high-quality filtering material helps, surgical masks are not as protective as NIOSH N95 face masks.

N95s are the only masks that adequately protect from contracting COVID-19*

Hand-made and surgical masks are missing **essential protective components of N95 masks: an airtight seal and specialized, medical-grade filters**. Without an airtight seal, COVID-19 can still infect an individual wearing a surgical mask or hand-made mask by entering in places where the mask bends away from the skin. N95 masks balance protection, filtration and breathability. They're uncomfortable, but they work. *Note this is for airborne spread specifically.

N95s become FDA, [NIOSH-approved](#) by passing a respiratory seal test with material that filters 95% of airborne particulate matter [greater than .3 microns](#) (300 nm) in diameter. NIOSH N95s come in different sizes, and healthcare professionals in the U.S. report to yearly [fit-testing](#) to make sure their size assignment is correct. This process is so sensitive that many [facial hair](#) styles prevent full air-tight seal protection, and folks who want to grow beards need to defer to larger respiratory units which covers the wearer's entire head.

Cloth masks are not useless. They are essential.

COVID-19 has been shown to be [spread by asymptomatic carriers](#), people who do not feel they are sick but are infected. Young people and children are major carriers, which is why there was rapid, national school closures. Asymptomatic transmission makes going to the grocery store for elderly people and immune compromised individuals a life-threatening experience. Asymptomatic transmission also puts grocery store clerks, delivery drivers, healthcare workers, domestic workers and restaurant workers at risk of continued exposure over time. Increased exposure is thought to increase symptom and disease severity.

Countries such as [China](#), [South Korea](#) and [Japan](#) have done an effective job of controlling COVID-19 spread, and many Asian nations have consistently recommended that all citizens wear masks. The Director-General of the Chinese CDC [stated that](#) **“The big mistake in the U.S. and Europe, in my opinion, is that people aren’t wearing masks.** This virus is transmitted by droplets and close contact. Droplets play a very important role—you’ve got to wear a mask, because when you speak, there are always droplets coming out of your mouth. Many people have asymptomatic or presymptomatic infections. If they are wearing face masks, it can prevent droplets that carry the virus from escaping and infecting others.”

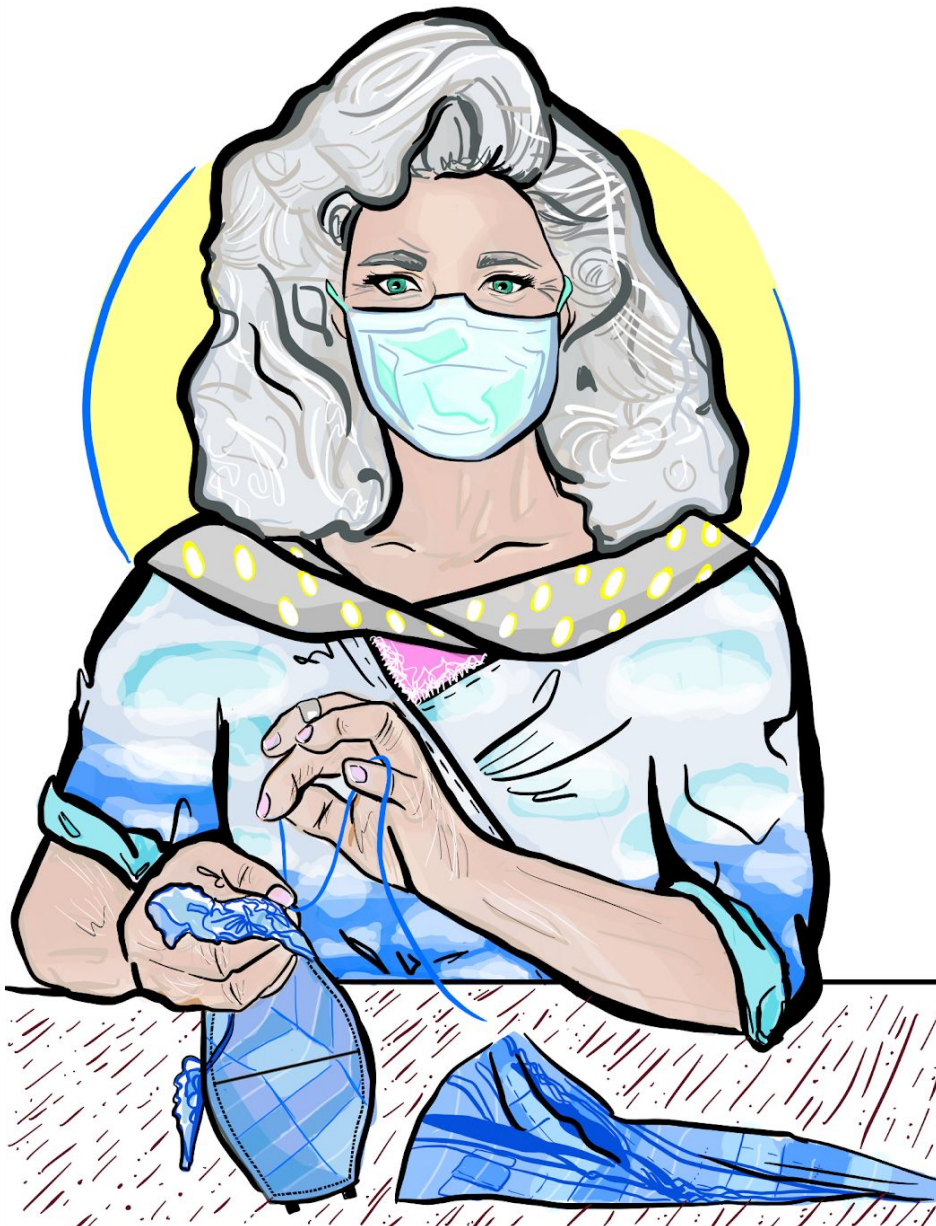
The United States CDC Director, Dr. Redfield, [stated](#) March 31, 2020 that as many as 25% of people infected with COVID-19 remain asymptomatic. The former commissioner of the FDA has also [suggested](#) that the CDC should recommend cloth masks for the general public, to offer some protection to the wearer and decrease transmission. Director-General of the World Health Organization, Tedros Adhanom Ghebreyesus, [said](#) March 27, 2020 that the “chronic, global shortage of personal protective equipment is one of the most urgent threats to our collective ability to save lives.” **On 4/3/20, the [White House](#) announced that the [CDC recommends](#) public cloth mask use.**

The United States does not have the same level quarantine measures as China. In our country, residents make trips for household necessities, go on walks with social distancing, order our favorite take-out, serve grocery-goers, take public transport to employment, and fly, drive or railway to various states to see our loved ones. With this freedom comes the collective duty to protect one another.

Looking into the future

The effects of a pandemic reach everyone. In the United States, UPS drivers are [denied paid time off](#) if they contract Coronavirus, [grocery store](#) workers are experiencing [unparalleled fear and anxiety](#), our elderly population is [dying in large numbers](#), the disabled community is facing [ventilator triage](#), and diverse urban areas are suffering record-breaking [death rates](#). The medical system is feeling profound effects. Doctors and nurses are using [garbage bags](#) as protection, healthcare workers are getting [infected](#) in large numbers, and young doctors in training are [dying](#). As of 4/27/20, 150+ [hospitals nationwide](#) are requesting “as many handmade masks as possible”, with numbers increasing rapidly. Overall, it is [expected](#) that [100,000](#) - 200,000 Americans could die from Coronavirus.

If we do our part in making and wearing masks, we can lessen the disease burden of those around us and join a global movement of individual responsibility for the collective good. By staying home, washing our hands and wearing masks, we can flatten the curve, lower viral transmission and save lives.



Mask-Making Tutorial

These 3 schemas are utilized by [Stitch Room](#) in partnership with hospitals and healthcare workers on a [national scale](#).

The first 3 masks are **classic mask styles used nationally**, with varying difficulty. Following is the recent CDC's no-sew mask. Later, we will offer **alternative materials that can be used for newer, innovative masks**. Hospital requests vary.

The idea behind offering various models and materials is to ensure **everyone has access to supplies** to decrease the chances of contracting and transmitting covid. Optimally, an individual should have multiple masks. After the CDC recommendations, dozens of masks have been suggested to the American people by news stations. **This guide will offer a few well-represented options with evidence-based research.**

There is no "one" superior DIY mask as of 4/27/20, and we do not need to resort to [desperation economics](#). This is one guide offering homemade schemas to sewers, with 60 pages of citations from studies and news articles worldwide. This is an overview of current materials research. **There are enough supplies to make masks.**

Contents:

1. [The Full-Coverage Mask](#)
2. [The Filter Pocket Mask](#)
3. [Simple Coverage Mask](#)

TOOLS AND MATERIALS

- *Cotton fabric
- Scissors
- Sewing machine or hands
- Pins
- Elastic or fabric for ties
- Printer for pattern or computer to watch tutorial
- Filter for filter pocket mask (optional)
- Wire for nose adherence (optional)

*Fabric must be cotton / cotton blend and washable. **TIGHTLY WOVEN COTTON is compliant with CDC recommendations**. Tightly woven cloth can be identified by holding it up to the light; you should not be able to see through it. [Finer weaves](#) are better when using woven material alone.

Please contact your local hospital for their specific needs before donating!

SAFETY AND HYGIENE

Putting masks on

Wash your hands for 20 seconds with soap and water before touching and putting on a mask. Once you [put on the mask](#), do not continue touching the mask. Re-adjusting will increase hand-mouth transmission and decrease mask hygiene. Ensure the mask is snug without gaps, and forms a tight seal on the nose and under the chin. [Mark](#) the inside / outside of the mask & the nose edge.

Taking masks off

Remove from the back and do not touch the front. Wash the mask. For storage, **hang the mask in a designated area** or placed in a paper bag and labeled - with one mask per paper bag.

Cleaning your mask

All face masks should be **washed and sterilized before use and cleaned again after becoming damp or moist.** **Wash masks daily and after use.** **Wash hands for 20 seconds after.** Can use detergent & washing machine to [clean](#). [Boiling](#) for 20 minutes works for cotton. Polypropylene N95s and HEPA filters cannot withstand alcohol wipes.

Materials Safety Advisory

DO NOT use HEPA filters containing fiberglass. More information [below](#). **Ensure you are not allergic to the materials;** safe alternatives offered.

Masks are inherently uncomfortable; they may make your face sweaty or red due to the seal. N95s that healthcare providers use are notoriously annoying. However, **you should be able to breath through your mask.**

Cloth face coverings [should](#) not be placed on young children under age 2, anyone who has trouble breathing, or is unconscious, incapacitated or otherwise unable to remove the cloth face covering without assistance. Do not fall asleep in masks.

Supervise children who wear / interact with masks.

The Full-Coverage Mask

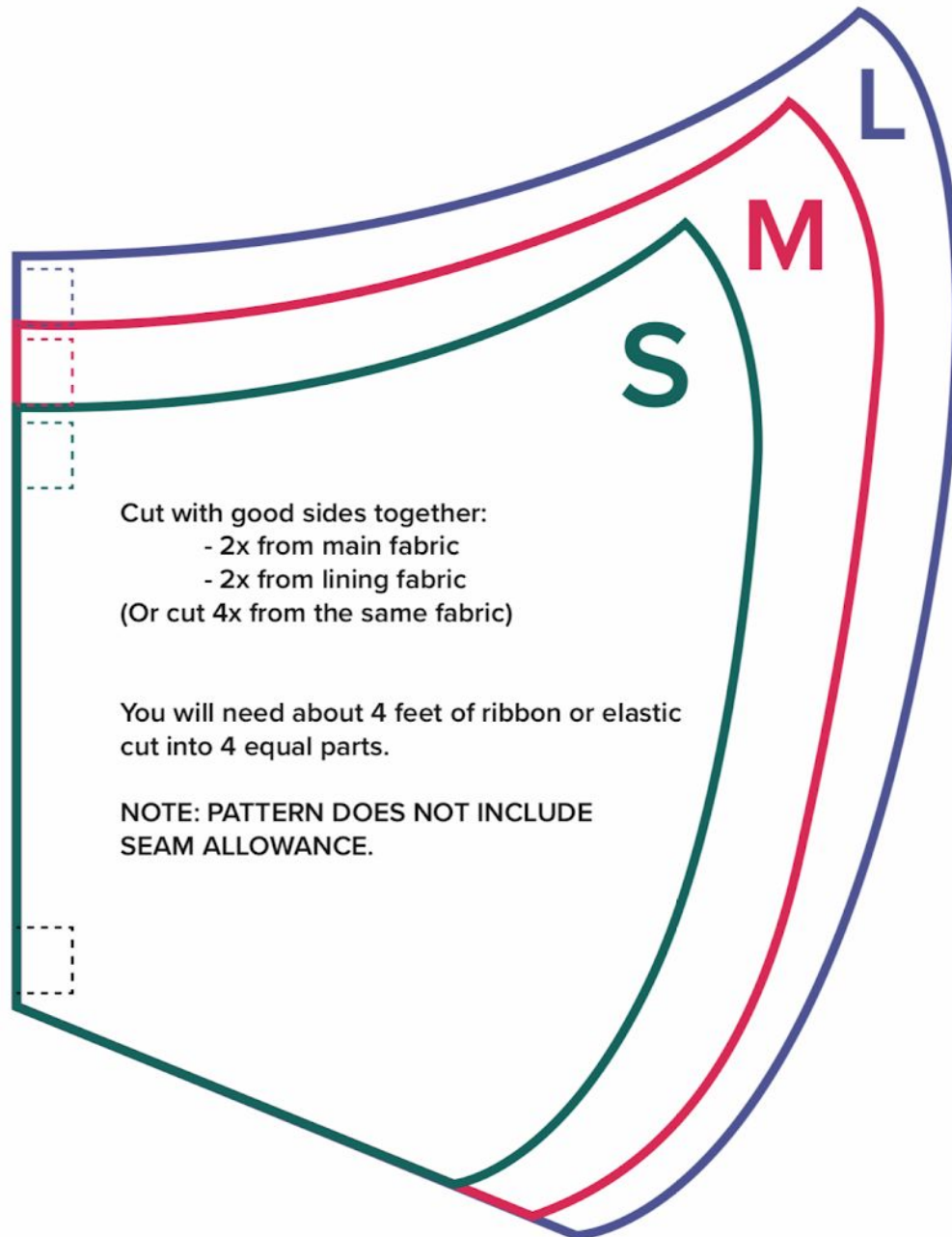
Retrieved from FreeSewing:

<https://freesewing.org/docs/patterns/fu/instructions/>

Watch the video tutorial:

https://www.youtube.com/watch?v=VcQ69_ANsRA&feature=youtu.be

This mask design has been featured in [The New York Times](#) and [Forbes](#).

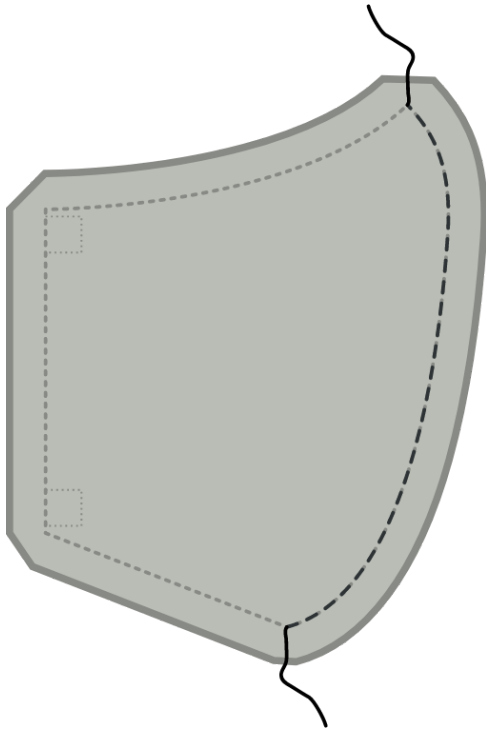


For scale, this box should be 4" when printed

Add a ¼ inch seam allowance

Step 1: Join center seam

Join the curved seam that is center of our mask by placing the good sides together and sewing them in place.



Repeat this step for both the outer (main) fabric, and the inner (lining) fabric.

Step 2 (optional): Press the center seam

**This step has no functional value, it will only make your mask aesthetically pleasing.*

Press the seam allowance on the center seam open so the seam lies nice and flat.

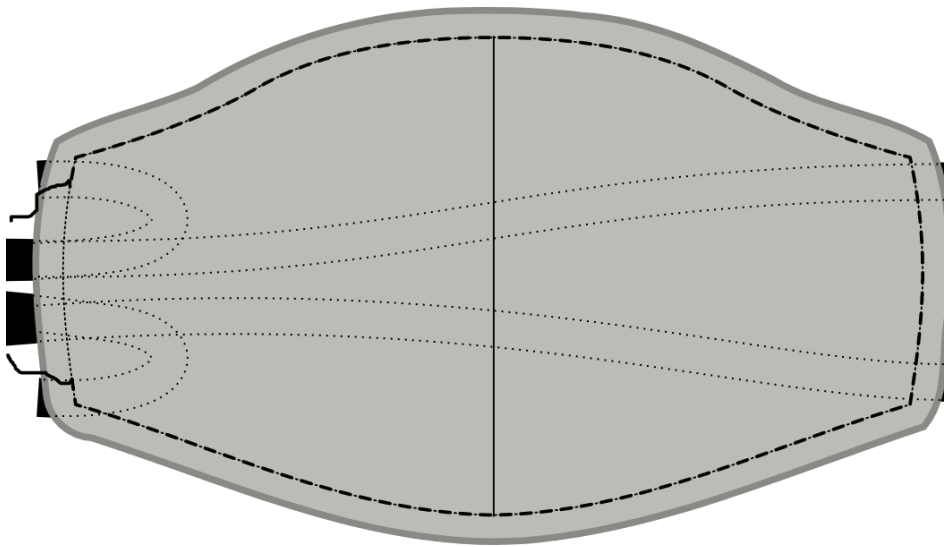
As this is a curved seam, it won't lay flat. But you can approach it with your iron from one side, then do the second half from the other side. Alternatively, you can use a tailor's hem or cushion to press.

Repeat this step for both the outer (main) fabric, and the inner (lining) fabric.

Step 3: Sew the outer to the inner fabric and attach ribbons

Now we will sew the inner (lining) fabric to the outer (main) fabric, and attach the ribbons all in one step.

- Place your lining fabric down with the good side up.
- Then, place two ribbons on the corners of one side (right in our example) so that they peak out just a bit from the mask, but the ribbon extends inwards.
- Now place the main fabric on top of this with the good side down. You should now have both layers of your mask on top of each other with good sides together and two ribbons sandwiched between them
- Pin through ribbons and layers to keep them in place
- Now do the same on the other side.



As you get some practice, you will find you don't need to pin this and can just insert the ribbons as you approach a corner.

Now sew around the mask, making sure to leave one side open so we can turn the mask inside-out later.

Be careful not to catch any of the ribbons in the seam apart from where you want them to. Either guide them through the opening you leave on one side, or bunch them up in between the masks of your layer to keep them out of the way.

Step 4: Turn the mask inside-out

Actually, your mask is inside-out now, so turning it inside out will mean we get it outside-out, or regular.

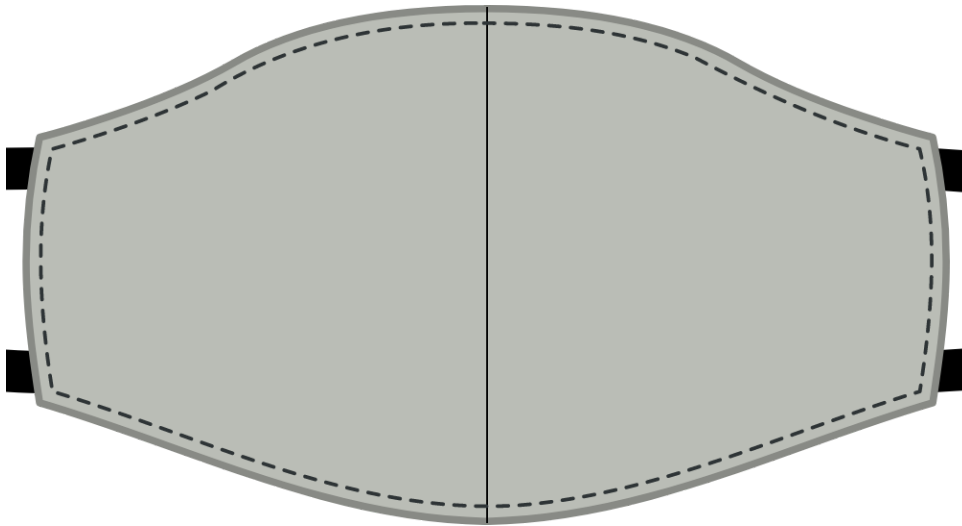
Just reach in through the side your left open and carefully pull the mask through to turn it.

Step 5 (optional): Press the mask

**This step has little functional value, it will only make your mask look better. So if you're not too bothered about that, feel free to skip it.*

Now that the mask is as it should be, it's time to press it. Before doing so, make sure to fold the seam allowance of the side we left open inwards, so that we press it flat as if it was sewn.

Step 6: Close open side of the mask and edge-stitch around the edge



Now it's time to close the side of our mask that we left open to turn it inside out.

We are not merely going to close the opening, but also edge-stitch around the entire mask to give our mask some extra stability, and keep the lining at the back.

Make sure the open side is folded neatly inside, then edge-stitch around the entire mask.

Step 7: Wear your mask or make a bunch

That's it, you're done! You can now wear your mask.

Even better, make a bunch so you can give others masks too.

The Filter Pocket Mask

Retrieved from:

<https://sweetredpoppy.com/how-to-sew-a-bias-tape-surgical-face-mask-with-flexible-nose/>

Watch the video tutorial: <https://www.youtube.com/watch?v=aHvghyn314U>

[This design](#) and similar [pocket face mask](#) is used by the [Mask Warriors Project](#) featured in [NBC Today](#) for Good Samaritan & Montefiore Nyack hospitals. Both are widely used.



SUPPLY LIST

- 100% Quilting Cotton Fat Quarters
- Sewing Machine
- Rotary Cutter
- Self- Healing Cutting Mat
- Acrylic Ruler
- Sewing Pins
- Floral Wire
- Wire Cutters

Cutting Chart

- Quilting (Tightly Woven) Cotton 3 Layers: Adult: 9" x 7" Child: 7" x 5"
- Cut 2 pieces of Double Fold 1/2" Bias Tape 40"
- Floral Wire 6"
- Learn how to make Bias Tape in the video: <https://youtu.be/-5EdcXG5oa8>

Step 1. Pin Fabric

Place two pieces of fabric right sides together. Save the third piece for the end of step 2. Place a pin in each corner of the rectangle and horizontally mark the center of the rectangle.



Step 2. Sew Filter Pocket

Halfway down from the top of the fabric sew a straight horizontal line 2-3" long. Repeat this on the opposite side as well, leaving the middle unsewn. Refer to the photo below as a guide.



Pinch both corners of the top fabric and pull them downwards to meet the bottom. Do the same on the back fabric.



A filter can easily be slid into this pocket at the end of the tutorial.

Place the last rectangle on top of the lining with right sides facing each other. Sew the short sides of the face mask making sure to backstitch at the beginning and end of each seam using a 3/8ths inch seam allowance.





Step 3. Turn Fabric

Turn the mask right side out and use an iron to press it flat. Take care to roll the seams outwards.



Step 4. Create Pin Tuck Markings

Create three pintuck markings by folding the mask in half and pressing it with an iron and then folding the outside edges to the center and pressing again.



Step 5. Sew Bias Tape.

Open the ends of the bias tape and fold them backwards so the right sides are touching each other. Sew a straight line along the short end of the bias tape making sure to backstitch. Turn the corner right side out to create a clean finish.

Find the center of the bias tape and position it at the center of the mask. Open the bias tape to align the raw edge of the bias tape with the raw edges of the mask. Pin in place along the length of the mask. Sew the bias tape in place along the crease closest to the raw edge, repeating this on the opposite side.

The filter slot should be facing away from you, this will be located on the backside of the mask.



*OPTIONAL: Cut a 5-6 inch piece of floral wire to create a flexible nose piece. Bend the ends of the wire inwards to prevent them from poking through the fabric. Slid the wire into the bias tape along the top middle of the mask. Pin on either side of the floral tape and push it upwards to avoid sewing over it.



Fold the bias tape upwards and encase the raw edge, pin in place and sew along the entire length of the bias tape 1/4th of an inch from the edge.



You can use your fingers on either side to guide the bias tape as you sew it.



Step 6. Create Pin Tucks

Create 1/2" folds facing downwards. Pin the folds in place making sure all tucks are facing the same direction.



Step 7. Topstitch

Sew over the pintucks along the right and left edge of the entire mask using a 3/8ths inch seam allowance.



HOW TO SEW A FACEMASK



1

CUT FABRIC

Cut 2 pieces of Quilting Cotton 9" x 7".
Cut 2 pieces of Bias Tape 54"



2

PIN FABRIC

Place 2nd piece of fabric on top with right sides together. Pin along right and left side leaving top and bottom unsewn.



3

SEW FACE MASK

Sew right and left side of mask using a 3/8ths inch seam allowance. Turn right side out and press flat.



4

CREATE PIN TUCKS

Fold mask in thirds and press. Create 1/2" pintucks facing upwards using pressed markings as a guide.



5

ATTACH BIAS TAPE

Open bias tape & align raw edges of fabric together with bias tape along mask. Sew along crease. Insert wire along top. Close bias tape, pin upwards & sew shut.



6

TOPSTITCH

Sew along either end of the wire to hold in place. Sew along over the pintucks along the right and left side of mask using a 3/8ths inch seam allowance.



SWEETREDPOPPY.COM

The Simple Coverage Mask

*easiest mask

Retrieved via Deaconess Health System: <https://deaconess.com/How-to-make-a-Face-Mask>

Watch the video tutorial: <https://www.youtube.com/watch?v=aHvghyn314U>

Elastic PDF (child and adult):

<https://deaconess.com/How-to-make-a-Face-Mask/Documents-Mask/Mask-Information>

**Note hospitals have stated they prefer cloth ties, but elastic ties are still accepted.*

Contact local hospital for details.

Ties PDF (adult):

<https://deaconess.com/How-to-make-a-Face-Mask/Documents-Mask/How-to-Make-an-Adult-Surgical-Mask-with-Ties-3-26>

This mask design has also been promoted by [Vanderbilt University Medical Center](#) and advertised on [CNN](#). This schema is also used by [JOANN](#) Fabrics [free materials](#) effort, and advertised on [USA Today](#). The [Mask Crusaders](#) featured in [LA Times](#) also use a [version](#) of this design with an added wire piece to the nose for better fit and seal.

With Elastic

What you will need

- Cotton fabric (designer's note: **a pretty print is best**). See [pg. 6 recommendations](#).
- Rope Elastic, beading cord elastic will work (you may also use 1/8" flat elastic)
- Cut the elastic 7" long and tie a knot at each end (DO NOT knot the ends of the flat)

You can make two sizes: Adult or Child

1. Put right sides of cotton fabric together -- Cut 9x6 (Adult) or 7.5 x 5 (Child)
2. Starting at the center of the bottom edge, sew to the first corner, stop. Sew the elastic with the edge out into the corner. A few stitches forward and back will hold this.
3. Sew to the next corner, stop, and bring the other end of the same elastic to the corner and sew a few stitches forward and back.
4. Now sew across that top of the mask to the next corner. Again put an elastic with the edge out
5. Sew to the next corner and sew in the other end of the same elastic.

6. Sew across the bottom leaving about 1.5" to 2" open. Stop, cut the thread. Turn inside out.
7. Pin 3 tucks on each side of the mask. Make sure the tucks are the same direction
8. Sew around the edge of the mask twice. It is so easy to make this. Be sure any fabric design is placed horizontally.

With Ties

What you will need

- One (1) 8x14 inch piece of cotton fabric
- Two (2) 1.5 x34 inch strips
- Thread & sewing machine / hands

Prepare the mask:

- On 8/14 inch piece, right sides together, sew $\frac{1}{4}$ inch seam, creating tube.
- Turn right sides out, press seam and fabric.
- Make 3 pleats, approx. 1 inch each in size, using steam or pins to hold.
- Mask will be approx. 3-3.5 inches in width.
- Sew $\frac{1}{4}$ inch seam on each side of mask, securing pleats. Trim seam allowance.

Prepare the ties:

- Fold in half and press (3/4 inch).
- Open tie back up.
- Fold each edge in to meet middle (3/8 inch/0.375 inch) and press.
- Fold in half again, securing raw edges inside and press.
- Each tie will be approx. 3/8inch in width

Assembly:

- Align center of tie w/ side of mask, open tie so edge of mask fits snugly inside. Pin.
- Sew tie to mask, seam will be very short, get as close as able while still catching all fabric. You are just attaching the mask to the tie at this point, not sewing the whole tie yet.
- Repeat for other tie and other side of mask.
- Sew down edges of tie, securing raw edges inside. Seam is very short. You will stitch over where mask is already attached. This is good because it helps reinforce. Repeat for other tie and other side of mask.
- Clip any stray fabric and enjoy

CDC No-sew coverage

This no-sew coverage schema is featured on the United States CDC [page](#) “Recommendation Regarding the Use of Cloth Face Coverings, Especially in Areas of Significant Community-Based Transmission”.

The CDC also recommended a sew option and no sew t-shirt option, shown on the same page. These tutorials are excellent for multiple masks and limited resources.

As with all DIY tutorials mentioned, the mask needs to balance filtration, pressure gradient and tight seal (more [below](#)). Ensure that these needs are met in your masks. As of 4/27/20, hospitals have not been reported to be requesting no-sew mask models. The seven 2020 “recent studies” [listed](#) by the CDC in this tutorial re-affirm previous research and global guidance that coronavirus is spread asymptotically.

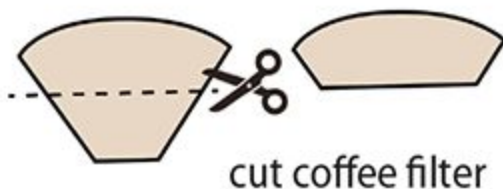
Note: Coffee filter use in masks has not been formally studied as of April 15, 2020. An [unpublished study](#) showed that coffee filters showed 40-50% filtration when stacked 3 layers. However, this made the mask less breathable due to a higher pressure gradient. More details on published materials research [below](#).

CDC No-Sew Coverage

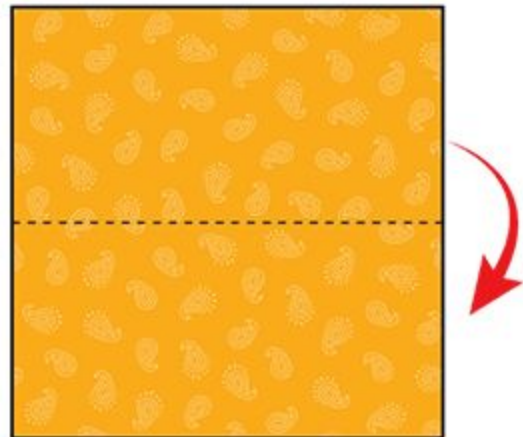
Using rubber bands and cloth, it offers protection with limited materials.

Video retrieved from: United States Center for Disease Control (posted 4/3/20)
<https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover.html>

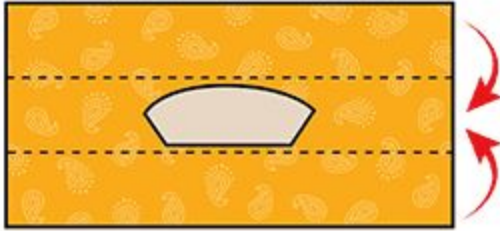
1.



2.



3.



Fold filter in center
of folded bandanna.
Fold top down. Fold bottom up.

4.



Place rubber bands or hair ties
about 6 inches apart.

6.



7.

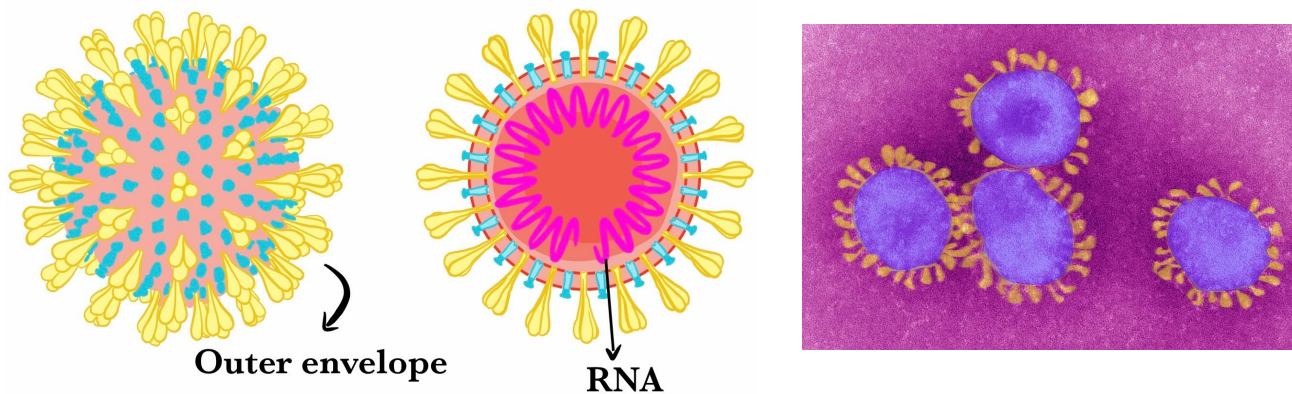


What we know about COVID-19

This brief tutorial was created using the CovidStudentResponse.org curriculum as a resource, citations are hyperlinked with recent news sources and research added. The Covid Student Response Curriculum was created by Harvard Medical students under the mentorship of Harvard physicians. See <https://curriculum.covidstudentresponse.org/> for a full in-depth review.

The Basics

The virus that causes COVID-19 / coronavirus disease is called **SARS-CoV-2**, a single-stranded enveloped RNA virus. It is part of a [family of viruses](#) called the coronaviruses, given their name because of the golden, crown-like projections surrounding the virus. “Corona” in Latin means crown.



Viral RNA (like human DNA) is how the virus makes more of itself. SARS-CoV-2 enters cells in the lung called [pneumocytes](#). When the virus enters the cell, it peels off its envelope and begins making more copies of itself using the machinery in lung cells and its RNA. When it has made a new version, the new SARS-CoV-2 virus escapes the cell and continues to replicate.

People infected with SARS-CoV-2 develop symptoms when the “viral load” overcomes the body’s ability to destroy the viruses with inflammatory cells and other immune molecules. This viral load of SARS-CoV-2, combined with our body’s immune response, creates the 3 major symptoms of COVID-19: fever, cough, and shortness of breath.

The most severe consequence of COVID-19 is Acute Respiratory Distress Syndrome (ARDS), which is thought to be caused when the immune system fights too hard to beat the virus. Immune cells called [neutrophils](#) and molecules called [cytokines](#) begin to damage the lungs. Some people need a ventilator to support their breathing when they

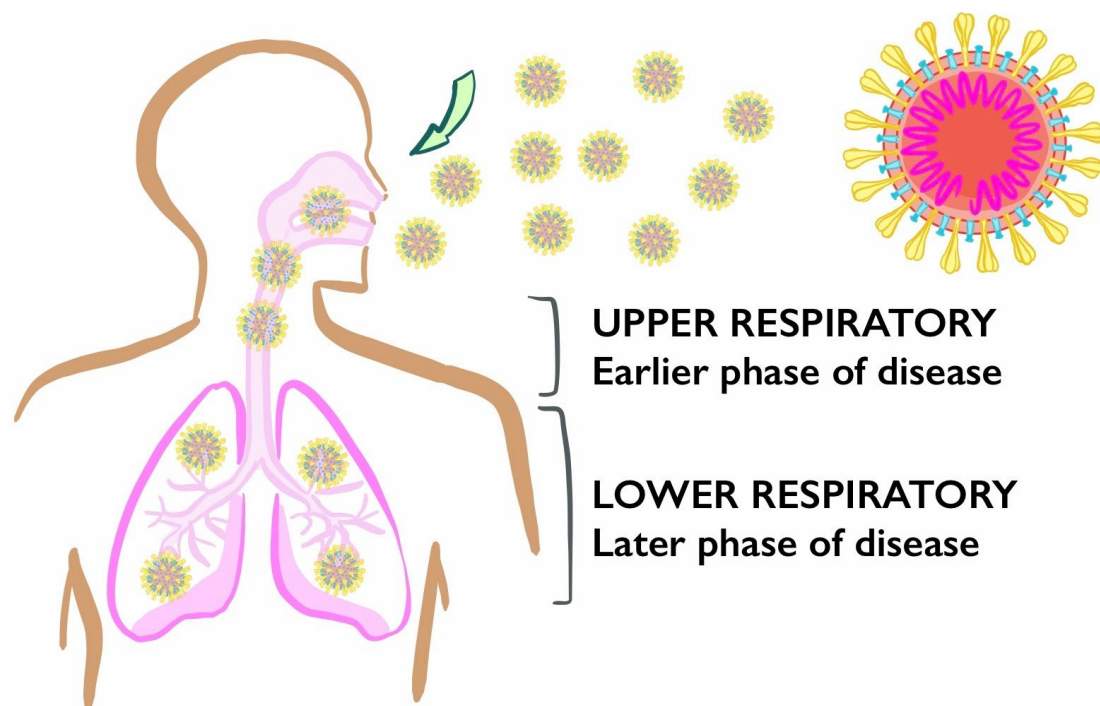
have ARDS, to make sure the body gets enough oxygen. The ventilators give the body time to recuperate.

Currently, scientists in several different countries are working to create a vaccine for coronavirus. A vaccine for coronavirus means that scientists are working on a way to inject a small, inactive version of the virus into people's bodies so they can make the immune cells and molecules the body needs to fight the real virus in the future. Then, if and when a person does contract Coronavirus from exposure to SARS-CoV-2, their body is better equipped to quickly fight and destroy the virus. Scientists and physicians have already begun testing trial vaccines on volunteers, but the possibility of a vaccine is still a long way into the future.

For elderly and immunocompromised people, COVID-19 can be particularly dangerous. This is because the body's ability to fight the virus is either delayed or muted in these populations. Because of this, it is essential to protect vulnerable patient populations by wearing a mask, practicing basic hygiene, adhering to social distancing practices, and extending quality PPE to disability rights [organizations](#) and elder-care facilities.

The spread

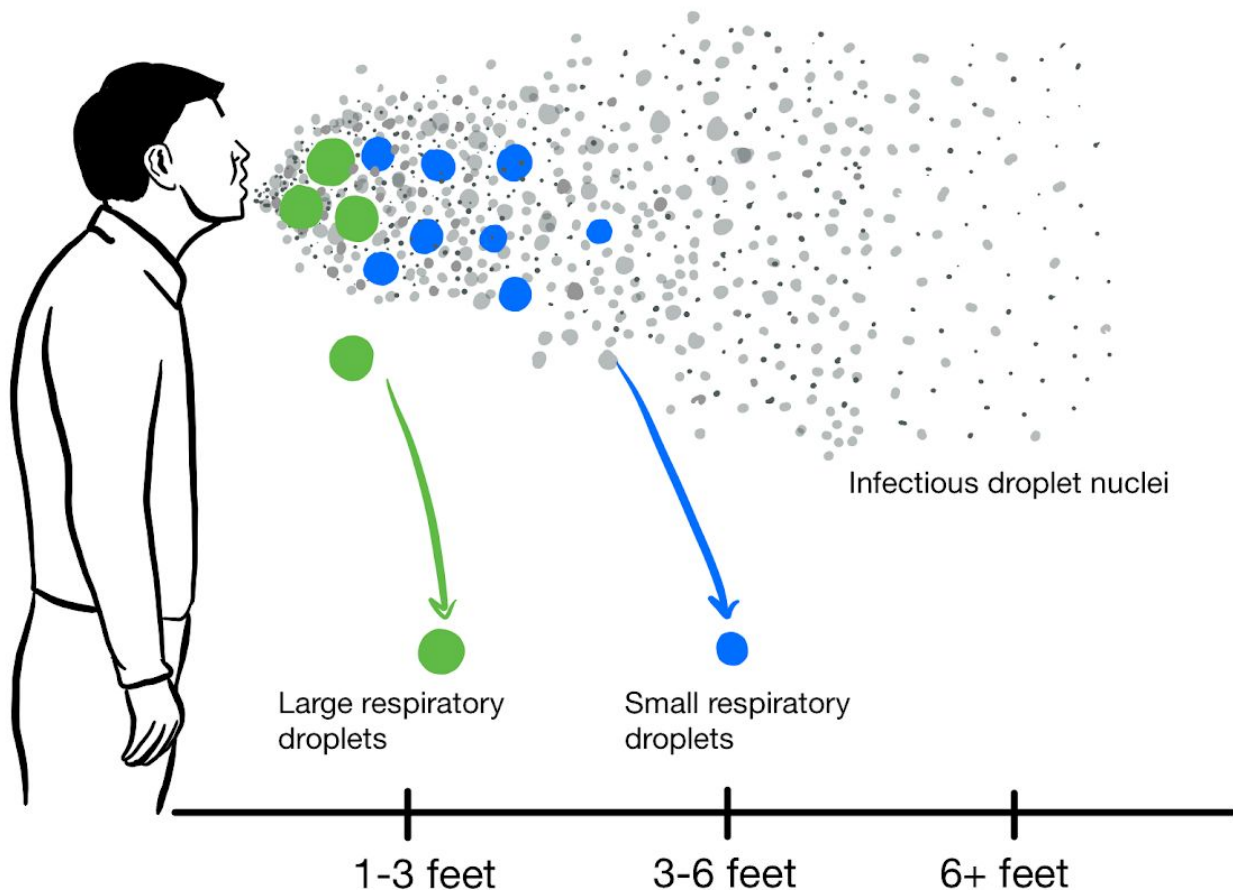
Transmission of SARS-CoV-2 is believed to occur primarily through [respiratory droplets](#) created by someone infected with the virus. Other routes of transmission include [touching objects](#) contaminated by the virus, and the virus lingering in the air within a confined space.



COVID-19 Respiratory Transmission

Asymptomatic individuals can spread coronavirus by producing respiratory droplets containing the virus. The Director of the U.S. CDC stated 3/31/20 that 25% of people with coronavirus [never show symptoms](#), and 4/3/20 Nature published a [study](#) affirming asymptomatic airborne transmission. **Even if you don't feel any symptoms, you could still infect other people** if you are carrying the virus. The asymptomatic carrier may not feel symptoms because their bodies are handling the viral load effectively, or may not yet be experiencing symptoms because the virus is still replicating. Data from a [German study](#) initially posted online March 8, 2020 and [formally published](#) in [Nature](#) on April 1, 2020 demonstrated that high levels of virus are emitted from the upper airways in the earliest days of COVID-19 disease, when individuals are experiencing mild or no symptoms. These symptoms peak before 5 days and then decrease steadily over time. This peak of viral load was found to be both earlier and 1000x higher than the peak viral load found in the 2002 SARS epidemic. This means the **coronavirus likely reaches its shedding peak before the appearance of very mild symptoms**.

This [study](#) shows that respiratory droplets are generated by sneezing, coughing and [talking](#). Sneezing creates 40,000 droplets, coughing creates 3,000 droplets and talking creates 600 droplets a minute. Each respiratory droplet can contain millions of viral particles. Wearing a mask can [help prevent](#) these droplets from escaping.



Different size droplets travel different distances. It is believed that SARS-CoV-2 mostly spreads via larger droplets. Researchers [vary](#) in estimates of larger droplets diameters, from [>5 microns](#) to [>6 microns](#). Basic physics tells us these larger droplets [spread 3 feet](#) (1 meter). These droplets require “droplet precautions” which include wearing a surgical mask so these large molecules do not enter the wearer’s mouth. This mode of transmission and [protection](#) is similar to the annual flu / influenza.

SARS-CoV-2 can also travel via [smaller droplets and aerosols](#). These aerosols help viruses move as a cloud through the air. N95 masks can help to prevent these smaller cloud particles from infecting the wearer when worn appropriately. The risk of creating SARS-CoV-2 clouds increases with certain medical procedures such as [ventilation](#), which is why doctors and nurses are at increased risk of contracting COVID-19.

Healthcare workers experience [severe disease](#) and increased transmission risk due to increased viral load from aerosol exposure and repeated contact with sick patients. The [study](#) “Viral dynamics in mild and severe cases of COVID-19” showed that patients with severe COVID-19 tended to have a high viral load and long virus-shedding period. According to these scientists, viral load of SARS-CoV-2 represents a “useful marker in assessing disease severity and prognosis.” Additionally, a recent Nature April 2020 article indicated that there is [great variety](#) in the “contagiousness” of individuals with coronaviruses infections.

Individuals who have recovered from the symptoms of coronavirus are still at risk of transmitting it to others by “viral shedding”. A retrospective, [multicentre study](#) of 191 adult inpatients in Wuhan, China showed that survivors of COVID-19 can have a **duration of viral shedding for an average of 20 days** up to 37 days. Those who had critical cases shed for 4 more days on average than those who had more mild cases. A [German study](#) demonstrated **shedding in stool** for weeks after symptoms resolve. Although it is unknown how long these later-stage viral particles can cause disease in others, it is still best practice to [self-quarantine for 14 days](#) after a potential exposure.

Experts are still in [conversation](#) with one another regarding the impact of viral load on symptom severity and duration of transmissible virus. However, it seems a general consensus is that **more viruses means more problems**. This is why healthcare workers experience [dire consequences](#) of coronavirus, including [death](#). Without proper PPE, healthcare workers are unable to avoid a high viral load.

Individuals who are in contact with many other people are more likely to contract and transmit coronavirus. Individuals who are at particular risk of continued exposure and who need some form of PPE include [healthcare workers](#), [grocery store](#) workers, delivery personnel, home health aids, domestic workers and other essential personnel. **Essential workers should be given PPE to protect their lives and provide society with needed supplies.** In addition, essential workers must be given adequate [compensated time off and accessible healthcare](#) to **ensure their safety, and the safety of 300 million United States residents who depend on essential workers for our daily needs.** A country of overworked and sick essential workers [puts us all](#) at risk.

When greeting your delivery provider, it is best practice to use a mask and keep six feet of distance between you. If possible, use no-contact delivery options, disinfect and discard your packaging, and wash your hands with soap and warm water for 20 seconds after receiving a delivery. If you have a **sanitary, hand-made mask to donate, please give it to your essential workers in an unused paper bag.** This will help protect them, your delivery packages, your neighbors and yourself.



Photo above retrieved from: <https://www.nytimes.com/2020/03/21/business/coronavirus-ups-fedex-xpo-workers.html>

Symptoms



Retrieved from U.S. [Centers for Disease Control](https://www.cdc.gov/)

The 3 cardinal symptoms are COVID-19 are **fever, cough and shortness of breath**. These symptoms typically develop between 2 and 14 days after being exposed to the virus, which means that someone with COVID-19 can spread the virus without knowing they have it.

Other symptoms include: tiredness, sore throat, and runny nose, conjunctivitis, diarrhea, chest tightness and palpitations.

These symptoms can also mimic the flu, seasonal allergies and panic attacks.

Serious symptoms include: pneumonia in both lungs, ARDS, multi-organ failure, and death.

When to Seek Medical Attention:

If you develop emergency warning signs for COVID-19 seek medical attention immediately. Emergency warning signs include*:

- Trouble breathing
- Persistent pain or pressure in the chest
- New confusion or inability to arouse
- Bluish lips or face



**This list is not all inclusive. Please consult your medical provider for any other symptoms that are severe or concerning.*

Prevention

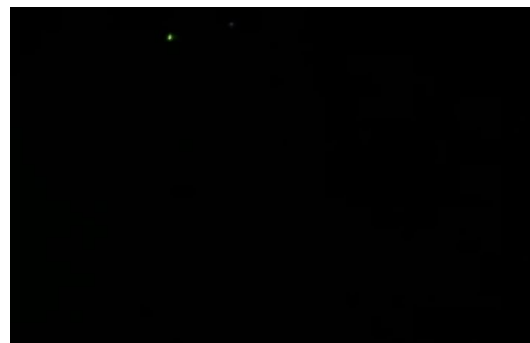
Most strategies to prevent COVID-19 have to do with personal hygiene.

- Wash your hands often with soap and water for at least 20 seconds, especially after blowing your nose, coughing, or sneezing; going to the bathroom; and before eating or preparing food.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Stay home when you are sick.
- Cover your cough / sneeze with a tissue; throw the tissue in the trash.



As of April 2020 in the United States, **cloth masks are an official public health strategy for combating COVID-19**. The intention behind the [CDC recommendations](#) is to **decrease the overall viral load of society during a severe global pandemic**. As discussed [above](#), the hope is that a lessened viral load will decrease symptom severity and save lives over the span of this crisis.

A recent [study](#) published 4/15/20 demonstrated that masks significantly reduce speech-generated fluid droplets with laser light scattering. The image to the left shows speech droplets without a mask, and the image to the right shows the significant decrease in droplet spread with a mask.



As much as masks help, it's important to note that cloth masks are [not foolproof](#), as shown in a study published 4/6/20. The researchers also found that **masks are also not without risks: there is a high viral burden on the outside of cloth masks** after the wearer coughs. However, the data did indicate that cloth masks could decrease the amount of virus that travels from person to person after a cough.

Masks are not “enough”. The only way to save as many lives as possible is to utilize all coronavirus prevention measures possible: hygiene, social distancing and **responsible mask use**. See [above](#) for how to use and clean masks safely.

Treatment

There is currently no cure for COVID-19.

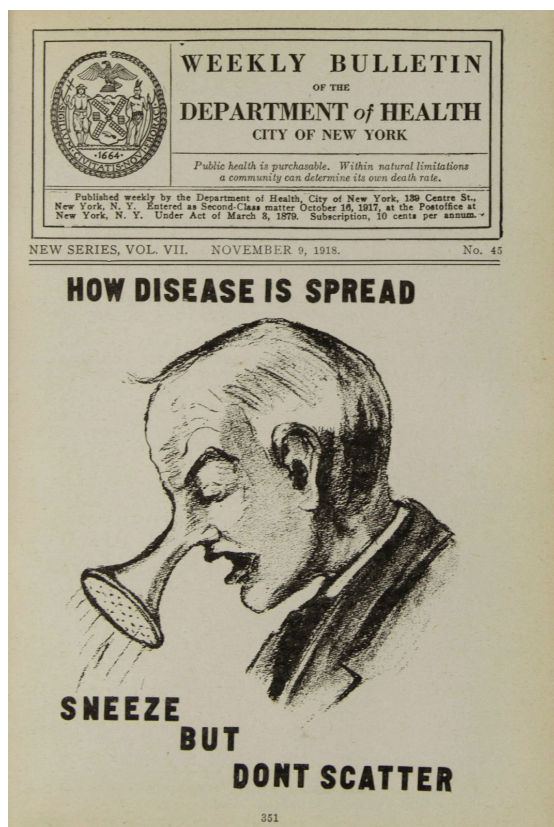
Household medications such as Tylenol (acetaminophen) can help with fevers, air diffusers can help with breathing difficulties, and adequate rest will give the body energy to fight the virus. Make sure to stay hydrated.

The bigger picture

If we all wear masks and maintain personal hygiene, we can decrease the overall presence of the SARS-CoV-2 virus and coronavirus / COVID-19 disease in our society. Nations world-wide are already implementing this strategy, and many top health experts and scientists believe a reason for the effective response to COVID-19 in countries such as [China](#), [South Korea](#) and [Japan](#) is in part due to national mask use. The CDC as of April 3, 2020 [recommends](#) public cloth mask use.

Wearing cloth masks is not a new or strange concept. The United States has a strong precedent for resident mask use. During the [1918 flu pandemic](#), many Americans donned masks to protect themselves and [others](#).

By making, distributing and wearing masks, we can save lives.



Photos courtesy of [New York Times](#)

What the research tells us about home-made masks

Do Handmade Masks Work in a Pandemic?

Another [study](#), entitled “Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population,” came to the conclusion that although individual subjects are not always optimally protected by the use of handmade masks compared to surgical masks, the use of masks could **decrease overall viral transmission** from a public health point of view. Although wearing a mask cannot guarantee your individual safety, it can help keep the general public healthier overall.

[This paper](#) also proposed that the level of protection offered by hand-made masks may reduce viral exposure, while allowing people enough exposure to begin mounting an effective immune response over time.

Finally, a [third study](#), “Face Mask Use and Control of Respiratory Virus Transmission in Households” featured in [Time](#) found that **adherence to mask use significantly reduces the risk of influenza-like infections within households**, but that this reduction was greatly affected by how often individuals within a household are wearing a mask. The study concluded that although the use of masks within households is not indicated for the seasonal flu, **during a severe pandemic there may be a larger role for household mask use**.

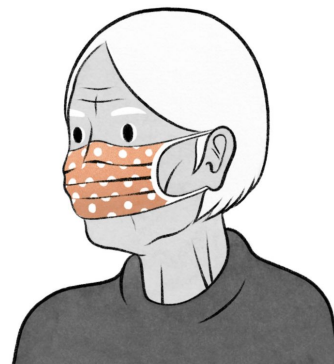
The efficacy of masks in the spread of illness is nuanced: it depends how the mask is made, how often it is worn, and the context it is worn in. **However, previous research and international COVID-19 prevention strategies indicate that wearing a cloth mask helps to decrease overall transmission risk.**

There have been many articles written on the theme of handmade masks, and wearing a mask properly is a major factor in successful control of the COVID-19 pandemic. This NYT [article](#) offers illustrations on how to wear masks. See above for [hygiene & safety](#).

DO: Wear your mask so it comes all the way up, close to the bridge of your nose, and all the way down under your chin. Do your best to tighten the loops or ties so it's snug around your face, without gaps.



DON'T: Leave your chin exposed.



The Materials

This section will describe the findings of various published and unpublished research studies which have tested the filtration efficacy of various materials.

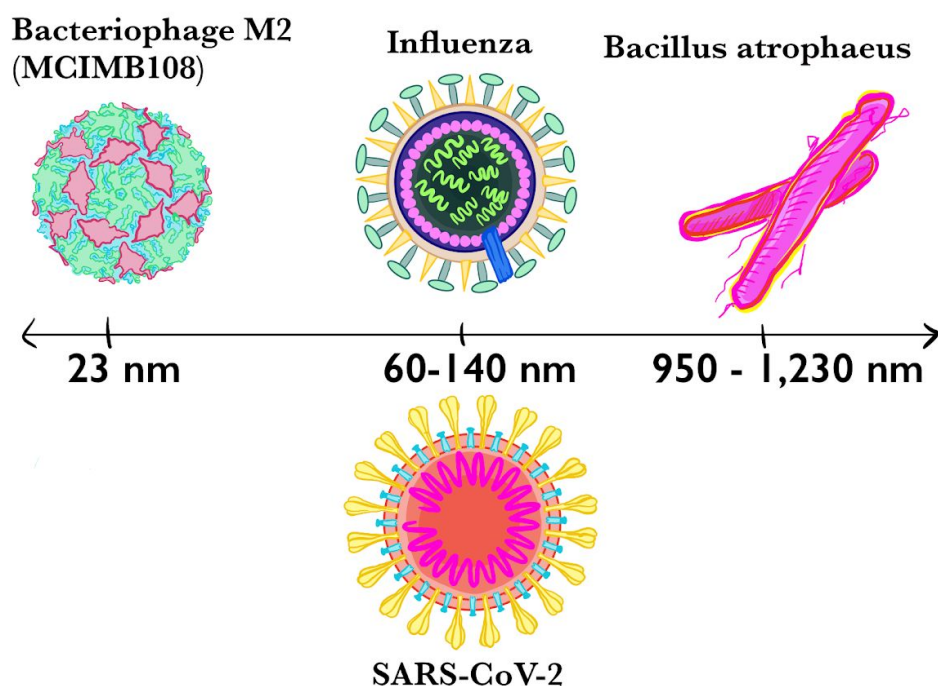
The most [pertinent study](#) was conducted in the UK in 2013, entitled “Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?”. This study and its mask designs are featured in [CNBC](#), [Time](#), and [New York Times](#).

Disaster Medicine and Public Health Preparedness

Volume 7, Issue 4 August 2013 , pp. 413-418

This study tested the abilities of common household materials to filter out high concentrations of bacterial and viral aerosols. Aerosols are airborne “clouds” of pathogens. The individual aerosols are larger than respiratory droplets. Pathogens such as bacterial cells and viruses can travel in the air in a cloud once “aerosolized”.

To test filtration for the influenza virus (60-100 nm), researchers measured microbes bigger and smaller than the influenza virus to find the range of protection. The smaller diameter pathogen is the virus Bacteriophage MS, 23 nm. The larger pathogen was the bacteria *Bacillus atrophaeus*, 950-1230 nm. By using the study’s data, we can approximate how effective different household materials would filter [coronavirus](#), which is similar to influenza at **60-140 nm**. ([Note](#) coronavirus can travel in units higher than this because it has proteins and salts attached to it even when it’s not in droplet form).



The study showed that **all materials tested showed some ability to block the microbial aerosol challenges**. In other words, all materials tested were more effective in blocking aerosols than not using any protection at all. In general, filtration efficiency for the smaller pathogens was 10% less than the larger pathogens. Additionally, both the surgical and homemade mask decreased the total amount of microorganisms expelled while coughing.

The researchers determined that the pillowcase and the 100% cotton t-shirt would be the best household materials for a homemade face mask. The stretchy quality of the cotton also provided good fit. The vacuum cleaner bag and tea towel had better filtration, but was more difficult to breathe through due to high pressure gradient.

The researchers did not recommend the use of vacuum bags or excessive layering of fabric due to the creation of a high pressure gradient which makes the mask difficult to breath in. The relationship between pressure gradient and filtration is diagrammed in the “Evidence-based mask making” section below.

The study concluded that although **protective masks do not eliminate the risk of infection**, they may help to **reduce the likelihood of infection.**

Cotton is a solid, reliable and safe choice for homemade masks. Recent COVID-19 unpublished research includes a [study](#) on NYT which showed doubling-up on cotton fabric helped filtration. Another unpublished [study](#) on NBC news claims the best tested masks were made of two layers of **heavyweight “quilters cotton” with a thread count of at least 180**. This fabric is thicker and has a tighter weave than most cotton clothing products. These quilter cotton masks performed at 79% filtration for particles above 0.3 microns. The same study found that this outperformed surgical masks, which filtered 62-65% of particles. As is evident by the above data, the quantification of “filtration” differs by scientist, and is an imperfect metric. However, the data indicate cotton is a viable option for masks, and provides breathable & high filtration protection.

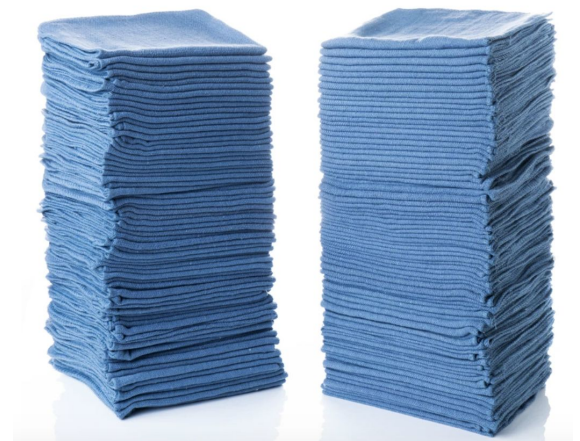
Coffee filters, as mentioned [above](#) in the CDC no-sew mask, are overall ineffective in blocking out the virus. Coffee filter use in masks has not been published in peer-reviewed literature as of April 15, 2020. An [unpublished study](#) showed that coffee filters showed **40-50% filtration when stacked 3 layers**. However, this made the mask **less breathable** due to a higher pressure gradient.

Bandana material, as mentioned [above](#) in the CDC no-sew mask, is likewise a less effective option. Bandana use in masks in the context of infectious disease has not been published as of April 15, 2020. However, there was a [2018 study](#) on volcanic ash inhalation that showed **bandanas folded 3 times had a filtration efficiency of 40%**,

and **single-layered bananas filtered at 29%**. This study found that N95-equivalent masks have FEs of 98%. Another [study](#) found that bandana material offered $\frac{1}{3}$ **the protection efficiency of surgical masks**. Overall, these 2 studies suggest bandana filtration percentages of around **30-40%**. It is possible that adding the coffee filter to a bandana would increase the overall efficacy, but as shown in [these two](#) published and peer-reviewed studies, layering material with inadequate filtration does not markedly increase filtration capacity. Overall, the CDC coffee filters and banana mask design offers the least amount of peer-reviewed literature, and cannot be recommended as they likely have lower efficacy than all of the above materials including scarves.

Paper towels have been recently [studied](#) by materials engineers, and show a **low filtration of 23% single layer and 33% double layer** for particles less than 0.3 microns (300 nm). For this reason, **we do not recommend paper towels** over used cotton, pillowcases or other household materials.

Blue shop towels masks have been featured in [Business Insider](#). As of 4/27/20 there are no published studies on shop towels. Business Insider claimed that inserting blue shop towels into cotton masks increases mask efficacy to 93%. It should be noted the “93% filtration” claim was from a 3 layered mask, not a single layer of material. Notably the designers were in the fashion industry, and tested mask material “in the lab she and her friends built.” However, **most concerning is the lack of safety information and explicit danger of blue shop towels**.



This [article](#) lists 12 potential hidden chemicals in common shop towels, stating “even workers who use just three towels a day can be exposed to higher levels of lead than are permitted in drinking water”. There are so many potential chemicals because shop towels are washed and re-sold after use, which is legal. The recommended brand “[ToolBox](#)” is made from “40% post-consumer recycled fibers”. Alarming, the recommended Toolbox and Zep products both have this [disclaimer](#): *WARNING: This product contains chemicals known to the State of California to cause cancer and/or birth defects or other reproductive harm*. The less effective “Scott” brand claims to be free of [carcinogens](#), but it may still be chemically contaminated. The media attention given to shop towels has resulted in these items going out of stock, which intensifies the [marketplace of desperation](#) and potentially puts thousands at risk due to “medical products” being recommended by the fast fashion industry.

Nylon stockings have been [proposed](#) to increase the filtration capacity of both surgical masks and cotton masks. An [unpublished](#) study found that an added nylon layer increased filtration of surgical masks from 75% to 90%. The study also found that adding a pantyhose layer boosts cloth mask performance by 15-50% depending on material. The benefit of Nylon stockings also lies in its ability to create a better fit with the tight seal, preventing leaking from the sides of the mask. The researchers recommended pulling the nylon stockings over one's head, and pulling it over the mask to create a tight fit to the face. This strategy has been previously used in the 1980s, to help keep out nuclear fallout materials. Overall, this appears to be a reasonable suggestion to increase fit, seal and filtration. However, it cannot be medically recommended as it has not been formally studied.



Miscellaneous materials

*Readers have reached out regarding **velvet, felt and sponges** as mask material. To the author's knowledge there is no research assessing the efficacy of these materials.*

Which Mask Should I Make?

From the literature it seems the safest and most common household materials which balance filtration and breathability are:

- Thick, 180 count quilted cotton
 - 2-3 layers
- Polypropylene shopping bags / conference bags
 - [Alone](#) or as a filter

To test if material provides adequate protection, put it up to a light and ensure there is minimal leakage through the fabric.

For polypropylene bags, the fabric should not flake. Small flakes can enter the respiratory system and damage the lung.

Test the water resistance of materials by spraying water on the fabric. If the water droplets ball up and not sink into the material, then it is “water resistant” and will help repel respiratory droplets. It should be noted this also traps droplets on the front of the mask, and caution should be used to avoid touching the front of a mask.

If you are an organizer, acquire goods in bulk depending on supply and price. This may change throughout the pandemic. As a rule of thumb, more experience with making a certain model of mask will improve the mask. Stick to 1-2 styles.

The key to making masks during a pandemic is to be adaptable. In a severe shortage, it would be appropriate to use the most recently bought cotton clothing item. Inversely, if high filtration material is safe and available, then consider including a filter layer of safe and breathable HEPA, or polypropylene.

It is important to emphasize that mask safety differs from person to person depending on physical diversity. The most mask size options, the better,

There is no one “best” mask. There are enough household supplies in the United States to create many effective masks to prevent the spread of droplets.

Evidence-based mask making

There are 2 main principles in mask-making:

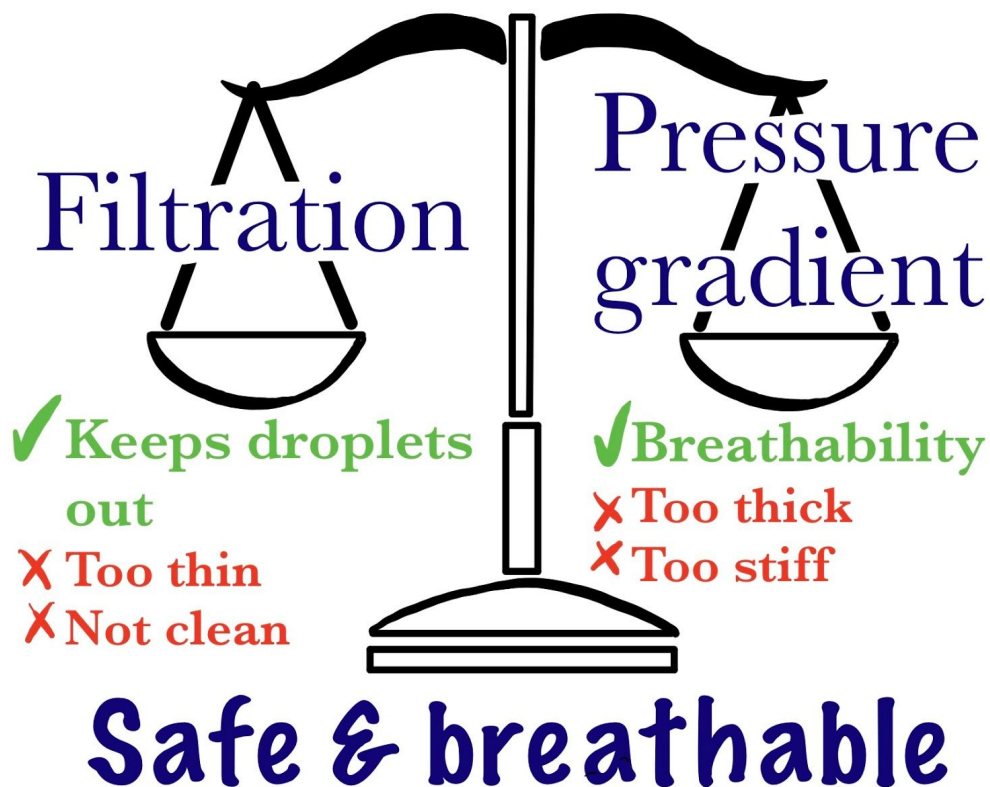
1. Filtration
2. Pressure Gradient

FILTRATION is how well the material prevents viruses and bacteria from moving through it. This offers protection to both the wearer and people around them.

PRESSURE GRADIENT describes how hard a person needs to breathe to get air in and out of the mask. Too high a pressure gradient affects the seal of the overall mask, because blowing air out from the sides of the mouth while breathing removes the mask from directly contacting the face. This leaves the wearer susceptible to a virus entering and exiting from the sides of the mask.

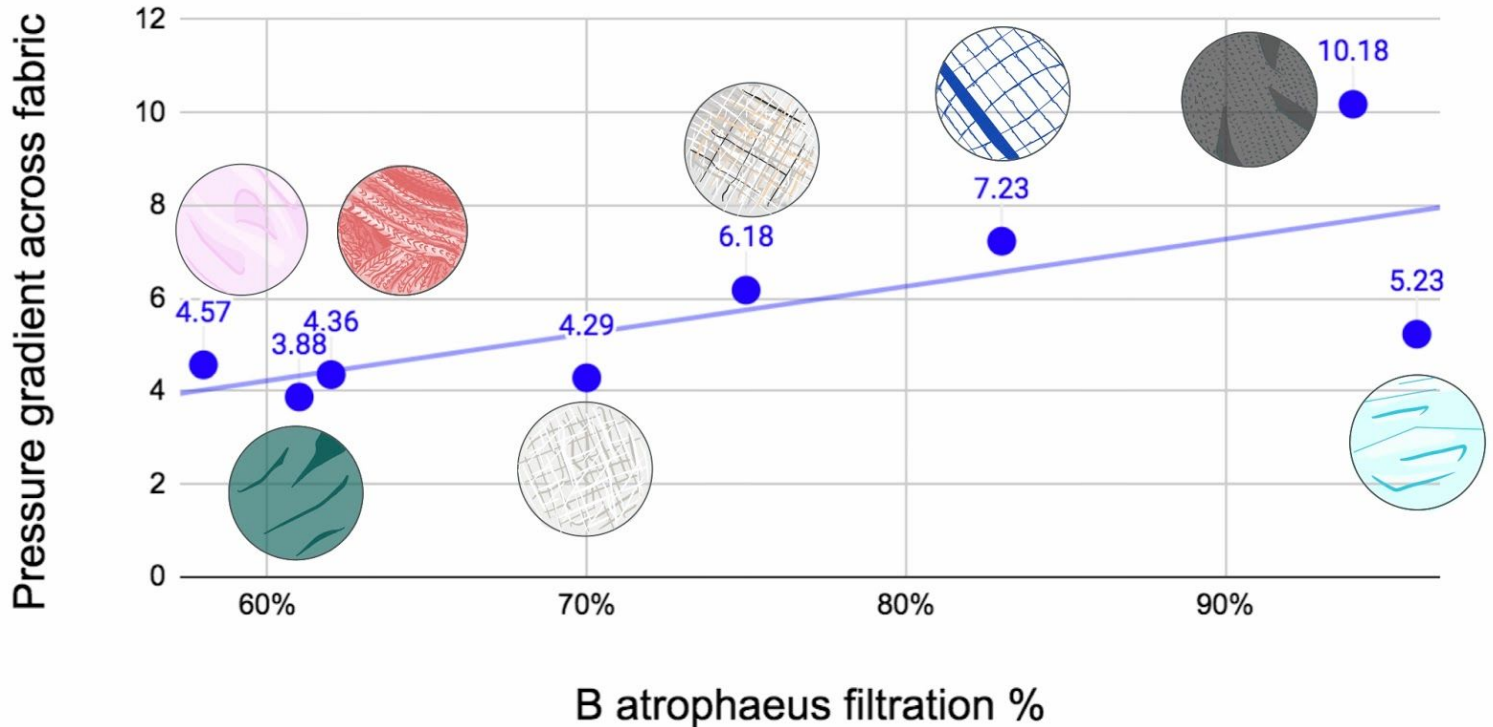
The key is having a **BALANCE** between filtration and pressure gradient.

Too high a pressure gradient due to an overly stiff, thick filtration material causes the mask to come off the face as the wearer breathes in and out with force. **Space between the face and mask can let SARS-CoV-2 particles in and out.**



The graph below shows findings from the [study](#) “Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?”.

Pressure gradient across fabric vs. *Bacillus atrophaeus* filtration %



As filtration increases, the fabric becomes harder to breathe through. The pressure gradient of 10.18 on the graph above represents the vacuum bag, which has similar protection to a surgical mask. The surgical mask is the gold-standard for protection because it has both good filtration and a low pressure gradient of 5.23. The vacuum bag provides similar filtration, but double the pressure gradient. Because of this high pressure gradient, **the researchers did not recommend vacuum bags as masks.**

Although these authors did not recommend using vacuum bags, it's important to note **there are a variety of vacuum bags** available. Jiangmei Wu, assistant professor of interior design at Indiana University, designed a [no-fold origami](#) face mask for vacuum bags, video [here](#). This material was found in unpublished studies to remove 60 - 87% of particles.

Ensuring a tight, comfortable seal using high-filtration material will decrease chances of contracting and transmitting COVID-19.



“HEPA filters” (more [below](#)) have variable pressure gradients. **“HEPA” is a general term to describe high filtration materials used in air filtration and vacuum bags.** [This article](#) discusses HEPA filters used for air filtration called “high-MERV pleated filters” made from polypropylene (NOT fiberglass). A downside of using polypropylene air filtration in homes (vs. older fiberglass fibers) is increased energy expenditure to power the unit. The energy the house uses is similar to the effort of breathing through a high pressure gradient mask. Read [below](#) about the safety and science of “HEPA”.

For the individual mask-maker, this means you need to determine what combination of masks and materials make sense to offer the protection you need given the time and materials you have access to.

The controversy around “HEPA” & Polypropylene

The main take-away

There has been controversy about HEPA filter masks in terms of safety and efficacy. Per the CDC, “[HEPA](#)” stands for high-efficiency particulate air filter. This **general term** is used to describe materials with high filtration. “MERV” pleated filters are also “HEPA”. Masks made with “HEPA” filters have [historically](#) helped healthcare workers treat infectious respiratory diseases. Other types of “HEPA” filters are used as air purifiers. It is important to distinguish between different types of HEPA filter materials.

1. FIBERGLASS or “glass fiber”
2. POLYPROPYLENE (PP) and POLYETHYLENE (PE) fibers (both are [polyolefins](#))
 - a. Potential added chemical materials

Fiberglass causes lung damage and should never be used in masks

Fiberglass HEPA air filters can look like harmless cloth material, but are very [harmful](#) when inhaled. Details [below](#). Most HEPA filters are not made from fiberglass. People may have fiberglass HEPA filters from decades ago in their homes, and may not realize they could be harmful when used in donated masks. Fiberglass is still occasionally used in air filtration because it is low cost.

Never buy or accept HEPA filters without materials information

Polypropylene (PP) does not chemically damage the human body as it is “[chemically inert](#)”. Non-woven [PP fibers](#) are used in [N95](#), [surgical masks](#) (USA FDA) and reusable grocery bags. Polypropylene is a nonpolar substance, and repels water droplets. Non-woven PP is currently in [short supply](#) due to the COVID-19 pandemic. **Although it is used in medical grade material and shopping bags which hold food, there are many types of PP.** The big picture is that HEPA or MERV materials advertised as polypropylene and polyolefins are potentially safe, but they can also be dangerous. Experts disagree on the balance of risk and rewards for this mask, more below.

- [Melt-blown PP](#) may cause **respiratory irritation** from [inhalation](#) because it tears easily. Although PP is not chemically reactive, small torn particles can enter the smallest areas of the lungs and can cause lung irritation just by being there.
- [MERV HEPA](#) masks can also flake, and some scientists believe this can be mitigated with a cotton layer. Other mask makers don’t advise it. More below.

Polyethylene (PE) is the most common plastic worldwide, and like PP is a polyolefin. MERV filters such as [this](#) state they use “polyolefins” for their materials which can

include [BOTH](#) PP and PE. This PE [risk profile](#) states that polyethylene is “non-hazardous by normal routes of exposure including skin contact, inhalation and ingestion”. However, in workplace contact with fine dusts of this material can cause “**respiratory irritation**”. This echoes what Dr. Wang, a materials engineer, says [below](#).

Although PP / PE products are chemically safe unless small particles are inhaled, other dangerous materials can be added. This [site](#) sells MERV 13 polypropylene / acrylic filters treated with acrylonitrile. Acrylonitrile is [carcinogenic](#) when inhaled over a lifetime.

Extreme caution must be exercised when evaluating HEPA filters.

Are HEPA Filters safe to use?

There is some new, unpublished [research](#) done by [world renown](#) aerosol expert, [Dr. Yang Wang](#). He explained in the [NYT](#) 4/9/20 that for masks “an allergy-reduction HVAC [HEPA] filter worked the best, capturing 89% of particles with one layer and 94% with two layers”. For similar filters, he recommended a “minimum efficiency reporting value (MERV) rating of 12 or higher or a microparticle performance rating of 1900 or higher”.

Dr. Wang cautions that **there is potential of small fibers being shed, which pose risk when inhaled**, see PE section [above](#). He says to sandwich the filter with 2 layers of cloth to stay safe. It’s important to note Dr. Wang is an [engineer](#), not a physician.

[This](#) modified version of the “Filter Pocket Mask” [above](#) explains how to insert a HEPA non-fiberglass filter. This design removes a layer of cloth for breathability and adds wire to the lower mask border. Video [here](#). As noted [above](#), **ensure the filter is breathable**.

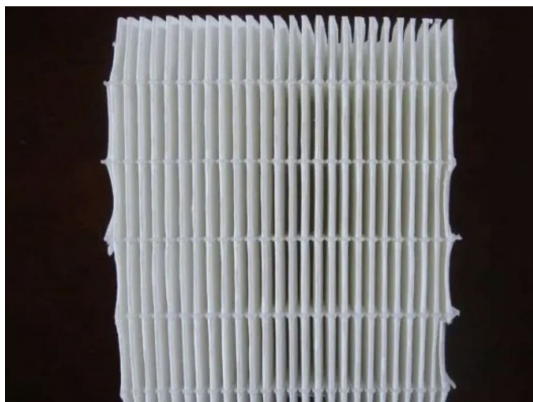
We cannot provide definitive medical advice for the use of air filters in masks due to the variety of definitions, materials and styles which use filters. **As of 4/27/20. Not all vendors clearly list materials used in HEPA filters.** [This vendor](#) selling HEPA “filter bags” does not explicitly state that it uses fiberglass, but the material details overall on this product is limited. This [DIY guide](#) recommends using pleated filters. However, they did not offer evidence-based literature. They also state this mask “should be more than enough to protect you from becoming infected with COVID-19”, which is not true for DIY masks.

Overall, it is difficult to tell fiberglass apart from polypropylene, and even more difficult to tell apart the various types of polypropylene from one another, and the potential carcinogenic additives. Many vendors simply don’t provide adequate information, and may pose a risk.

A deep-dive into the science of HEPA filters

FIBERGLASS

[Some physicians](#) have made warnings that there is fiberglass in HEPA filters and should not be used for COVID-19 public masks. “Fiberglass” is a material which [causes pulmonary issues](#). This [HEPA filter](#), these [disposable air filters](#) and [another HEPA filter](#) are all meant for large air filtration units, and **all use fiberglass**.



Chapter 8 “[Ventilation](#)” in the 2017 textbook “Nuclear Facilities: a Designer’s Guide” offers more information on glass fiber use in air filtration systems.

POLYPROPYLENE (PP)

Engineers responding to the physician’s warning above asserted that **most HEPA filters are made from PP fibers, which are safe**. This [study](#) confirms glass fibers are harmful to humans, but PP fibers are “chemically inert” and doesn’t directly damage human tissue.

This April 2, 2020 [article](#) written by Dr. Peter Tsai, inventor of a polypropylene component of filter media used in medical N95s, affirms the utility of polypropylene N95s during the coronavirus pandemic. He also echoes the above recommendation that this material cannot be sterilized with alcohol for reuse, as it degrades the material. However, he is talking about medical grade layers of PP and not air filters.

PP shopping and conference bags are used in the mask [below](#) by Makermask. Makermasks combine practical understanding of [polypropylene science](#) and the worth of view reusable products. The [Maker Masks](#) below give instructions on [how](#) to make masks with polypropylene shopping bags and conference bags. These bags are intended to carry food, and intentionally have minimal particle sheddings and are designed to withstand washing and disinfection. The pros of this polypropylene material

is that it is hypoallergenic (chemically inert), water-resistant, conducive to mechanical filtration and can be disinfected by boiling.

Some [vendors](#) sell materials with melt-blown polypropylene, which as stated above potentially poses an inhalation risk. Because of this, [some](#) believe the use of melt-blown polypropylene in DIY masks should not be advised. As with all the masks in this guide, definitive medical recommendations cannot be made.

Chapter 10 “[Nonwoven fabric filters](#)” in the 2016 textbook “Advances in Technical Nonwovens” confirms that “Polypropylene (PP), polyethylene (PE), and polyester (PET) fibres are the **three major synthetic fibres** for making filter media of large quantities.” The recent 2019 [materials textbook](#) “Electrospinning: Nanofabrication and Applications” can provide additional information.

HOW TO TELL THE DIFFERENCE

Various vendors advertise that their products do not contain fiberglass, such as the entire [Smart Air](#) site and [169 products](#) from [Air filters delivered](#). The reason fiberglass filters for air purification are still used is because of low price, about 3x less than polypropylene.

Despite Smart Air selling non-fiberglass materials, this vendor does not recommend using HEPA air filters for masks and instead [recommends the use of cloth masks](#) and cites studies mentioned in this manual. This makes sense given **Smart Air is an air filtration company, not a medical organization.**

Innovations in mask-making: new materials

Although the following masks have not been formally studied yet, they have been worked on by expert material and medical scientists for widespread use during the COVID-19 pandemic. These are provided to broaden the scope of materials utilized by mask-makers internationally.

Maker Mask

1. **“Cover”**: non-woven polypropylene shopping bag
2. **“Surge”**: NWPP bags

“The MakerMask project team has reviewed extensive literature on the science and manufacturing of NIOSH-approved respirators. We selected a multi-layered design that balanced increased filtration capabilities with permeability for breathing. Spunbonded non-woven polypropylene (NWPP) outer layers use the same material as used in medical-grade commercial masks, providing a tightly structured filtration layer with water-resistance for blocking droplet transmission. While a meltblown polypropylene inner filter is ideal, international supply chains are disrupted due to the current crisis, so we have substituted a third layer of NWPP. To improve usability for communities with latex allergies against common elastic, as well as to facilitate sterilization, we use finished strips of bias tape or NWPP for tying the mask around the head.

We believe our designs offers a substantial step beyond cotton alternatives and are pursuing rigorous testing to provide data on particle filtration efficiency, fluid penetration resistance, and breathing resistance. Because these are do-it-yourself designs, we cannot control the manufacturing of the masks, but we have worked to ensure that the designs are simple and backed up with good science to ensure the best solution in this circumstance. Even a simple NWPP layer fit over other masks may help reduce instantaneous penetration of aerosols.[3]”

“Cover”: non-woven polypropylene shopping bag

Retrieved from MakerMask:

<https://makermask.org/>

Download the PDF:

<https://makermask.org/wp-content/uploads/2020/03/MakerMask-Cover-Sewing-Guide-rev0-10.pdf>



Materials and Tools

- Pattern (see final page)
- Clean non-woven polypropylene shopping bag (warm wash & low heat dry)
- Straps/Bias tape, 1/2" double folded
- Sewing machine
- Thread
- Scissors, pins, etc.

Step 1: Print and prepare the pattern

Print out the mask pattern on Letter-sized (8.5" x 11") paper. Check that the measurements shown on the reference square of the printed page are accurate – otherwise you may need to adjust your printer's scale settings.

Cut the pattern out. Please note this pattern's seam allowance is 1/4" (6mm).

Step 2: Cutting

Fold the fabric in half. Place the pattern on the folded edge where indicated. Cut mask pattern out of the fabric.



Step 3: Sewing mask body

Sew from the top of the fold to the top of the mask, stitching 1/4 inch from the edge. Then sew seam from the bottom of the fold to the bottom of the mask.

Fold over and sew side hems.



Step 4: Sewing the straps

Note: These instructions are for double-folded fabric tape material creating the strap. If you don't have bias tape, you can make your own straps.

Cut two 36" (91.4cm) long pieces of 1/2" (1.2cm) double-fold bias tape for the head ties.

Unfold the bias tape and position the middle of the tape to the middle of the mask. Sew to the inside of the mask cover, 1/4 inch from edge.



Fold the bias tape over to the outside of the mask and top stitch the full length of the tape to make finished straps.

Repeat for the lower edge of the mask.



Additional Information

The MakerMask:Cover is designed to wear over other masks as a droplet cover to reduce the level of moisture reaching the primary mask. This can help prolong the use of commercially available N95 masks.

Sterilize before use

Masks should be sterilized before use. While autoclaving is ideal, home users can submerge the masks in boiling water for 10 minutes.

Non-woven polypropylene (NWPP) Bags

Despite being called “non-woven”, NWPP is pressed with a cross pattern that gives it a woven appearance. A common source of NWPP is reusable shopping bags. Look for reusable grocery bags with a cross-hatch pattern, no insulation or waterproofing. Hold it up to your nose / mouth, you should be able to breathe through it. NWPP bags can be safely laundered.

Fabric Ties

For securing the mask to the face, bias tape is a great option and commonly found at craft stores. Alternatively, ties may be fashioned from clean strips of NWPP, shoelaces, or other available material that is machine washable and long enough to tie around the head. Elastic may cause severe reactions in individuals with a latex allergy, does not generally hold up as well to the heat of sterilization, and therefore should not be used.



“Surge”: NWPP bags

Retrieved from MakerMask:

<https://makermask.org/>

Download the PDF:

https://makermask.org/wp-content/uploads/2020/03/MakerMask_SewersGuide_0.1.pdf



Required Materials:

- Sewing machine
- Freshly washed NWPP bags
- Bias tape or other ties

- Pipe cleaners or coated paper clips
- Scissors and pins
- Measuring tape or ruler

Gather your materials



Sheets should be 8 inches high by 9 inches wide. Top stitch three layers. Sew 1/4 inch from the edge all the way around. Turn both sides and the bottom in

Fold three sides in approximately 1/2 inch, as shown, leaving the top open for the nose band.

Stitch a seam on these three folds, approximately 1/4 inch from the edge.



Twist two pipe cleaners together. This will allow the mask to be pressed down over the bridge of the nose, forming an acceptable seal.

You can also use coated paper clips for this step.



Cut the pipe cleaners to length



Trim your nose bridge material just shorter than your mask is wide. If sharp ends remain, consider folding over the tips to prevent injury to users.



Fold the unstitched top over the twisted pipe cleaners

Lay the pipe cleaners 1/2 inch from the top edge, fold the fabric over them, and stitch this in place. Stitch the channel closed on both ends.

Make three folds to pleat the mask for expansion



Pleats should be approximately 1/2 inch wide. If it helps, mark lines on your fabric at 1 1/2, 2 1/2, 3, 4, 4 1/2, and 5 1/2 inches from the bottom of your mask.

Fold the 1 1/2 inch line up to meet the 2 1/2 line, crease, and if helpful pin in place on each side. Repeat by folding the 3 inch line up to the four inch line. And finally, the 4 1/2 inch line up to the 5 1/2 inch line.

Stitch these in place by sewing both sides 1/4 inch in from the edge again.



Measure cloth ties for a snug fit. Ties should be long enough to tie behind the head (~12 inches) and hold the mask comfortably to the face. Sew ties to the front of the mask, 1/4 inch from the edge.

Sterilize before each use. While autoclaving is ideal, home users can simply submerge the masks in boiling water for 10 minutes.

University of Florida medical fabric masks

*difficult construction, medical-grade materials

1. Prototype 1
2. Prototype 2

As of May 31, 2020

The makeshift masks use Halyard H600 two-ply spun polypropylene that cannot be penetrated by water, bacteria, or particles. It **blocks 99.9% of particulates**, making the masks about **4% more effective at blocking particulate material than the N95 masks**, according to Bruce Spiess, M.D., a professor of anesthesiology in the UF College of Medicine, who made that calculation based on the manufacturer's specifications.

Both prototypes have been fit tested. We are still refining our designs and assessing which work better for different types of faces. We will update this as we gain experience.



MUST DOs

Demarcate each mask with an ID tag that does not pierce the material. No writing on the material secondary to the degradation of material.

Do not use pieces of fabric that are ripped.

Minimize the use of pins: Better alternatives are paper clips/sewing clip.

The surgical mask information is provided as research information only and has not been tested for commercial use. The design is bare bones and materials should be locally available at hospitals that sterilize equipment. This design is for an **adult mask** for anyone at a higher risk for coronavirus, exposure or concern thereof. The mask information is experimental in nature and the safety or efficacy for use in humans has not been proven. It has been tested using the standard N95 fit test and can fit test pass most people. It should not be used without the wearer N95 fit testing before use. If reused it is advised to use one of the standard CDC N95 mask reuse protocols. The design, and masks built in accordance with the design, have not been approved by the FDA or NIOSH.

Prototype 1

Retrieved from: University of Florida Department of Anesthesiology
<https://anest.ufl.edu/clinical-divisions/alternative-n95-mask-production/#prototype1>

Video tutorial: https://youtu.be/bxA8Xw_S1Go

This mask consists of two layers of HALYARD H600 medical fabric. The blue side is the right side and will face out.

The mask has passed the Respirator Fit Test. Please note that the masks will be sterilized after they are returned to the hospital.



Supplies

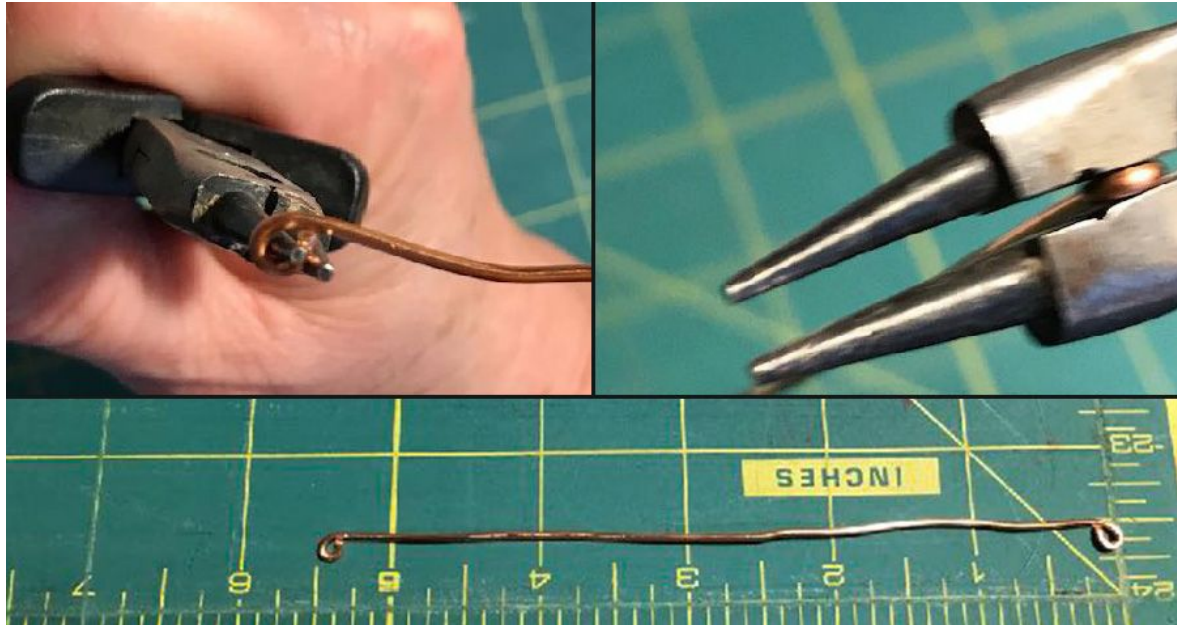
- Medical grade fabric (Halyard H600) supplied by hospital
- One piece of 16-gauge wire (not aluminum as it is too soft)
- 100% Acrylic yarn, size medium # 4 (used for ties)
- Cutting mat, ruler, rotary cutter if available
- Sewing machine, thread, scissors, sewing clips/paperclips, seam ripper (NOTE: please use pins sparingly to avoid holes)
- Jewelry pliers or needle nose pliers and wire cutters

Directions

1. Cut two pieces of the Halyard fabric 7" × 8" (mask body) and two pieces 1" × 36" (tie/binding fabric). The blue side will be the outer side of the mask and the white side the inside of the mask. The 7" sides will be the width across the top and the bottom of the mask. The 8-inch sides will be pleated. Three pleats will make the final mask 4" deep.

2. Layer the 2 pieces of 7" x 8" fabric on top of each other. Sew a 1/4" inch seam on the 7" sides.

3. Turn the mask right side out. Finger press and clip, topstitch 1/4" from both edges on the sides you just clipped.



4.
For
the

nose piece, cut the wire into a 6" piece. Make a small loop on each end of the wire and press flat. See image 1. The loops should be facing the same way. Insert the prepared wire into the 1/4" seam on one of the sides you top stitched. Center the wire. This is now the TOP of the mask.

5. Mark 2" down from the TOP edge of the mask on both sides. Make three accordion-style pleats along the 8" side as follows: Make the 3 half-inch pleats starting at the 2" mark and clip each pleat. Space the pleats one after the other and clip them to make the mask 4" wide.

6. Adjust the pleats accordingly. The pleats do not have to be perfect as long as the mask is 4 inches wide. This is VERY important because if the mask is too short, it won't go under the chin in some cases, and if the mask is too long, it could leave too much of a gap on the side of the face. Do not change the number of pleats as the bottom pleat is especially important to the

curvature of the mask under the chin. See image 2.



6. Sew the pleats down by sewing $\frac{1}{4}$ " seam. Repeat on the other side. When finished, the pleats will all be going down.

7. Cut four pieces of yarn 36" long. Mark the center of the yarn and clip to the center of the mask where the pleats are. Mark the center of the 36" strip and place under the edge of the mask where the yarn is. You want it halfway under the edge. Fold the side of the fabric strip over the top and clip in place (this is the "binding"). Start sewing where the pleats are. As you sew you need to scoot the yarn into the fold of the tie/binding fabric. Use a $\frac{3}{8}$ " seam and stitch down the edge of the mask. Keep folding the fabric in half lengthwise and stitch all the way to the end. Flip it over and sew the $\frac{3}{8}$ " seam all the way to the other end of the strip. To reinforce, sew a second line of stitching on both sides of the mask where the pleats are. Repeat on the other side. Note: the medical fabric does not fray so a single fold is sufficient. See image 3.

Prototype 2

Retrieved from: University of Florida Department of Anesthesiology

<https://anest.ufl.edu/clinical-divisions/alternative-n95-mask-production/#prototype1>

Video tutorial: <https://youtu.be/glmBd704uxE>

This mask is made of 2 layers of HALYARD H600 medical fabric. It has a roundish shape and darts to snug the mask under the chin. There is no binding on this mask. The raw edges are topstitched after insertion of the nose wire and attachment of the ties.

The mask has passed the Respirator Fit Test. Please note that the masks will be sterilized after they are returned to the hospital.

Supplies

- Halyard H600 FABRIC supplied by the hospital.
 - Cut 2 pieces 10" x 6.5"
 - Cut 4 pieces 1" x 20" (these are for the ties)
- MASK TEMPLATE provided for a pattern
 - Thick card stock or other material to make a firm template for tracing
- 100% ACRYLIC YARN, size medium #4
 - Cut 8 pieces 20" (used for the ties)
 - Note: We are testing materials to make this easier, but for now this is how we are doing it. The strength of the ties is critical to get a snug fit. (We have tested Double zig zag stitching without yarn and it does not work...)
- 16 GAUGE CRAFT WIRE for the nose wire.
 - Cut 1 piece 5". Make a loop at each end of the wire. All loops should face the same way. Press the loops flat with your pliers to make sure there are no sharp edges sticking up. (Loops are needed to keep the wire from poking through the fabric.)
 - Note: If you don't have 16-gauge wire, use 20-gauge wire, but cut 3 pieces, make a loop on all ends.

TOOLS

- Sewing machine that can do a straight stitch and zig zag stitch. Your presser foot needs to be able to accommodate the zig zag stitch.
- Ruler
- Scissors
- Pins or clips
- Jewelry pliers that have tapered round ends and cutter or needle nose pliers and wire cutters
- Ink pen to trace the pattern onto the fabric
- EXTRA HELPFUL: cutting mat, long ruler and rotary cutter!

MACHINE: Setting: 2.5 stitch length or whatever the “normal” stitch is for your machine. The zigzag stitch setting used is 2.0 length and 7.0 for width. If your machine does not go to 7 for a width, use the widest setting.

Directions

Step 1: Mask Template.

Print the template and glue to a thin cardboard such as a cereal box or card stock or use template plastic. The thin “cutting mats” are also good template material. Trace the pattern onto a 10” x 6.5” piece of fabric. Carefully cut it out. There are cutouts for the 2 darts. Cut out the darts on the solid line. DO NOT CUT OUT THE TIE PLACEMENT MARKINGS. Layer the 2 mask pieces and clip.

Step 2: Making the mask ties and attaching to the mask.

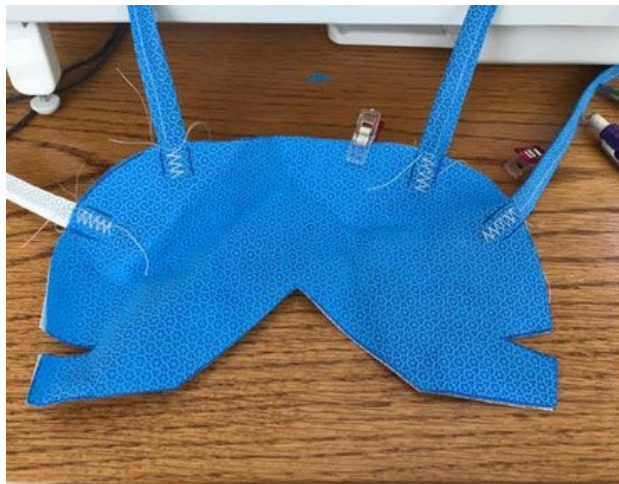
Take a piece of the 20” x 1” medical fabric and 2 pieces of yarn. You will be folding the fabric in half lengthwise, tucking the yarn into the fold and sewing with a 3/8” seam. As you sew, continue tucking the yarn into the fold until you reach the end. Repeat until you have 4 ties. (We like to sew at an angle across the end of the tie to secure the yarn. Do not worry about the first end as it will be sewn into the mask.)

Step 3: Set your machine for ZIGZAG stitch to attach the ties.

We used 2.0 for the stitch length and 7.0 for the stitch width. The darts should be cut out and you should have markings for placement of the ties.

Tip: Make a second template and only cut out the tie placement marks. Lay it on the blue side, making marks for easier placement of the ties.

Place the squared end of the tie 3/4" in from the edge, between the 2 layers at the notch, LOOK at the template to make sure you place it in the correct place. Hold together and place under the presser foot. Zigzag stitch from the outside edge of the mask to the end of the tie that's between the layers; reverse stitch back to the starting point of the stitching. Carefully place and zigzag stitch each tie.



Ties Attached



Darts Sewn

Step 4: Darts and partial topstitch of the mask.

Next, sew the darts. **NOTE: SEW THE DARTS ON THE BLUE SIDE!** The dart seams will show on the outside of the mask. Fold and sew each dart using a tapering seam from the narrow point of the dart to the bottom ending with 1/4" seam. Backstitch at the beginning and end.

When the darts are completed, sew a 1/4 topstitch from one corner of the mask around to the other corner folding the darts up toward the top as you sew. (Sew from point A through AB and to point B). **The other seams are left until last so the nose wire can be inserted.**

Step 5: Insert the wire.

Your prepared wire should be about 4.5" long. If it is longer, you may need to adjust it as it needs to fit between the ties sewn into the mask. Push it all the way up to the seam made when you topstitched the two layers together and used clips to hold it there. Now you will CAREFULLY sew a 3/8" topstitch from Point C to Point D between where the top 2 ties are sewn in. Position the presser foot so the right edge is on the line of the 1/4" topstitching so that you are encasing the nose wire within the 3/8" seam. You want to go slowly so you can control where the wire is. You don't want a broken needle!



Note: If using 20-gauge wire, be sure to make that loop at each end of all wires and push and clip all 3 into position. All ends must have a loop: We don't want to injure health care providers!

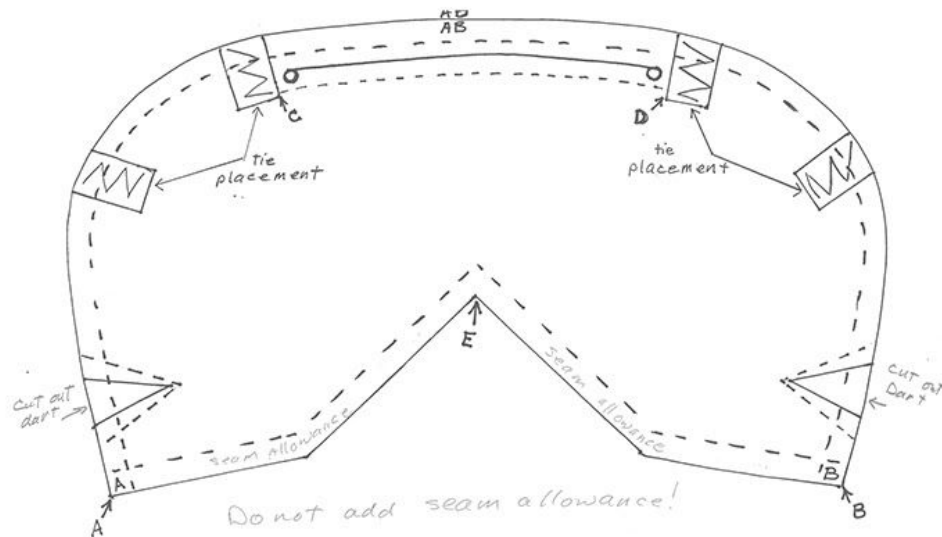
The wire is inserted between the top two ties. Stich a 3/8" seam to encase the wire.

Step 6: Sew the outside seams.

You are going to sew on the blue side so that the seams will be on the outside of the mask. Slightly bend the nose wire so you can line up the remaining seams and clip, blue side out.

Using a 1/4" seam, backstitch at the beginning (Point E), sew to 1/4" from the corner, turn the mask and sew to the end and backstitch. Trim the seam to 1/8" inch to trim it up a little.

Now you will sew a 1/4" topstitch on the outside edge from one dart across the seam you just made and across the other dart. You are done!



Homemade Cotton Mask for Deaf and Hearing Impaired

Made by the [DHH Mask Project](#)

This mask design has been featured in [CBS News](#), [Huffpost](#), and [Forbes](#).

If you are a part of the Deaf or Hard of Hearing community and would like to request a mask, please reach out to us a dhhmaskproject@gmail.com.

Thank you for your outpouring of love and support. We never expected the magnitude of interest we received when we decided to adapt the cotton mask, everyone is making for personal use, to the deaf and hard of hearing community. It would be quite impossible for us to fulfill all the requests we have received from all over the world. So, we challenge you to join us in making these masks.

We used materials we had on hand in our home and would like to be very clear these are **NOT medical grade masks, they are NOT FDA approved, and they have not been tested in any way**. The choice to make and wear these masks is your own.

The full guide can be found here:

<https://drive.google.com/file/d/1Pk7hMTtOEQ6BIIUys82RAuDs7oxD7fe4/view?fbclid=IwAR1lrqn7SbWRwMEI2cBg8PMgzUuu71NU-zsiufodOLVfFzeeDw9yfaSSJQ8>



The making of an N95

An N95 becomes FDA, CDC & Niosh approved after having met 4 core requirements: filtration, polarization, seal and fit.

Filtration: The polypropylene N95s filter 95% of airborne particulate matter [greater than .3 microns](#) (300 nm) in diameter. Filtration efficacy does not directly translate into exposure reduction for individuals.

- *N95 filtration material is a sophisticated medical-grade product, made from layering and polarizing polypropylene.*

Polarization: N95s contain an [electrocharged layer](#). The charges on the mask trap aerosol droplets, preventing them from entering the user's mouth. The process of polarization is through a complex industrial electrospinning process.

- *It's important to note this polarization increases the importance of sanitary mask removal, and the clinical potential of cloth masks to protect N95s.*

Seal: It is essential that N95s have complete contact with the skin in order to prevent inflow or outflow through the sides of the mask. N95s achieve a tight but breathable seal.

- *N95 material balances filtration and pressure gradient to ensure the wearer can physically breathe in the mask while maintaining a constant seal.*

Fit: N95s become FDA, [NIOSH-approved](#) by passing a respiratory seal test. NIOSH N95s come in different sizes, and healthcare professionals in the U.S. report to yearly [fit-testing](#) to make sure their size assignment is correct. This is a highly intentional process, in which the wearer performs different physical and respiratory maneuvers to ensure the mask does not break contact with the face.

- *This process is so sensitive that many [facial hair](#) styles prevent full air-tight seal protection, and folks who want to grow beards need to defer to larger respiratory units which covers the wearer's entire head.*

Non-NIOSH approved N95 masks each miss **essential protective components of N95 masks: medical-grade polarized & high filtration material, consistent seal and personalized fit**. N95 masks are optimized from a medical standpoint to balance protection and breathability. The industrial process to meet these protection measures is time-consuming, costly and highly specialized. Masks claiming to provide N95 / N99 protection are not citing from the formal scientific literature, and are not selling masks that correlate with the product descriptions or offer the protection the buyer may think they are getting.

Below are some examples of products which claim to be synonymous with N95s.

Carbon Filters: The False Claims of N95 / N99 Protection

Carbon filters have been advertised on most major social media platforms as providing such exceptional coverage that quarantine measures and hygiene can be relaxed. Despite the lack of peer reviewed research for this product, carbon filters have lit up the world of purchased advertised space. Many of these websites state their products are “N99” and “better than N95s” and go so far as to mention CDC recommendations within the advertising. Despite the extravagant claims made by vendors, carbon filters for mask use as of 4/27/20 has not been shown by formally peer-reviewed literature to perform at the level advertised. Two examples are given below to highlight the lack of evidence-based research in the mask economy: Men’s Journal advertising and Cambridge Mask Co’s products.

The advertising of carbon filters

The website “Men’s Journal” released an undated article named “The Best Carbon Filter Face Masks You Can Buy Right Now at Amazon”, with a clear advertisement disclaimer. The site claimed that “If you want real protection without using a vital (and scarce) N95, you need a carbon filter face mask.” The author elaborates saying:

“If you’re feeling overwhelmed by all this social distancing, or if you’re just cooped up for too long, order a carbon filter face mask (or several!) from Amazon today. You’ll get them within a week or so, and you’ll feel safe knowing you can go outside and run, bike, or just enjoy a nice long walk in the springtime sun.”

It is important to emphasize that virtually all of the published literature on coronavirus disagrees with this statement. Wearing a mask will not protect individuals with coronavirus. It is not medically advised to leave the house for recreational activities. The definitive methods to defeat this virus, save the most lives and protect yourself is to social distance, stay in quarantine, keep up responsible hygiene and wear masks. Masks will not be sufficient.

Note that the heavy-handed and uncited article (advertisement) directly generates revenue for the “Men’s Journal” site, as stated directly on the page:

Men’s Journal aims to feature only the best products and services. We update when possible, but deals expire and prices can change. If you buy something via one of our links, we may earn a commission.

Per our nation’s emphasis on capitalism, uncited claims can be made on the effectiveness of a product if it is agreed on by the consumer and the advertiser that what is being sold is not a “medical product”, it is a non-FDA or CDC supervised “advertised” item. However, these adjuncts inherently undermine the claim that the

product is up to clinical gold standards which define evidence based medicine in the United States. Carbon filter masks are simply not NIOSH N95s.

The tension between freedom to advertise and responsibility to the truth has been playing out on an international scale during the coronavirus pandemic. However, a cooperation between vendors, consumers and scientific authenticity could lend itself to collective protection and health during COVID-19 and future pandemics.

What does “government standard” mean?

The “PM2.5” filtration power of carbon filter masks corresponds to a 2.5 micron (250nm) filtration cut off. For context, the N95 uses .3 microns as a cut off. The “PM2.5” filtration feature is cited by manufacturers such as [Cambridge Mask Co.](#) as [evidence](#) for the efficacy of their masks.

Cambridge Mask Co. claims that the “Military grade filters used in the Cambridge Mask Pro meet the N99 Standard (higher than N95). This is the Government standard specification for pollution masks. The masks use a triple-layer filter which protects the wearer from an extensive range of airborne contaminants.”

The statement above is intentionally misleading. The reader now believes this product is “better than N95”, ie. better than the dominant NIOSH-N95 standard cited in millions of media publications globally. However, the statement is noticeably missing the FDA, CDC and NIOSH approval of filtration, polarization, seal at fit which defines 95% protection against coronavirus.

Upon reading the finer print, the PRO Cambridge Mask is described as having been “independently tested by Nelson Labs of America, a US FDA facility which does testing for the National Institute of Occupational Safety and Health (NIOSH) compliance.” Although this statement is correct, it is again misleading. The masks advertised on the website *do not perform as well as or better than N95 masks*. Nelson Labs is a private Utah-based company which does testing for various scientific, governmental and academic clients. However, *Nelson Labs is not a vendor* on the [CDC suppliers](#) list, and does not sell N95 products to the federal government. The implication that the masks sold on this website were “government standard” by proxy of a large testing organization is inaccurate.

The role of Nelson’s Lab in the formulary of this mask is to verify that ¼ of the NIOSH tenants (filtration, polarization, seal and fit) are met in regard to *filtration efficacy*. This is backed up by the company’s assurance that their products pass the “NIOSH N99 filter requirements”, but not any of the other metrics which make a NIOSH N95 mask.

Even with the promise of high filtration, the assertion that the masks accomplish 99.6% filtration of “viruses” and 99.77% filtration of “bacteria” is a disconcerting claim given that no primary literature was cited. Without the original data set and primary literature, the claims are unsubstantiated. The fact that a fabric (when working optimally) filters out a large percentage of airborne particles *does not make the mask itself 99.6% effective in filtering out coronavirus*. As studied by scientists in formally peer-reviewed and published literature above, the efficacy of high-filtration PM2.5 carbon masks is of extremely variable quality and definitively does not provide the implied 99% protection advertised on Cambridge Mask Co.

The utility of carbon filter masks

The carbon filter mask is not a bad mask. It is actually quite good as far as non-medical grade products go for personal protection. It is not dangerous like fiberglass HEPA filters, or chemically hazardous like blue shop towels. In fact, some carbon masks have been certified as child safe. Carbon filter masks have the potential (but not inevitability) to protect more than the safe and reliable “quilted” cotton. Carbon masks are used on an international scale to offer protections to millions of people living in loci of urban pollution and dense populations. Carbon masks can be especially useful if offered in various sizes and fit tested on individuals.

In all, the carbon mask is not an inherently bad product. Carbon masks could serve some utility from a public health standpoint if used responsibly and in conjunction with social distancing, quarantine and hygiene.

However, the fundamental issue with carbon filter masks within medical and epidemiological context is statements like this: “Filters meet N99 standard, filtering 99.79%+ of particles as small as PM0.3, outperforming N95 masks.”

Carbon filter masks will never holistically “outperform N95 masks”, and this claim is inherently false until demonstrated directly by the FDA and the CDC that the masks on the Cambridge Mask Co. meet NIOSH-n95 standards. Based on primary research done on carbon masks with PM2.5 capacity, this claim is also directly contradicted in peer-reviewed primary literature.

Additionally, the emphasis of carbon mask vendors regarding the supremacy of their products will only stoke the global market of desperation. The [founder](#) and CEO of Cambridge Mask Co. during an [interview](#) with BNN Bloomberg in March 2020 compared different types of non-medical masks: “You can have a full face thing with military technology and will pretty much filter everything under the sun. Or, you can have a little

piece of paper surgical mask or cotton fabric which of course isn't going to do a lot for you."

The assertion that "a little piece of paper surgical mask" isn't "going to do a lot" undermines the fact that surgical masks are not made from paper, they are made from a complex layering of medical grade polypropylene. As shown above, paper towels and surgical masks are fundamentally different materials. Additionally, the assertion that "cotton fabric" isn't "going to do a lot" undermines unpublished research previously discussed which shows quilter's cotton has the filtration potential of 78%. As explained below, primary literature on consumer PM2.5 carbon masks demonstrate an actual filtration range of 71-99.74% filtration. This hardly offers coverage from "everything under the sun."

The fundamental issue with carbon masks is the marketplace of desperation it forces upon consumers. These vendors "advertise" without evidence that their masks are of a higher efficacy than all other products citing virtually no research evaluated by an academic peer review board.

The issue with centering carbon masks as superior to medical grade products arise from a cost-benefit, sustainability and scientific analyses.

1. Cost-benefit: The current [prices](#) in the United States allocated to these "fast fashion" products do not correlate with the adequacy of protection claimed. It could potentially waste the shrinking and valuable resources of an unstable global economy during the COVID-19 pandemic. Generating higher quality and cheaper masks would be a high yield utilization of resources for collective health.

2. Sustainability: A major downside of the carbon filter mask is that the filter expires and must be changed out consistently. They also [cost](#) a good amount. Although this offers the option of regular washing and increased mask hygiene, the filter itself inherently is unsustainable. More on activated carbon filters ***.

3. Scientific analysis: When held up to scientific scrutiny, the claims of carbon mask filter masks as synonymous with N95 masks fall flat.

- A 2018 Beijing [study](#) evaluated the effectiveness of masks "claiming protection against fine PM (PM2.5)." The researchers found the following data for 9 types of Beijing consumer outlet "black carbon" (BC) masks:
 - Percent penetration (100% - filtration %) ranged from 0.26 to 29%, depending on the *flow rate* and *mask material*.

- This means that with high quality, low flow rate and newer carbon filters, the carbon masks filter quite well.
- These data also indicate that the filtration rates with worn out masks combined with a high flow rate renders the material only capable of 70% filtration. Thick, quilted and high thread cotton achieves better coverage at 78%.
- Average total inward leakage ranged from 3-65%. Only one mask provided more than 90% protection from inward leakage.
 - This means at best the carbon filter mask has a seal and fit necessary for protection against 97% of inward airflow, and at worst a carbon filter mask only protects against 35% of inflow. An inward leakage of 65% renders a mask fundamentally unable to protect against a highly protective virus, regardless of the potential filtration efficacy.
- Given the objective data, PM2.5 masks do not perform at the level of an N99 mask, and in some cases perform more poorly than surgical masks and quilter's cotton. The researchers conclude that "further attention" should be given to mask design and "providing evidence-based guidance to consumers."

The Beijing "black carbon" mask studied above is synonymous with the U.S. ["carbon black" masks](#) which claim >99% Particle Filtration Efficiency (PFE). The "activated carbon" masks such as the Cambridge Mask Co. [PRO N99](#) above are advertised as a step up from "carbon black" masks using the [following reasons](#). Researched addendums to the assertion Cambridge Mask Co. masks "outperform" N95s are provided.

1. The 100% pure activated carbon was "developed by the UK Ministry of Defence for chemical, biological and nuclear warfare protection."
 - a. Activated carbon is a commonly used filtration material; its development by the UK Ministry of Defense does not mean the product is medical grade or comparable to an N95.
 - b. The website states that Cambridge Mask Co. holds "exclusive global rights for this material for use in a consumer pollution mask." This renders it inherently unable to compare to other masks.
2. Activated carbon adsorbs gaseous molecules, including anions and cations into their internal pores.
 - a. This is a strength of the Cambridge Mask Co. mask, and it emulates some of the polarized properties of N95s in that it allows viruses to be drawn into the mask and trapped.

3. The carbon filter is “treated with silver to ensure 99% of harmful pathogens are removed and killed.”
 - a. Silver as an antiviral objectively does not ensure the elimination of “99% of harmful pathogens”. If silver killed 99% of pathogens, medicine on earth would be fundamentally different. Although silver has been shown to have some [antibacterial properties](#) when used in masks, the discourse surrounding antiviral protection is much less straight-forward.
 - i. Silver has [not](#) been shown to be effective against coronavirus.
 - ii. Assertions that silver is antiviral are made by non-FDA regulated self-defined “natural” [vendors](#).
 - iii. The sale of products which claim to prevent coronavirus has been condemned by the FDA. The FDA sent [formal warnings](#) to 7 companies mandating a cease sale of products claiming to “treat” coronavirus. These included teas, essential oils, tinctures and colloidal silver products.
 - iv. Many silver products such as colloid silver are dangerous to ingest and apply to skin.
 - v. There is [some literature](#) which shows the potential of silver as an antiviral agent, but virtually no research available on the efficacy of silver in masks to “remove” or “kill” viruses.
4. PM.03 is used as the cut-off standard as opposed to PM2.5.
 - a. This increases filtration by a margin, but does not significantly increase the overall safety of the mask.

In good faith in the medical and collaborative potential of innovation, this guide hopes to challenge vendors, researchers and purchasers to achieve adequate universal precautions at a price margin which prioritizes human life and revitalizes the economy. If the 4 principles of coverage (filtration, polarization, seal and fit) are met and proven in the literature, then our entire world will be healthier.

Please [contact](#) the author to collaborate if this mission aligns with your core messaging.

Guidance for sewers, physicians and healthcare leaders on homemade cloth masks for clinical use

Retrieved from OCMS Face Masks public access doc, modified for this manual:

<https://docs.google.com/document/d/1TKkGWLQcFaQYyN9Nlyd8gkdkgCkhHmWns3ZEclbOJsQ/edit#>

CDC Stance on Sewn Masks: The Center for Disease Control notes that [fabric masks are a crisis response option when other supplies are not available](#).

Tips on Fabric Masks

- Fabric masks provide different levels of filtration depending on the materials used. Please see the research overview [above](#) for levels of filtration. All homemade designs are to be used at provider's own risk.
- Clinicians should **consider using multiple masks over an 8 hour period if using woven fabric alone** (and not over existing PPE to protect against soiling).
- Store similar to N95s. Allow the mask to hang in a designated area or place the mask in a paper bag and labeled - with one mask per paper bag. Launder after each use or boil (more [hygiene](#) information above).
- Almost any [breathable](#) design that fits over a respirator and can be worn securely can be used to protect an N95 respirator from soiling, in turn potentially prolonging its availability for use as PPE.
- **When making masks to protect PPE:**
 - 1) Lighter colors are better because they make it easier to see soiling
 - 2) Use no more than 2 layers for this as [no filtration](#) is needed - the goal is protection from soiling
 - 3) Ensure coverage if using over an N95 (these come in several sizes and from different manufacturers)
 - 4) Fit is important. [Ties that go around the back of the head are preferred](#)
 - 5) No latex should be used for clinical settings - elastic discouraged.
 - 6) Using different colors on the front (outside facing; lighter is better) and back (inside facing) part of the mask is ideal so that the sides can easily be recognized.

Donations and Resources

Please reach out to local hospitals, shelters, clinics, places of worship, community centers, trusted non-profits and mutual aid networks for information on how to donate your hand-made PPE. Although the schemas used in this manual have been requested by hospitals nationally, local regulations, needs, and resources may differ.

Comprehensive information on which hospitals are accepting handmade masks:

<https://docs.google.com/document/d/12a5YO0Z9RpHZk9Zkz4l4NOj9CbzhFfoKjPLFFC-21LU/edit>

International PPE Exchange: <https://covid19masks.info/webapps/f?p=2222:1>

Relief Crafters of America: <https://www.facebook.com/groups/reliefcraftersofamerica/>

Guidance for individual sewers on how to donate to hospitals:

<https://docs.google.com/document/u/2/d/e/2PACX-1vQVnocKNgEPNSC4DRp0QV-kKfSrPmVMsczMuq1kclUxNA8DmvG5PS5S0e8zuPRFNe0VnlGzd6segMsl/pub>

Comprehensive, collaborative literature & tutorial review:

https://docs.google.com/document/u/0/d/16cweIYIJ0SuC1LKU_BkibrqlyFG4x-jgiD2_Is9S7U/mobilebasic

Tutorial on how to verify real N95s:

https://docs.google.com/document/d/1ZShy_hrXvgpdyX-zFlxFTscosOI4GPvg7pCP3WYhts/edit

Guiding Principles for Avoiding Disability Discrimination in Treatment Rationing:

http://www.bazon.org/wp-content/uploads/2020/04/4-3-20-Guidance-to-States-Hospitals_FINAL.pdf

Coronavirus Guidance for Patients Engaged in Substance Use Treatment:

https://medicine.yale.edu/intmed/genmed/addictionmedicine/Patients%20Yale%20ADM%20COVID-19%20Guidance_032620_380628_5_v2.pdf

Project LETS is a national grassroots organization and mutual aid network which advocates for Disability Justice. [Reach out](#) to support or be supported.

JOANN Fabric is giving out FREE materials: [JOANN's](#) is distributing PRECUT masks, **MATERIALS AND ELASTIC INCLUDED**. 5 per person.

Note there have been [concerns](#) over the quality of fabric offered and worker safety. “[Simple Coverage Mask](#)” is used, and is featured in [USA Today](#), [CNN](#) and [LA Times](#).



Boston Mutual Aid Networking & Physician Advocacy

As of 4/27/20

There is no national-level or global effort to ensure every individual has masks.

If you are an organizer, a political figure or a mask creator, consider facilitating sanitary mask distribution.

Grassroots

Boston Mutual Aid Hotline: +1 (857) 302-2742

- To volunteer click [here](#)

[Request](#) & [Volunteer](#) resources

[How to Deliver Supplies Safely](#)

[List](#) of non-hospital organizations in Boston that need PPE

[Project LETS](#) helps provide PPE for immune compromised & high risk folks with mutual aid fundraising in the northeast.

Boston Mutual Aid [resources](#) (draft)

Feminine Empowerment Movement ([FEMS](#))

Free flyering & PSA Artwork: [Amplifier](#)

- [Mutual Aid Hero](#) example to the right

Physician Advocacy

[Covid Action Committee](#)

- MA Department of Public Health [governor letter](#)
- [Facebook page](#)



Contact information

Thank you for reading & saving lives.

Thank you to the hundreds of scientists, physicians, design artists, grassroots sewers and journalists who made this collective body of work possible.

For resource, suggestions or other inquiries, please email

Casey Orozco-Poore (research author & illustrator): Casey_Poore@hms.harvard.edu

Click [here](#) for more information regarding the Harvard Medical School Student Covid Response.



[“Por Nuestro Pueblo” on Amplifier](#)