

Q&A COVID-19 VACCINES: WHAT YOU SHOULD KNOW

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In late 2019, a novel coronavirus, SARS-CoV-2, was identified in China. The virus had two important features. First, it could infect people. Second, infected people could easily spread the virus to others. These characteristics set the stage for a COVID-19 pandemic, or worldwide epidemic, which was declared by March 2020. Knowing the important role for prevention, work to develop COVID-19 vaccines started immediately. With unprecedented speed and fortuity, the first vaccines were ready by December 2020. Because vaccines typically take years — if not decades — to create, some wondered whether this shortened timeline affected COVID-19 vaccine safety. Importantly, steps were not skipped. Two reasons for the speed were *resources* and *processes*. More resources than ever in history were dedicated to vaccine development. Likewise, processes typically completed one after the other were completed at the same time. So, instead of the steps occurring like the cars of a train going down the tracks, they were more like vehicles traveling on a multilane highway.

COVID-19 MRNA VACCINES (e.g., Pfizer and Moderna)

Q. What is mRNA?

A. mRNA stands for messenger RNA, which is the blueprint for making proteins. DNA, which lives in the nucleus of cells, makes mRNA and ships it outside the nucleus to the surrounding cell cytoplasm. Once in the cytoplasm, mRNA is translated into a host of cell proteins and enzymes. Because our cells make proteins all the time, they also make mRNA all the time. Soon after making proteins, mRNA breaks down.

Q. How do mRNA vaccines work?

A. COVID-19 mRNA vaccines take advantage of the cellular process of making proteins by introducing mRNA that contains the blueprint for the coronavirus spike protein. This protein attaches coronavirus to our cells, so by preventing virus-cell attachment, we can prevent coronavirus from infecting our cells. The mRNA delivered in the vaccine is taken up by specialized cells of the immune system, called dendritic cells. These cells make the spike protein and put small pieces of it on their surface. The spike-protein-decorated cells then travel to a nearby lymph node and stimulate other cells of the immune system. Antibodies made as a result of this process prevent



virus-cell attachment in the future.

Watch an animation on the Vaccine Makers Project YouTube channel, bit.ly/3TOvXYH.

Q. Do COVID-19 mRNA vaccines work?

A. mRNA vaccines prevent severe COVID-19 in more than 9 of 10 vaccinated people. To date, mRNA vaccines have been effective at preventing serious illness caused by newer variants, but they continue to be monitored.

COVID-19 PROTEIN-BASED VACCINES (e.g., Novavax)

Q. How do protein-based vaccines work?

A. Protein-based vaccines have been used for decades to prevent diseases like influenza, hepatitis B and shingles. These vaccines work by delivering the protein of interest (e.g., the spike protein from the virus that causes COVID-19) directly, so our cells do not need to produce it. Our immune system recognizes that the protein is “foreign” and becomes activated. Specialized immune system cells, called dendritic cells, take pieces of the protein to nearby lymph nodes to activate other cells of the immune system, creating a short-term “takedown” of the foreign protein and longer-lasting immunologic memory that can protect us during future encounters.

Watch an animation about the adaptive immune system on the Vaccine Makers Project YouTube channel to see this process in action, bit.ly/3Qv3Gb4.



Q. Do COVID-19 protein-based vaccines work?

A. Yes. In clinical trials, the COVID-19 protein-based vaccine, known as Novavax, prevented severe disease and hospitalization in about 9 of 10 vaccinated individuals and about 8 of 10 people 65 years of age and older.

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COVID-19 ADENOVIRUS-BASED VACCINES (e.g., J&J/Janssen and AstraZeneca)

Q. How do adenovirus-based vaccines work?

A. Adenoviruses are a family of viruses that can infect people and some animals. Some types cause the common cold, while others do not cause illness in people. COVID-19 adenovirus-based vaccines take advantage of these relatively harmless viruses to deliver the DNA for the spike protein of the coronavirus that causes COVID-19. The adenovirus used in these vaccines has been altered so that it cannot reproduce in people; as a result, people who get the vaccine do not develop an adenovirus infection. The DNA for the spike protein enters the nucleus of specialized cells of the immune system, where it is used to make mRNA that is released into the cytoplasm. The mRNA serves as a blueprint for the cell to make the spike protein. Pieces of the newly produced spike protein are put on the surface of the cell, which then travels to a nearby lymph node and activates other immune system cells.



Importantly, this process cannot change the DNA in our cells.

Watch an animation on the Vaccine Makers Project YouTube channel, bit.ly/3Adn3ia.

Q. Do COVID-19 adenovirus-based vaccines work?

A. In clinical trials, the adenovirus-based vaccines prevented COVID-19 infection in 7 or 8 of every 10 vaccinated people, and they prevented hospitalization and death in all vaccine recipients. They continue to be highly effective at preventing serious illness caused by COVID-19 variants, but their use has been limited by some rare but serious side effects. (See “COVID-19 vaccine safety” section.)

COVID-19 VACCINE RECOMMENDATIONS

Q. If I had COVID-19, do I need the vaccine?

A. Yes. People who had COVID-19 are recommended to get the vaccine after they have recovered. Evidence suggests that the vaccines more consistently provide greater levels and a wider breadth of immunity than natural infection.

Q. How many doses are needed and when?

A. Recommendations for additional doses of COVID-19 vaccine are based on an individual’s immune status, age, and type of COVID-19 vaccine(s) received previously. Because of the variety of factors that are considered, booster recommendations vary between individuals. As such, it is recommended to check with your healthcare provider to get the latest information.

Q. Who should get the COVID-19 vaccine?

A. Because SARS-CoV-2 virus can affect all people in all age groups, most people should get the COVID-19 vaccine.

Q. Who should NOT get the COVID-19 vaccine?

A. A few groups should not get the vaccine, and some others should consult with their doctor or follow special procedures.

People who should NOT get the COVID-19 vaccine:

- Anyone with a severe allergy to a vaccine component (i.e., one that causes anaphylaxis or requires medical intervention). These individuals may be able to get another type.
- Those younger than 6 months of age.
- People currently isolating or experiencing symptoms of COVID-19. These people can get vaccinated once they have finished isolation and their primary symptoms have resolved. But since they will have short-term protection, these individuals may opt to wait for at least three months before getting another dose. Some evidence suggests the delay allows for stronger immunity when they are vaccinated.

People who may get the vaccine after considering risks and benefits and, if needed, consulting with their healthcare provider or who should follow special procedures:

- Individuals with a history of severe allergy to any vaccine or injectable medication – If vaccinated, these individuals should stay at the vaccination location for 30 minutes after receipt of the vaccine.
- People with a known COVID-19 exposure should wait until their quarantine is over before getting vaccinated (unless they live in a group setting, in which case they can be vaccinated during the quarantine period).
- People who experience the rare, but severe, side effects of COVID-19 vaccines (myocarditis, TTS, or GBS), or who have a recent history of MIS-C or MIS-A, should consult their healthcare provider regarding receipt of further doses as well as the timing and type of vaccine for future doses.

Q. Which version should I get for the third dose?

A. It is preferable to get the same version when possible, but in some cases a different version may be more appropriate:

- People who originally received the J&J/Janssen or Novavax vaccine are recommended to get an mRNA-based version.
- People who had a severe allergic reaction to a dose in the original series may be advised to get an alternate version.
- If supplies are limited, an individual may opt to receive a different version.

Q. Can pregnant women get the COVID-19 vaccine?

A. Yes, data from thousands of pregnant women who received the COVID-19 vaccine have shown it to be safe for pregnant women and their unborn babies. Given that pregnant women diagnosed with COVID-19 are at increased risk of suffering severe illness, vaccination is particularly important for this group. Importantly, if a pregnant woman develops a fever as a side effect of COVID-19 vaccination, she should take acetaminophen as fever during pregnancy can negatively affect a developing baby.

Q. Can I get the COVID-19 vaccine while breastfeeding?

A. Yes. Studies of both COVID-19 disease and vaccination have shown that antibodies are transmitted through breast milk. On the other hand, the vaccine components would not be expected to be transmitted based on how the vaccines are processed, and the virus is not transmitted through breast milk as determined in studies of women who breastfed before realizing they were infected. For these reasons, women do not need to delay breastfeeding after they have been vaccinated.

COVID-19 VACCINE SAFETY

Q. Can I spread the virus after getting COVID-19 vaccine?

A. No. None of the COVID-19 vaccines used in the U.S. contain live virus. Additionally, since both types that deliver genetic material (mRNA and adenovirus-based) only include information for the spike protein, neither can lead to production of whole viral particles. As such, vaccinated people cannot shed the virus.

Importantly, however, if vaccinated people get infected, they may shed small quantities of the virus from their nose in the first few days before their immune response can stop the infection. Whether enough virus would be produced during this time to infect someone else depends on a variety of factors, including how much virus they produce, how transmissible the virus is, and how close they are to others during this time. However, even in this scenario, an infected vaccinated person would be expected to shed much less virus over a shorter period than an infected unvaccinated person.

Q. Can COVID-19 vaccines change a person's DNA?

A. No. In order to alter someone's DNA, several events would need to occur. None of the COVID-19 vaccines meet all of the criteria necessary for altering a person's DNA:

- Ability to enter the nucleus – mRNA vaccines do not have the nuclear access signals that would allow mRNA to enter the nucleus. The adenovirus vaccine DNA does enter the nucleus but does not meet other necessary criteria for altering a person's DNA. Protein-based vaccines do not deliver genetic material, so they can't enter the nucleus.
- Presence of an enzyme called integrase – This enzyme is required for DNA to insert itself into a cell's DNA. Adenovirus vaccines do not include this enzyme.

Q. What ingredients are in the COVID-19 vaccines?

A. The types of ingredients are described below:

mRNA vaccines

- mRNA – The mRNA is for the spike protein of SARS-CoV-2, the virus that causes COVID-19.
- Lipids – These are molecules that are not able to dissolve in water. They protect the mRNA so that it does not break down before it gets into our cells. These lipid particles can be thought of as little “bubbles of fat” that surround the mRNA like a protective wall and make it easier for the mRNA to enter cells.
- Salts – Salts, similar to table salt, are used to keep the pH of the vaccine close to that found in the body, so the vaccine does not damage cells when it is administered.
- Sugar – This ingredient is the same as the sugar you put in your coffee or on your cereal. In the vaccine, it helps keep the “bubbles of fat” from sticking to each other or to the sides of the vaccine vial.

Adenovirus-based vaccines

- Adenovirus – The J&J/Janssen vaccine contains a human adenovirus, known as Ad26, and the AstraZeneca vaccine contains a chimpanzee adenovirus. The adenovirus has been altered so that it cannot replicate in people.
- Stabilizers – These include salts (including table salt), sugars, alcohols, polysorbate 80, and hydrochloric acid. These contribute to keeping the vaccine effective during transport and storage.
- Manufacturing by-products – Amino acids

Adenovirus-based vaccines are made in fetal cells that can support the growth of the altered adenovirus since it can no longer grow on its own. The purification process ensures removal of most fetal-cell components in the final product.

Protein-based vaccines

- Protein – The spike protein of the virus that causes COVID-19 is delivered in this vaccine.
- Adjuvant – Known as Matrix-M™, this material is made from the soap bark tree (*Quillaja saponaria*). It is also used in the shingles vaccine.
- Stabilizers – These include polysorbate 80, salts (like table salt), and hydrochloric acid.

COVID-19 vaccines do NOT contain:

Animal products, antibiotics, blood products, egg proteins, gluten, microchips, pork products, preservatives (e.g., thimerosal) or soy.

COVID-19 mRNA and protein-based vaccines do not contain DNA or fetal cells, but remnants may remain in the adenovirus-based vaccines.

Q. What side effects do COVID-19 vaccines cause?

A. COVID-19 vaccines generally cause minor side effects, but in rare instances, more serious side effects have been identified for each type of vaccine:

mRNA vaccines – The mRNA vaccines tend to cause side effects more often after the second dose and more commonly in people 12 to 55 years of age. The most common side effects include fatigue, headache and muscle aches that last for about a day or two. Less often, these vaccines can also cause low-grade fever, chills and joint pain, and swelling of the lymph nodes under the arm in which the vaccine was given. Children less than 5 years of age tend to experience injection site tenderness, fever, irritability, decreased appetite and fatigue. Some also have headache, chills, achiness, joint pain, and nausea or vomiting.

In rare instances, young people, particularly teen boys and young men less than 30 years of age, may experience a short-lived inflammation of the heart, called myocarditis. Typically, this occurs within four days of vaccination and causes symptoms like chest pain and shortness of breath. Recently vaccinated individuals with these symptoms should seek medical care. Importantly, this condition appears to be less severe after vaccination than when it occurs during COVID-19 infection, and it goes away on its own without causing long-term damage.

Protein-based vaccines – Recipients of this vaccine are most likely to experience injection site pain, headache, fatigue and muscle aches. A small number of cases of myocarditis have been reported, so recently vaccinated individuals who experience heart-related symptoms should seek medical care.

Adenovirus-based vaccines – Typical side effects following receipt of adenovirus-based vaccines can include pain, redness or swelling at the injection site; headache; fatigue; muscle aches; and fever. These symptoms were most common in the first couple of days after vaccination. Two rare, but more concerning, side effects have decreased use of this vaccine:

- **Thrombosis with thrombocytopenia syndrome (TTS)** – TTS causes a unique situation characterized by both blood clots and a decrease in platelets, which help blood to clot. It can affect about 3 of every 1 million vaccinated people, most commonly, but not limited to, women between the ages of 30 and 49 years old. TTS can occur in the three weeks after

vaccination, causing severe headache, shortness of breath, severe abdominal pain, unexplained leg pain, easy bruising or small red spots on the skin. Recently vaccinated individuals with these symptoms should seek immediate medical care.

- **Guillain-Barré syndrome (GBS)** – GBS is a neurological disorder that causes muscle weakness and sometimes leads to paralysis; however, most people fully recover. About 3,000 to 6,000 people are diagnosed with GBS annually, often after having a viral infection. Receipt of the COVID-19 adenovirus-based vaccines has been associated with a small increase in cases, (about 1 of every 120,000 vaccine recipients), typically occurring in the first three weeks after vaccination and more often in, but not limited to, males younger than 65 years of age. GBS has also been reported following COVID-19 infection.

As a result of the side effects caused by the COVID-19 adenovirus-based vaccine, the CDC has expressed a preference for use of the mRNA- or protein-based versions when possible.

Q. Will COVID-19 vaccines cause long-term effects?

A. COVID-19 vaccines are processed within the first few weeks after getting vaccinated. This processing includes breakdown and removal of the vaccine components. As such, the only thing that remains after vaccination is the immunity generated to protect against future encounters with the virus that causes COVID-19. For this reason, long-term effects would not be expected. Two hundred years of vaccine history provide additional evidence of this, as any negative effects following vaccination have occurred within six weeks of receipt of a vaccine. It is for this reason that the Food and Drug Administration (FDA) required at least eight weeks of clinical trial data before COVID-19 vaccines could be submitted for approval.

Q. Do COVID-19 vaccines cause fertility issues?

A. No. Several lines of evidence, as well as understanding of how these vaccines are processed, have indicated that the COVID-19 vaccines do not affect fertility in either males or females.

This information is provided by the Vaccine Education Center at Children's Hospital of Philadelphia. The Center is an educational resource for parents, the public and healthcare professionals and is composed of scientists, physicians, mothers and fathers devoted to the study and prevention of infectious diseases. The Vaccine Education Center is funded by endowed chairs from Children's Hospital of Philadelphia. The Center does not receive support from pharmaceutical companies. ©2022 Children's Hospital of Philadelphia. All Rights Reserved. 22182-08-22.