

# INNOVATIVE SCIENCE POWERS COVID-19 VACCINES

The year 2020 will be ingrained in the American psyche for decades to come. The emergence of the SARS-CoV-2 virus, the causal agent of COVID-19, caught the world's population off guard. With no previous immunity to the virus, it quickly spread throughout the United States and impacted millions of American lives. For most of the year, the primary means of slowing the virus's spread were mitigation strategies, physical barriers, social distancing and wearing masks. While capable, these methods have their limits and require continued compliance by most of the population to be highly effective.

The best way to combat an emerging infectious disease is by vaccinating the public. With the current pandemic, scientists quickly launched an intensive effort to develop a vaccine. Thanks to bioengineering advances, scientific and healthcare professionals created and safely tested vaccines against SARS-CoV-2 in record time. But how exactly do the vaccinations fight contagious diseases like COVID-19?

Viruses and other pathogens can invade the body and trigger an immune response. The body's white blood cells and antibodies are particularly important in developing a targeted immune response to specific pathogens like SARS-CoV-2. When the body encounters a pathogen for the first time, the non-specific immune response will attack and kill a percentage of the pathogen. Once dispatched, the body's next step consists of taking parts of the pathogen, called antigens, and utilizing them to help mount a more robust and targeted immune response. After the infection, the immune system remembers the pathogen and responds much quicker to a second encounter, a process called immunological memory. However, this process is complex and potentially causes severe illness or death. Vaccines are crucial because they mimic an infection's early steps without causing disease. The process primes our white blood cells to develop immunological memory and fight future encounters.

There are several available methods to create a vaccine. The three COVID-19 vaccines that have received emergency use authorization (EUA) by the U.S. Food and Drug Administration (FDA) were the results of novel technologies.

The first two vaccines that garnered EUA from the FDA were from Moderna and Pfizer-BioNTech. Both products are also the first approved messenger RNA- (mRNA) based vaccines. These vaccines were developed using new technology that circumvents the need for placing a weakened or inactivated virus into the body. The mRNA from the vaccine can enter a host cell and serve as a template for the cell to make a protein fragment. In the Moderna and Pfizer-BioNTech vaccines, the protein fragment is from the SARS-CoV-2 spike (S) protein, a portion that helps the virus enter host cells. The cells that receive the mRNA and display part of the S protein will prime the immune system to remember the protein and protect against a future infection from SARS-CoV-2.

The Johnson & Johnson vaccine, the third to obtain EUA, was devised through what is called non-replicating viral vector technology. This process delivers genetic material into host cells without making new viral particles. J & J uses an adenovirus vector that has been modified to include the SARS-CoV-2 S protein. As with the other two vaccines, it prepares the immune system for any future SARS-CoV-2 encounter.



Prof. Ilhem Messaoudi

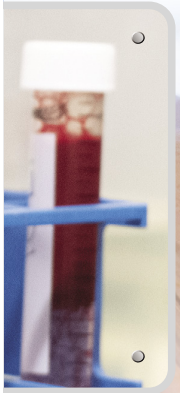
There are additional COVID-19 vaccines on the horizon that utilize new or traditional methods of development. Nevertheless, future vaccine candidates and the current FDA-approved vaccines may need to be modified to counter the growing emergence of SARS-CoV-2 variants. In viral outbreaks, the genomes of viruses mutate as they spread from person to person, and this phenomenon is occurring with SARS-CoV-2. Some of these alterations make it more transmissible, which has been the case for several currently being tracked in the U.S.

The impact of these COVID-19 vaccines has been clear. As more Americans have gotten vaccinated, hospitalizations and deaths have dropped nationwide. Vaccinations were vital for fighting many diseases throughout the 20th century and are proving their power now during the pandemic. We are thankful for the hardworking people who save lives and make history by developing and testing COVID-19 vaccines. Their work is not yet complete, but it remains of great importance.

## - Ilhem Messaoudi, PhD

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CORONAVIRUS  
**COVID-19**  
Vaccine  
10 ml  
Injectable only

0.5  
1  
1.5  
2  
2.5 ml

SARS-COV-2  
MRNA  
PANDEMIC  
FDA  
VIRUS INFECTION  
IMMUNE RESPONSE  
TRANSMISSIBLE  
SPIKE PROTEIN  
ANTIGENS  
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