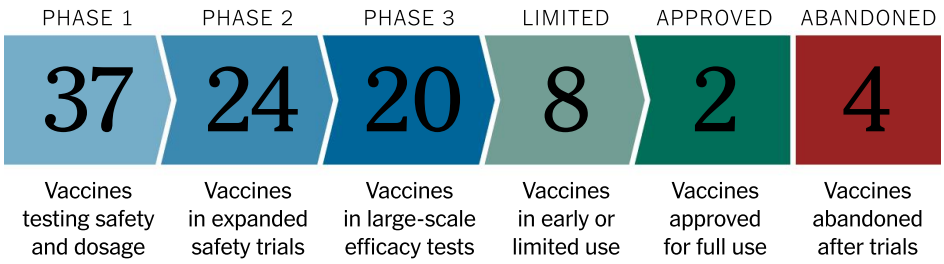
Coronavirus Vaccine Tracker

By Carl Zimmer, Jonathan Corum and Sui-Lee Wee Updated Feb. 1, 2021



Vaccines typically require years of research and testing before reaching the clinic, but in 2020, scientists embarked on a race to produce safe and effective coronavirus vaccines in record time. Researchers are currently testing **67 vaccines** in clinical trials on humans, and 20 have reached the final stages of testing. At least 89 preclinical vaccines are under active investigation in animals.

New additions and recent updates

Jan. 30 Hungary is the first E.U. country to authorize the **Sinopharm** vaccine.

Jan. 29 The E.U. authorizes the **Oxford-AstraZeneca** vaccine.

Jan. 29 **Johnson & Johnson** reports lower efficacy data in South Africa.

Jan. 28 **Novavax** reports lower efficacy data in South Africa.

Jan. 28 Korea's **EuBiologics** launches a Phase 1/2 trial.

Jan. 28 Canada's **Providence Therapeutics** enters Phase 1.

Jan. 28 **Imperial College London** abandons their Phase 1/2 RNA vaccine.

Jan. 25 **Merck** abandons two vaccines being developed with Themis and IAVI.

Jan. 21 **Gamaleya** begins testing a single-dose version called "Sputnik Light."

Jan. 21 Turkey's **Erciyes University** moves to Phase 2.

Jan. 20 Korea's **Genexine** moves to Phase 1/2.

Jan. 14 The **Israel Institute for Biological Research** moves to Phase 2.

Jan. 13 Brazil announces **Sinovac**'s vaccine has an efficacy of just over 50 percent.

Jan. 12 California-based **Arcturus** moves to Phase 2.

Jan. 12 Canada's **VIDO** enters Phase 1/2.

Leading vaccines

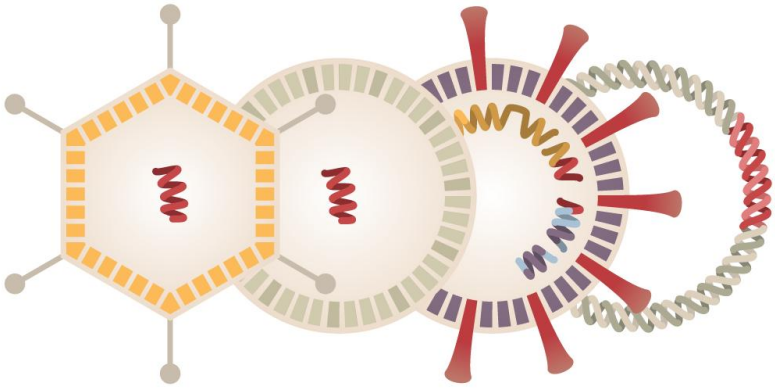
Developer	How It Works	Phase	Status
Pfizer-BioNTech	mRNA	2 3	Approved in Bahrain, Saudi Arabia, Switzerland. Emergency use in U.S., E.U., other countries.

Moderna	mRNA		3	Emergency use in U.S., U.K., E.U., others.
Gamaleya	Ad26, Ad5		3	Early use in Russia. Emergency use in other countries.
Oxford-AstraZeneca	ChAdOx1	2	3	Emergency use in U.K., E.U., other countries.
CanSino	Ad5		3	Limited use in China.
Johnson & Johnson	Ad26		3	
Vector Institute	Protein		3	Early use in Russia.
Novavax	Protein		3	
Sinopharm	Inactivated		3	Approved in China, U.A.E., Bahrain. Emergency use in Egypt, other coutries.
Sinovac	Inactivated		3	Emergency use in China, Brazil, others.
Sinopharm-Wuhan	Inactivated		3	Limited use in China, U.A.E.
Bharat Biotech	Inactivated		3	Emergency use in India.

Below is a list of all vaccines that have reached trials in humans, along with a selection of promising vaccines being tested in animals. For an overview of treatments for Covid-19, see our Coronavirus Drug and Treatment Tracker. For an explanation of eight leading vaccines, see How Covid-19 Vaccines Work.

The Vaccine Testing Process

The development cycle of a vaccine, from lab to clinic.



PRECLINICAL TESTING : Scientists test a new vaccine on cells and then give it to **animals** such as mice or monkeys to see if it produces an immune response.

PHASE 1 SAFETY TRIALS : Scientists give the vaccine to a **small number of people** to test safety and dosage, as well as to confirm that it stimulates the immune system.

PHASE 2 EXPANDED TRIALS : Scientists give the vaccine to **hundreds of people** split into groups, such as children and the elderly, to see if the vaccine acts differently in them. These trials further test the vaccine's safety.

PHASE 3 EFFICACY TRIALS : Scientists give the vaccine to **thousands of people** and wait to see how many become infected, compared with volunteers who received a placebo. These trials can determine if the vaccine protects against the coronavirus, measuring what's known as the efficacy rate. Phase 3 trials are also large enough to reveal evidence of relatively rare side effects.

EARLY OR LIMITED APPROVAL : Many countries have given emergency authorization based on preliminary evidence that they are safe and effective. China, Russia and other countries have begun administering vaccines before detailed Phase 3 trial data has been made public. Experts have warned of serious risks from jumping ahead of these results.

APPROVAL : Regulators review the complete trial results and plans for a vaccine's manufacturing, and decide whether to give it full approval.

COMBINED PHASES : One way to accelerate vaccine development is to combine phases. Some vaccines are now in Phase 1/2 trials, for example, which this tracker would count as both Phase 1 and Phase 2.

PAUSED or **ABANDONED** : If investigators observe worrying symptoms in volunteers, they can pause the trial. After an investigation, the trial may resume or be abandoned.

Filter the list of vaccines:

All vaccines Preclinical Phase 1 2 3 Approved Abandoned

Genetic Vaccines

Vaccines that deliver one or more of the coronavirus's own genes into our cells to provoke an immune response.

RNA vaccine DNA vaccine

PHASE 2 PHASE 3 COMBINED PHASES
APPROVED IN SEVERAL COUNTRIES EMERGENCY USE IN U.S., ELSEWHERE

VACCINE NAME: Comirnaty (also known as tozinameran or BNT162b2)
EFFICACY: 95%
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Freezer storage only at −94°F (−70°C)

On Nov. 9, New York-based **Pfizer** and the German company **BioNTech** made history by announcing that their coronavirus vaccine was over 90 percent effective. It was the first time anyone had found such evidence. Just over a month later, on Dec. 11, the Food and Drug Administration granted it the first emergency use authorization ever given by the United States to a coronavirus vaccine.

In January 2020, BioNTech researchers began work on the vaccine, basing it on a genetic molecule called messenger RNA (mRNA). The vaccine contains genetic instructions for building a coronavirus protein, known as spike. When injected into cells, the vaccine causes them to make spike proteins, which then get released into the body and provoke a response from the immune system. In March, BioNTech partnered with Pfizer to scale up the research, launching a clinical trial in May. They gave the vaccine the generic name tozinameran and the brand name Comirnaty

The researchers found that Comirnaty caused volunteers to produce antibodies against SARS-CoV-2, as well as immune cells called T cells that respond to the virus. On July 27, the companies announced the launch of a Phase 2/3 trial with 30,000 volunteers. On Sept. 12, Pfizer and BioNTech announced that they would seek to expand the trial to 44,000 participants.

Through the summer and into the fall, the world focused more and more of its attention on the Pfizer-BioNTech trial. In September, Dr. Albert Bourla, the chief executive of Pfizer, said the Phase 3 trial would deliver enough results as soon as October to show if the vaccine worked or not. President Trump touted their progress, hinting that a vaccine would be available before the election. But on Oct. 27, Dr. Bourla announced that the volunteers in the trial had yet to experience enough cases of Covid-19 to determine if the vaccines work. Finally, on Nov. 9, Pfizer and BioNTech released preliminary analysis of the first 94 cases.

Over the next month, Pfizer and BioNTech released more data on more cases. On Dec. 8 the FDA released their independent analysis of the clinical trials. They determined that the Comirnaty has an efficacy rate of 95 percent. While Comirnaty caused no serious side effects, it frequently caused short-lived fatigue, fever, and muscle aches.

These impressive results led rapidly to authorizations across the world. On Dec. 2, the United Kingdom gave emergency authorization to Pfizer and BioNTech's vaccine, becoming the first Western country to give such an approval to a coronavirus vaccine. Injections began on Dec. 8, with William Shakespeare, age 81, among the first to receive a dose. On Dec. 13, workers at a

Pfizer plant in Kalamazoo, Mich., loaded the vaccines onto trucks for the first deliveries across the United States. In the weeks that followed, many more countries authoriazed Comirnaty, and on Dec. 31, the World Health Organization gave the vaccine an Emergency Use Listing, which will speed up its authorization across the world.

As the trials progressed, Pfizer and BioNTech also scaled up factories to produce Comirnaty in huge amounts. They currently expect to manufacture 2 billion doses worldwide by the end of 2021. But in the United States, Pfizer was not able to meet the initial supply promised by Operation Warp Speed. The Trump administration awarded a $1.9 billion contract in July for 100 million doses. The New York Times reported in December that the administration passed up the chance over the summer to secure another 100 million doses. Later that month, Pfizer and BioNTech reached an agreement to supply 100 million doses by July 2021.

In January, scientists grew concerned about the emergence of fast-spreading variants that might be able to evade antibodies. Pfizer and BioNTech found that the antibodies are somewhat less effective against another variant called B.1.351. It's not clear whether those results mean that people who get the vaccine will be at greater risk of developing Covid-19 from that variant. But the companies are moving ahead with creating a version of the vaccine based on the B.1.351 spike protein.

For more details, see **How the Pfizer-BioNTech Vaccine Works** and **Inside the B.1.1.7 Coronavirus Variant**.

APPROVED FOR USE IN: Bahrain, Saudi Arabia, Switzerland.
EMERGENCY USE IN: Argentina, Australia, Canada, Chile, Colombia, Costa Rica, Ecuador, European Union, Iraq, Jordan, Kuwait, Lebanon, Malaysia, Mexico, Oman, Panama, Qatar, Serbia, Singapore, Switzerland, Tunisia, United Arab Emirates, United Kingdom, United States. Emergency use validation from the World Health Organization.

Updated Jan. 31

Pfizer-BioNTech vaccine

PHASE 3 EMERGENCY USE IN U.S., E.U., ELSEWHERE

moderna NIH National Institutes of Health Turning Discovery Into Health

VACCINE NAME: mRNA-1273
EFFICACY: 94.5%
DOSE: 2 doses, 4 weeks apart
TYPE: Muscle injection
STORAGE: 30 days with refrigeration, 6 months at −4°F (−20°C)

On Dec. 18., the F.D.A. gave emergency use authorization for a vaccine made by the Boston-based company **Moderna**. The Moderna vaccine is the second one authorized by the F.D.A., coming a week after the vaccine made by Pfizer and BioNTech.

Like Pfizer and BioNTech, Moderna makes its vaccine from mRNA. In recent years, the company has tested mRNA vaccines for a number of diseases, but they have yet to bring one to market. Last January, they began developing a vaccine for the coronavirus.

The United States government bankrolled Moderna's efforts, providing nearly $1 billion in support. In partnership with **National Institutes of Health**, they found that the vaccine protects monkeys from the coronavirus. In March, the scientists were the first to put a Covid-19 vaccine into human trials. After those studies yielded promising results, Phase 3 testing on 30,000 volunteers began on July 27.

On Nov. 16, Moderna announced the first preliminary data from the trial, followed by the complete data on Nov. 30. Out of 196 cases of Covid-19 among trial volunteers, 185 were in people who received the placebo. And of the 11 vaccinated volunteers who got Covid-19, none suffered from severe disease. The researchers estimated that the vaccine had an efficacy rate of 94.1 percent, far higher than experts had expected when vaccine testing began. While it's not clear how long this efficacy will last, Moderna has found that after three months the trial participants still have a strong immune defense against the coronavirus. On Dec. 2, Moderna registered a trial to test the vaccine on adolescents between 12 and 18 years of age.

Meanwhile, the company entered deals with several countries to supply the vaccine pending its approval. On Aug. 11, the United States government awarded the company an additional $1.5 billion in exchange for 100 million doses if the vaccine proves safe and effective, following up in December with a deal for another 100 million doses in the second quarter of 2021. As of Jan. 26, Moderna had supplied the United States with 30.4 million doses. On Nov. 25, the company reached an agreement with the European Commission to supply up to 160 million doses. Moderna has made similar deals with other countries including Canada, Japan, Qatar and South Korea.

For more details, see **How Moderna's Vaccine Works**.

EMERGENCY USE IN: Canada, European Union, Israel, Switzerland, United Kingdom, United States.

Updated Jan. 31

Moderna vaccine

E.U., U.K. AND SWITZERLAND

CANADA

U.S.

ISRAEL

Approved
Early, limited or emergency use

PHASE 3

VACCINE NAME: CVnCoV
EFFICACY: Unknown
DOSE: 2 doses, four weeks apart
TYPE: Muscle injection
STORAGE: Stable at least 3 months at 36–46°F (2–8°C)

Last March, the Trump administration unsuccessfully tried to entice **CureVac** to move its research on a mRNA vaccine from Germany to the United States. The company plowed ahead with its work in Germany, seeing responses to the vaccine in mice and monkeys before launching clinical trials in July. In December, CureVac launched a Phase 3 trial, recruiting up to 36,500 volunteers in Germany.

In November, CureVac negotiated a deal to provide the European Union with up to 225 million doses of their vaccine. They project manufacturing up to 300 million doses in 2021 and up to 600 million doses the following year. CureVac has collaborated with Elon Musk's company Tesla on creating mRNA "micro-factories," which could potentially be deployed around the world to make billions of doses of the vaccine. On Nov. 12, the company announced that its vaccine could be kept in a refrigerator at 41 degrees. Other RNA vaccines made by Pfizer and Moderna have to be kept frozen at chillier temperatures. On Jan. 8, CureVac announced that it had formed a partnership with pharmaceutical giant Bayer, which would support the vaccine's development and production.

Updated Jan. 21

PHASE 2 PHASE 3 COMBINED PHASES

VACCINE NAME: AG0302-COVID19

EFFICACY: Unknown
DOSE: 2 doses, 2 weeks apart
TYPE: Skin injection
STORAGE: Over a year at room temperature

On June 30, the Japanese biotechnology company **AnGes** launched a Phase 1 trial to test a DNA-based vaccine, developed in partnership with **Osaka University** and **Takara Bio**. The company moved on to a Phase 2/3 trial in December.

Updated Dec. 8

PHASE 3

VACCINE NAME: ZyCoV-D
EFFICACY: Unknown
DOSE: 3 doses, 4 weeks apart
TYPE: Skin injection
STORAGE: Stable at room temperature for three months

In July, the Indian vaccine-maker **Zydus Cadila** began testing a DNA-based vaccine delivered by a skin patch. They launched a Phase 2 trial on ZyCoV-D on Aug. 6 and announced at the end of December that it was complete. On Jan. 3 the Indian government gave Zydus Cadila permission to advance to a Phase 3 trial with 30,000 volunteers. In a Dec. 11 interview, company's chairman Pankaj Patel, the company's chairman, said the company expects to have their vaccine ready for distribution by March 2021.

Updated Jan. 3

PHASE 2

VACCINE NAME: INO-4800
EFFICACY: Unknown
DOSE: To be determined
TYPE: Skin injection
STORAGE: Over a year at room temperature

Before the pandemic, the Pennsylvania-based company **Inovio** developed DNA-based vaccines that are delivered into the skin with electric pulses from a hand-held device. They are running clinical trials for vaccines against a number of diseases, including HIV, Zika, and several forms of cancer. At the start of the pandemic, Inovio developed a DNA vaccine against the spike protein on the coronavirus. A Phase 1 trial, published in December, did not uncover any serious adverse effects, and measured an immune response in all 38 volunteers.

Inovio is embroiled in several lawsuits with stockholders and a company partner. On Sept. 28, the F.D.A. put the vaccine on a partial hold due to questions about the delivery device. On Nov. 16, Inovio said that the F.D.A. had given them permission to move forward. They are now running Phase 2 trials in the United States as well as in China and South Korea.

Updated Dec. 26

ABANDONED

Imperial College London MORNINGSIDE

Imperial College London researchers have developed a "self-amplifying" RNA vaccine, which boosts production of a viral protein to stimulate the immune system. They began Phase 1/2 trials on June 15, partnering with **Morningside Ventures** to manufacture and distribute the vaccine through a new company called VacEquity Global Health. On Dec. 18, the researchers announced a collaboration with Enesi Pharma to formulate a solid version of the vaccine that can be implanted in the skin without a needle.

On Jan. 27, Robin Shattuck, the leader of the project, announced that "it is not the right time to start a new efficacy trial for a further vaccine in the U.K." Instead of competing with authorized vaccines, they are turning their efforts to making candidates that will work well emerging variants of the coronavirus.

Updated Jan. 28

PHASE 2

ARCTURUS therapeutics DukeNUS Medical School

The California-based company **Arcturus Therapeutics** and **Duke-NUS Medical School** in Singapore have developed an mRNA vaccine. It has a "self-replicating" design that leads to a greater production of viral proteins. Tests on animals showed that it protected them against infection. In August, Arcturus launched a Phase 1/2 trial at Singapore General Hospital. On Nov. 9, the company announced that an interim analysis of the trial showed that the vaccine produced an immune response that's in the range of responses seen in people who recovered from Covid-19. On Jan. 6 Arcturus announced that they had permission to start the Phase 2 portion of the trial in both Singapore and the United States. Singapore reached an agreement with Arcturus to spend up to $175 million to acquire vaccines when they're ready.

Updated Jan. 12

PHASE 1 PHASE 2 COMBINED PHASES

GENNOVA HDT Immune Therapy For All

Gennova Biopharmaceuticals in India and Seattle-based **HDT Bio** partnered to develop a vaccine based on self-amplifying RNA. The vaccine, known as

HGC019, was able to safely provoke animals to make antibodies to the coronavirus, leading India to grant the companies approval in December to start Phase 1/2 trials.

Updated Dec. 12

PHASE 1 PHASE 2 COMBINED PHASES

GeneOne Life Science, a South Korean biotech company, developed a DNA-based vaccine that encodes two proteins from the coronavirus. In December they launched a Phase 1/2 trial with 345 participants.

Updated Dec. 17

PHASE 1 PHASE 2 COMBINED PHASES

The Korean company **Genexine** started testing the safety of a DNA-based vaccine in June. In December, Korea Biomedical Review reported that Genexine got disappointing results from their initial formulation and decided to restart their trials with a modified vaccine. On Jan. 20, the company registered a Phase 1/2 trial.

Updated Jan. 20

PHASE 1

In June, Chinese researchers at the **Academy of Military Medical Sciences**, **Suzhou Abogen Biosciences** and **Walvax Biotechnology** announced they would start their country's first safety trials on a mRNA-based vaccine, called ARCoV. Earlier studies on monkeys reportedly showed protective effects, and in the Phase 1 trial indicated it was safe in people. On Dec. 21, Xinhua reported that China was building a factory to produce 120 million doses per year.

Updated Dec. 22

PHASE 1

Researchers at Thailand's **Chulalongkorn University** have been developing several potential vaccines for the coronavirus. The furthest along is an mRNA-based vaccine known as ChulaCov19. On Sept. 29, the **Chula Vaccine Research Center** registered a Phase 1 trial to test it in humans. Due to delays in funding and manufacturing, the trial is expected to begin in spring 2021. In an

interview with the Bangkok Post, the leader of the project said that up to 30 million doses might be produced for Thailand and six other Asian countries if the vaccine proved to be safe and effective.

Updated Dec. 18

PHASE 1

The Canadian company **Entos Pharmaceuticals** has created a DNA vaccine for the coronavirus. Most other genetic vaccines carry the gene for the spike protein on the surface of the virus. Entos instead chose the gene for nucleocapsid, a protein that sits inside the virus's membrane. They are betting it can offer long-lasting immunity. In October, Entos launched a Phase 1 trial in Canada for their vaccine, called Covigenix VAX-001.

Updated Oct. 20

PHASE 1

On Nov. 2, the Canadian company **Symvivo** announced they had administered a DNA vaccine to their first volunteer in a Phase 1 trial. The DNA is inserted into harmless bacteria, which volunteers swallow in a frozen liquid (the company is working on putting the bacteria into a pill). When the bacteria reach the intestines, the DNA slips into cells in the gut lining, which then make viral proteins.

Updated Nov. 3

PHASE 1

New Jersey-based **OncoSec Immunotherapies** has developed experimental cancer treatments that deliver genes into tumors. There, the injected genes produce a natural signalling molecule called IL-12, which attracts the attention of immune cells that attack the cancer. In the spring, OncoSec began adapting their technology to make a vaccine for the coronavirus. The vaccine, called CORVax12, consists of a loop of DNA that encodes both the spike protein and IL-12. Causing the body to make extra IL-12 could potentially enhance the immune system's ability to make antibodies to the spike protein. On Nov. 13, the company registered a Phase 1 trial to test the safety of the CORVax12.

Updated Nov. 13

PHASE 1

Canada's **Providence Therapeutics** specializes in messenger RNA vaccines to treat cancer. In response to the pandemic, they developed an mRNA vaccine against the coronavirus. They launched a Phase 1 study of an RNA vaccine in late January. The company expects to move into Phase 2 trials by May.

Updated Jan. 28

PRECLINICAL

The French pharmaceutical company **Sanofi** is developing an mRNA vaccine in partnership with **Translate Bio**. They have found that it produces a strong antibody response in mice and monkeys and are planning on starting Phase 1 trials in the first quarter of 2021. It would become Sanofi's second Covid-19 vaccine candidate in clinical trials, along with their protein-based vaccine.

Updated Dec. 24

PRECLINICAL

Other genetic vaccines in active preclinical development include vaccines from: Applied DNA Sciences, EvviVax and Takis Biotech; DIOSynVax; Elixirgen Therapeutics; ETheRNA; Globe Biotech; Greenlight Biosciences; Infectious Disease Research Institute and Amyris; Mediphage Bioceuticals; National institute of Chemistry of Slovenia and Kemijski Inštitut; National Research Centre, Egypt; the OPENCORONA Consortia; Providence Therapeutics; Scancell; the Spanish National Center for Biotechnology and the Spanish National Research Council; Vaccibody.

Updated Jan. 14

Viral Vector Vaccines

Vaccines that contain viruses engineered to carry coronavirus genes. Some viral vector vaccines enter cells and cause them to make viral proteins. Other viral vectors slowly replicate, carrying coronavirus proteins on their surface.

PHASE 3 EARLY USE IN RUSSIA, ELSEWHERE

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

VACCINE NAME: Sputnik V (also known as Gam-Covid-Vac)
EFFICACY: 91.4%
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Freezer storage. Developing an alternative formulation that can be refrigerated.

The **Gamaleya Research Institute**, part of Russia's Ministry of Health, has created a vaccine with an efficacy rate of 91.4 percent, according to a Dec. 14 announcement.

Gamaleya produced the vaccine, initially called Gam-Covid-Vac, from a combination of two adenoviruses called Ad5 and Ad26. Both kinds have been tested as vaccines over a number of years. By combining them, the Russian researchers hoped to avoid a situation in which the immune system could learn to recognize the vaccine as a foreign object that needed to be destroyed.

The researchers launched clinical trials in June. On Aug. 11, President Vladimir V. Putin announced that a Russian health care regulator had approved the vaccine, renamed Sputnik V, before Phase 3 trials had even begun. Vaccine experts decried the move as risky, and Russia later walked back the announcement, saying that the approval was a "conditional registration certificate," which would depend on positive results from Phase 3 trials. In addition to Russia, volunteers for the trial were recruited in Belarus, the United Arab Emirates, and Venezuela. On Oct. 17, a Phase 2/3 trial was launched in India.

On Sept. 4, three weeks after Putin's announcement, Gamaleya researchers published the results of their Phase 1/2 trial. In a small study, they found that Sputnik V yielded antibodies to the coronavirus and mild side effects.

On Nov. 11, the Russian Direct Investment Fund announced the first preliminary evidence from their Phase 3 trial indicating that the vaccine is effective. Based on 20 cases of Covid-19 among the trial participants, Russian scientists estimated that the vaccine demonstrated 92 percent efficacy. By December, the trial had reached its final total of 78 cases. The efficacy rate was effectively unchanged, at 91.4 percent. Out of the 78 cases of Covid-19 in the trial, 20 were severe — and all 20 were in volunteers who received the placebo. In addition, the researchers announced that they found no serious side effects from the vaccine. On Dec. 26, the makers of Sputnik V tweeted that they had found that the vaccine had an efficacy of over 90 percent in people over 60.

In November, the Russian government began offering Sputnik V within Russia in a mass vaccination campaign. But worry that the vaccine was rushed to approval led to widespread hesitancy in the country. Meanwhile, the trial has continued to gather data. But on Dec. 24, the Associated Press reported that volunteers who suspected they had received the placebo were dropping out to receive the vaccine now that it's widely available. The researchers running the trial reduced its planned size from 40,000 to 31,000 participants, causing experts to worry that it would not have enough statistical power to reach strong conclusions about the safety and efficacy of the vaccine. The full details of the trial have yet to be published in a scientific journal.

In an unprecedented move in the coronavirus vaccine field, the Gamaleya Institute joined forces in December with the drugmaker AstraZeneca, which makes a vaccine with human adenoviruses. The two teams will combine their vaccines to see if the mixture can increase the efficacy of the AstraZeneca vaccine. AstraZeneca registered a Phase 1 trial for the combination on Dec. 24. In January, Gamaleya researchers also started a trial on a single-dose version of the vaccine, which they dubbed "Sputnik Light."

Starting in the summer, Russia negotiated a number of deals to supply other countries with the Sputnik V vaccine, including Brazil, India, Mexico, and Venezuela. On Dec. 22, Belarus became the first country outside of Russia to register Sputnik V, and since then a number of other countries have followed suit.

For more details, see **How Gamaleya's Vaccine Works**.

EARLY USE IN: Russia.
EMERGENCY USE IN: Algeria, Argentina, Armenia, Belarus, Bolivia, Guinea, Hungary, Iran, Palestinian Authority, Paraguay, Serbia, Tunisia, Turkmenistan, United Arab Emirates, Venezuela.

Updated Feb. 1

Gamaleya's Sputnik V vaccine

Approved
Early, limited or emergency use

PHASE 2 PHASE 3 COMBINED PHASES

EMERGENCY USE IN BRITAIN, E.U., ELSEWHERE

VACCINE NAME: AZD1222 (also known as Covishield in India)
EFFICACY: 62% to 90%, depending on dosage
DOSE: 2 doses, 4 weeks apart
TYPE: Muscle injection
STORAGE: Stable in refrigerator for at least 6 months

On Dec. 8, researchers with the **University of Oxford** and the British-Swedish company **AstraZeneca** published the first scientific paper on a Phase 3 clinical trial of a coronavirus vaccine. The trial demonstrated that the vaccine can protect people from Covid-19, but it left many questions unresolved about the results.

Early in the pandemic, Oxford researchers developed the vaccine by genetically engineering an adenovirus that normally infects chimpanzees. When they gave the vaccine to monkeys, they found that it protected the animals from the disease. Last April they followed up with a Phase 1/2 trial. The vaccine developers did not detect any severe side effects in the trial, while observing that the vaccine raised antibodies against the coronavirus as well as other immune defenses. The vaccine began Phase 2/3 trials in the United Kingdom and India, and (where it's known as Covishield). In addition, AstraZeneca later launched Phase 3 trials in Brazil, South Africa, and the United States.

On Sept. 6, AstraZeneca halted global trials of the vaccine to investigate one volunteer, who developed a form of inflammation called transverse myelitis. Within a week, the trials began in all countries except the United States. Meanwhile, a newspaper in Brazil reported on Oct. 21 that a volunteer in the trial there died of Covid-19. While AstraZeneca did not comment, the Brazil trial was not paused, suggesting that the volunteer received a placebo. On Oct. 23, the F.D.A. authorized the restart of the U.S. trial.

On Nov. 19, researchers published the first findings from the Phase 2/3 trials in the United Kingdom. They looked in particular at how people at different ages responded to the vaccine, studying 160 people aged 18 to 55 years old, 160 people between 56 and 69, and 240 people 70 years or older. They didn't observe any serious side effects at any age. Encouragingly, the older volunteers produced about as many antibodies against the coronavirus as the younger ones.

On Nov. 23, AstraZeneca and Oxford announced that the vaccine had good efficacy, based on a study of the first 131 cases of Covid-19 in the trials in the United Kingdom and Brazil. The volunteers all got two doses, but in some cases the first dose was only half strength. Surprisingly, an initial half-strength dose led to 90 percent efficacy, while two standard-dose shots led only to 62 percent efficacy. The researchers speculated that the lower first dose did a better job of mimicking the experience of an infection, promoting a stronger immune response. But only after the initial announcement did it become clear that the low dose version was the result of a mistake in how the vaccines were measured out, not part of the original plan for the trial. It also emerged that the

low dose was only tried out on volunteers under 55, raising more questions about how strong the preliminary results were.

Despite these questions, the United Kingdom and Argentina gave the vaccine emergency authorization on Dec. 30. On Jan. 3, India followed suit, approving a version called Covishield, made by the Serum Institute of India.

In an unprecedented move in the coronavirus vaccine field, AstraZeneca announced on Dec. 11 that it would collaborate with the Russian creators of the Sputnik V vaccine, which is also made from adenoviruses, to see if a combination with Sputnik V might increase the efficacy of the Oxford-AstraZeneca vaccine. The trial is planned to take place in early 2021 in Ukraine.

Last May, AstraZeneca began securing a series of agreements to provide vaccines to governments should they prove effective. The United States awarded the project $1.2 billion in support for 300 million doses. In August the European Union reached an agreement for AstraZeneca to deliver 400 million doses if the trials yield positive results. COVAX, an international collaboration to deliver the vaccine equitably across the world, secured 170 million doses. The company has said their total annual manufacturing capacity for the vaccine, if approved, stands at two billion doses.

For more details, see **How the Oxford-AstraZeneca Vaccine Works**.

EMERGENCY USE IN: Argentina, Bangladesh, Bhutan, Brazil, Chile, Dominican Republic, El Salvador, European Union, India, Maldives, Mexico, Morocco, Nepal, Pakistan, South Africa, United Kingdom.

Updated Feb. 1

Oxford-AstraZeneca vaccine

PHASE 3 LIMITED USE IN CHINA

CanSinoBIO

VACCINE NAME: Convidecia (also known as Ad5-nCoV)

EFFICACY: Unknown

DOSE: Single dose

TYPE: Muscle injection
STORAGE: Refrigerated

The Chinese company **CanSino Biologics** developed Convidecia in partnership with the Institute of Biology at the country's **Academy of Military Medical Sciences**. The vaccine is based on an adenovirus called Ad5. Last May, researchers published promising results from a Phase 1 safety trial on Convidecia, and in July they reported that their Phase 2 trials demonstrated the vaccine produced a strong immune response. In an unprecedented move, the Chinese military approved the vaccine on June 25 for a year as a "specially needed drug." On Nov. 28, the Chief Executive of CanSino Biologics said in an interview that about 40,000 to 50,000 people had received Convidecia.

Starting in August 2020, CanSino began running Phase 3 trials in a number of countries, including Pakistan, Russia, Mexico and Chile. In February, Reuters reported that an interim look at the trial did not reveal any safety concerns, allowing the study to continue.

LIMITED USE IN: China.
Updated Feb. 1

CanSino vaccine

CHINA

Approved
Early, limited or emergency use

PHASE 3

Johnson & Johnson

Beth Israel Lahey Health
Beth Israel Deaconess Medical Center

VACCINE NAME: Ad26.COV2.S
EFFICACY: 72% in United States, 66% in Latin America, 57% in South Africa
DOSE: 1 dose
TYPE: Muscle injection
STORAGE: Up to two years frozen at −4° F (−20° C), and up to three months refrigerated at 36–46° F (2–8° C).

A decade ago, researchers at **Beth Israel Deaconess Medical Center** in Boston developed a method for making vaccines out of a virus called Adenovirus 26, or Ad26 for short. **Johnson & Johnson** developed vaccines for Ebola and other diseases with Ad26 and have now made one for the coronavirus. Last March

they received $456 million from the United States government to support their move towards production. The vaccine has provided protection in experiments on monkeys. Johnson & Johnson began Phase 1/2 trials in July. Unlike other leading vaccines in clinical trials, the company gave one dose, not two.

Johnson & Johnson launched a Phase 3 trial in September. On Oct. 12, the company announced it was pausing the trial to investigate an adverse reaction in a volunteer. The trial resumed eleven days later. Although Johnson & Johnson initially set out to recruit 60,000 volunteers, it capped the trial at 45,000 in December as cases rose.

On Jan. 29, Johnson & Johnson announced the results of the trial: the vaccine had an efficacy of 72% in the United States, 66% in Latin America, and 57% in South Africa. The lower result in South Africa is likely due to the rise of the B.1.351 variant in that country. But when the company looked at just severe cases of Covid-19, the vaccine had an efficacy against severe disease of 85% in all the regions. That could translate into many lives saved and less pressure on hospitals.

In August, the federal government agreed to pay Johnson & Johnson $1 billion for 100 million doses if the vaccine is approved, although the company may fall short of expectations for its initial delivery. The European Union reached a similar deal on Oct. 8 for 200 million doses, and COVAX, an international collaboration to deliver the vaccine equitably across the world, secured 500 million doses. The company is aiming for production of a billion doses in 2021.

On Nov. 16, Johnson & Johnson announced that they were also launching a second Phase 3 trial to observe the effects of two doses of their vaccine, instead of just one. The results are expected in early spring.

For more details, see **How the Johnson & Johnson Vaccine Works**.

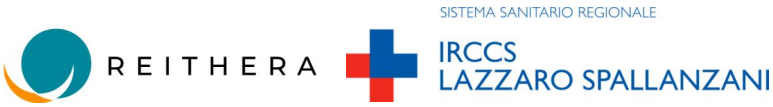
Updated Jan. 29

PHASE 2

In the spring, the **Israel Institute for Biological Research** started work on a coronavirus vaccine based on vesicular stomatitis viruses. They engineered the viruses to carry the gene for the coronavirus spike protein. On Oct. 25, the Israeli government announced that the vaccine, called Brilife, would be going into a Phase 1 trial. The Phase 2 trial, which is recruiting up to 1,000 volunteers, started on Jan. 5. It's not clear how the trial will fare now that Israel is aggressively vaccinating its citizens with authorized vaccines by Pfizer.

Updated Jan. 14

PHASE 1



The Italian biotechnology company **ReiThera** has developed a Covid-19 vaccine, called GRAd-COV2, that is based on an adenovirus that infects gorillas. Working in collaboration with the **Lazzaro Spallanzani National Institute for Infectious Diseases** in Rome, they launched a Phase 1 trial at the end of July. In November, they announced that the vaccine was well tolerated and produced antibodies, opening the way to a Phase 2/3 trial in the coming months.

Updated Nov. 24

PHASE 1

While many vaccines are given as injections, some vaccines can be taken as a pill. Oral vaccines have been approved for diseases including polio, cholera, and typhoid fever. The small San Francisco company **Vaxart** specializes in developing oral vaccines. They have created and tested pills for influenza and other diseases. Last spring Vaxart began work on an oral vaccine for Covid-19. It contains an adenovirus called Ad5 (the same viral vector in CanSinoBio's vaccine and in Russia's Sputnik V).

When Vaxart gave the pill to mice, they produced antibodies against the coronavirus. Mice don't suffer symptoms of Covid-19, however, so the researchers then switched to hamsters, which do. In an unpublished study, they found that the vaccine pill not only dramatically reduced the amount of coronavirus in sick hamsters, but also protected them from two important symptoms of the disease: weight loss and swollen lungs. In October, the company began giving the pill to volunteers in a Phase 1 clinical trial.

Although none of Vaxart's vaccines have yet been licensed, the company's stock price increased 3,600 percent in the first half of 2020. In June, The New York Times reported, a hedge fund that partly controlled the company sold off most of its shares, netting over $200 million in profits. In the wake of that reporting, the Department of Justice began investigating the company, while a number of shareholder lawsuits were brought against Vaxart, its executives and its board.

Updated Nov. 12

PHASE 1

香 港 大 學
THE UNIVERSITY OF HONG KONG

厦門大學
XIAMEN UNIVERSITY

万泰生物
WANTAI BioPharm

In 2019, researchers at the **University of Hong Kong** and **Xiamen University** created a nasal-spray vaccine for the flu based on a genetically weakened form of the influenza virus. Earlier this year, they engineered the vaccine to produce part of the coronavirus spike protein as well. On Sept. 9, they received approval to start clinical trials in partnership with **Beijing Wantai Biological Pharmacy**.

Updated Sept. 9

PHASE 1

DZIF
German Center for Infection Research

Three decades ago, the **German Center for Infection Research** developed a smallpox vaccine from a harmless virus called Modified Vaccinia Ankara, or MVA for short. In recent years, they adapted it to create a vaccine for MERS, a disease caused by another coronavirus.

This spring, they made an MVA-based vaccine for SARS-CoV-2, the coronavirus that is causing the Covid-19 pandemic. It carries the gene for the spike protein, which is produced inside cells that it invades. On Sept. 29, the center and a consortium of German universities registered a Phase 1 trial. In January the center announced that their initial formulation provided disappointing results and are postponing the trial until they update it.

Updated Jan. 13

PHASE 1

ImmunityBio

The California-based company **ImmunityBio** created a vaccine using the Ad5 adenovirus, the same one used by CanSinBio and the Gamaleya Institute in Russia. ImmunityBio engineered the Ad5 virus to carry genes for two genes from the coronavirus. In addition to the spike protein, it also carries the gene for a protein called nucleocapsid. The company hopes that this combination will provoke a strong immune response.

The company found that the vaccine protects monkeys from the coronavirus. ImmunityBio launched a Phase 1 trial of a Covid-19 vaccine in October in the United States and another in South Africa in January. In February the company registered a Phase 1 trial of an oral version of the vaccine.

The chairman and C.E.O. of ImmunityBio is billionaire Patrick Soon-Shiong, the owner of the Los Angeles Times.

Updated Feb. 1

PHASE 1

City of Hope

Researchers at **City of Hope**, a California biomedical research institute, created a vaccine based on a weakened form of a virus called Modified Vaccinia Ankara, or MVA for short. They added two coronavirus genes to the virus — one for the spike protein, and one for another protein called nucleocapsid. They hope the combination will enable the vaccine to produce immunity that's both fast and long-lasting. On Nov. 24 they announced the start of a Phase 1 trial, with hopes for a Phase 2 trial to start in the second quarter of 2021.

Updated Nov. 24

PHASE 1

CELLID LG Chem

In April, the South Korean biotech company **Cellid** began to develop a vaccine for Covid-19. The vaccine is based on a combination of two strains of adenoviruses, called Ad5 and Ad35. After testing the vaccine out on monkeys, Cellid entered into a partnership with the South Korean chemical manufacturer **LG Chem** to manufacture the vaccine. In December, they registered a Phase 1 trial.

Updated Dec. 14

PHASE 1

altimmune

VACCINE NAME: AdCOVID
EFFICACY: Unknown
DOSE: 1 dose
TYPE: Nasal spray
STORAGE: Refrigerated

Maryland-based **Altimmune** is a biopharmaceutical company that focuses on developing vaccines delivered by nasal spray. Recently, they've tackled influenza and anthrax using this technology. They have now used it to make a nasal spray vaccine for Covid-19, delivering the Ad5 adenovirus to the airway. The company says its nasal spray may be more effective for blocking the transmission of the virus than vaccines given by injection. On Dec. 22, the company registered a Phase 1 clinical trial for adults.

Updated Dec. 22

ABANDONED

The American company **Merck** acquired the Austrian firm **Themis Bioscience** in June to develop their vaccine, which had been originally developed at **Institut Pasteur**. The vaccine used a weakened measles virus that carries a gene for the coronavirus spike protein. Researchers launched a Phase 1 trial in August. On Jan. 25, Merck announced it was abandoning the effort, because the vaccine provoked a response that was weaker than a natural infection.

Updated Jan. 25

ABANDONED

In addition to its project with Themis, **Merck** partnered with **IAVI** on a second viral vector vaccine. It was based on vesicular stomatitis viruses, the same approach Merck successfully used to produce the first approved vaccine for Ebola. They designed their coronavirus vaccine as a pill, which could have made it easier to distribute than syringes for injections. Merck and IAVI received $38 million from the United States government to support their research, and on September 30 they registered a Phase 1 trial. But on Jan. 25, they announced they were abandoning the effort because the vaccine failed to trigger an immune system comparable to what happens in a natural infection of Covid-19.

Updated Jan. 25

PRECLINICAL

Other viral vector vaccines in active preclinical development include vaccines from: Ankara University; Icahn School of Medicine at Mount Sinai; ID Pharma; Institut Pasteur Lille; KU Leuven; Meissa Vaccines; Ohio State University and Kazakh National Agrarian University; the Spanish National Center for Biotechnology and the Spanish National Research Council; TheraVectys and Institut Pasteur; Thomas Jefferson University and Bharat Biotech; Tonix Pharmaceuticals; University of Georgia; University of Helsinki, University of Eastern Finland, and Rokote Laboratories Finland; University of Pittsburgh; University of Western Ontario; Valo Therapeutics and University of Helsinki; Vivaldi Biosciences; Walvax Biotechnology, Tsinghua University, and Tianjin Medical University; Washington University; Zydus Cadila.

Updated Jan. 14

Protein-Based Vaccines

Vaccines that contain coronavirus proteins but no genetic material. Some vaccines contain whole proteins, and some contain fragments of them. Some pack many of these molecules on nanoparticles.

PHASE 3 EARLY USE IN RUSSIA

BEKTOP

VACCINE NAME: EpiVacCorona
EFFICACY: Unknown
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Stable in refrigerator for up to two years

On Aug. 26, the **Vector Institute**, a Russian biological research center, registered a Phase 1/2 trial for a coronavirus vaccine they call EpiVacCorona. The vaccine contains small portions of viral proteins, known as peptides. Less than two months later, on Oct. 14, Vladimir Putin announced that Russia has granted regulatory approval to the vaccine, making it the second one to receive that designation after the Gamaleya Institute's Sputnik V vaccine.

A Phase 3 trial began in November, and as of Dec. 15, the Interfax News Agency reported that 1,438 volunteers had received the vaccine. In January, Russia launched a mass vaccination campaign, using EpiVacCorona as well as Sputnik V, an adenovirus-based vaccine. The Vector Institute has yet to announce the details of its Phase trial indicating whether the vaccine is effective or not.

EARLY USE IN: Russia.

Updated Jan. 21

Vector Institute vaccine

RUSSIA

Approved
Early, limited or emergency use

PHASE 3

NOVAVAX
Creating Tomorrow's Vaccines Today

VACCINE NAME: NVX-CoV2373
EFFICACY: 89.3% against most variants
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Stable in refrigerator

Maryland-based **Novavax** makes vaccines by sticking proteins onto microscopic particles. They've taken on a number of different diseases this way; their flu vaccine finished Phase 3 clinical trials last March. The company launched trials for a Covid-19 vaccine in May, and the Coalition for Epidemic Preparedness Innovations invested $384 million to support research on the vaccine. In July the U.S. government awarded Novavax another $1.6 billion to support the vaccine's clinical trials and manufacturing.

After getting promising results from preliminary studies in monkeys and humans, Novavax launched a Phase 2 trial on 2,900 people in South Africa in August, and the next month it launched a Phase 3 trial with up to 15,000 volunteers in the United Kingdom.A 30,000-person Phase 3 trial in the United States was delayed because of problems with manufacturing the doses required for the study. It finally launched on Dec. 28 and is expected to deliver results in March.

On Jan. 28, Novavax reported that their United Kingdom trial determined an efficacy rate of 89.3 percent. But in South Africa, the result was just under 50 percent — potentially the result of a new variant there that can evade the antibodies produced by the vaccine. The company is developing a new version of the vaccine that is tailored to the variant.

In September, Novavax reached an agreement with the Serum Institute of India, a major vaccine manufacturer, that could enable them to produce as many as 2 billion doses a year. If its clinical trials succeed, Novavax expects to deliver 100 million doses for use in the United States in 2021. They also have an agreement with other countries, including one to the United Kingdom for 60 million doses, with Canada for 52 million doses, and with Australia for 51 million doses.

For more details, see **How the Novavax Vaccine Works**.

Updated Feb. 1

PHASE 3

ZFSW The Biologics Company
INSTITUTE OF MEDICAL BIOLOGY
CHINESE ACADEMY OF MEDICAL SCIENCES

VACCINE NAME: ZF2001
EFFICACY: Unknown
DOSE: 3 doses, 4 weeks apart
TYPE: Muscle injection

The Chinese company **Anhui Zhifei Longcom** and the **Chinese Academy of Medical Sciences** partnered to make a vaccine. Their candidate is composed of an adjuvant, along with a section of the spike protein called the receptor-binding domain. They launched Phase 2 trials in July, followed by a Phase 3 trial with 29,000 volunteers in December.

Updated Dec. 2

PHASE 2 PHASE 3 COMBINED PHASES

medicago gsk

VACCINE NAME: CoVLP
EFFICACY: Unknown
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Stable in refrigerator

Canada-based **Medicago**, partly funded by the cigarette maker Philip Morris, grow vaccines in a plant called Nicotiana benthamiana, a wild species related to tobacco. They deliver virus genes into leaves, and the plant cells then create protein shells that mimic viruses.

In July, Medicago launched Phase 1 trials on a plant-based Covid-19 vaccine in combination with adjuvants to boost the immune system's response to the viral proteins. In that study, they found that an adjuvant made by GSK produced promising levels of antibodies in volunteers. On Oct. 23, the company announced it had reached an agreement with the government of Canada to supply 76 million doses. A Phase 2/3 trial of the vaccine began on Nov. 12.

Updated Nov. 24

PHASE 2 PHASE 3 COMBINED PHASES

三叶草生物制药 Clover Biopharmaceuticals DYNAVAX INNOVATING IMMUNOLOGY

Clover Biopharmaceuticals developed a vaccine containing the spike protein from coronaviruses. To further stimulate the immune system, the company is testing so-called adjuvants made by British drugmaker **GSK** and the American company **Dynavax**. Investments from the Coalition for Epidemic Preparedness supported the development of manufacturing that could lead to the production of a billion doses a year. Clover's formula looks to be especially durable; the vaccine can sit out at room temperature for a month and remain viable.

Clover launched a Phase 1 trial last June, and in December the company announced that the vaccine triggered a high level of antibodies. It registered a Phase 2/3 trial with the GSK adjuvant, but in February the company announced it was cancelling the study. Instead, it will move forward with a trial with the Dynavax adjuvant.

Updated Feb. 2

PHASE 2

In July, researchers at **West China Hospital of Sichuan University** published a study in Nature describing a vaccine made from the RBD region of the spike protein that could protect mice and monkeys from the coronavirus. To make the vaccine, researchers encode the RBD region in a gene, which they insert into a virus. They then infect insect cells with the virus, causing them to make the molecule in huge amounts. On Aug. 24, they launched a Phase 1 trial, and on Nov. 16 they moved to Phase 2 with a study on 960 volunteers. On Jan. 22 they registered another Phase 2 trial with 4000 volunteers.

Updated Jan. 24

PHASE 2

In October, Cuba's **Finlay Vaccine Institute** launched clinical trials on their second experimental vaccine for the coronavirus, known as Soberana 2. It contains the RBD part of the coronavirus spike protein, which is fused to a standard tetanus vaccine to make it stable. It also uses aluminum hydroxide as an adjuvant to boost the immune system.

In December, the Finlay Vaccine Institute moved to a Phase 2 trial to gauge the strength of the immune response. In January Cuba reached an agreement with Iran to test their vaccines in a Phase 3 trial. Cuba is planning to make 100 million doses of Soberana 2 in order to vaccinate its entire population.

Updated Jan. 21

PHASE 2

Taiwan-based vaccine maker **Medigen** is making a vaccine made of a combination of spike proteins and an adjuvant from **Dynavax**. After a series of promising experiments on animals, they began injecting volunteers for a Phase 1 trial in early October. On Dec. 30, Medigen announced that it had received permission to commence a Phase 2 trial. The first volunteers in the trial were injected in late January.

Updated Jan. 26

PHASE 1 PHASE 2 COMBINED PHASES

On Aug. 18, the head of epidemiology at Cuba's public health ministry announced the country's first trial of a vaccine of Covid-19. The **Finlay Vaccine Institute** in Havana began testing a vaccine called Soberana 1. It contains a part of the spike protein, called RBD, along with two extra ingredients: proteins from a bacteria and aluminum hydroxide. These ingredients, known as adjuvants, boost the immune system's response to the coronavirus RBD.

Updated Dec. 18

PHASE 1 PHASE 2 COMBINED PHASES

In addition to their mRNA vaccine, **Sanofi** developed a Covid-19 vaccine based on viral proteins. They produced the proteins with engineered viruses that grow inside insect cells. **GSK** supplemented these proteins with adjuvants that stimulate the immune system. The vaccine is based on the same design Sanofi used to create Flublok, an approved vaccine for influenza. The companies launched a Phase 1/2 clinical trial in September.

Sanofi's vaccine was widely expected to play a major role in tackling the pandemic. In the United States, Operation Warp Speed selected it as one of six vaccines to secure in large quantities, reaching a $2.1 billion agreement for 100 million doses. On Sept. 18 Sanofi closed another deal with the European Union for 300 million doses for an unspecified amount, and later reached an agreement with Canada for up to 72 million doses. In addition, Sanofi agreed to provide 200 million doses to COVAX, an international collaboration to deliver the vaccine equitably across the world. The company expected to move to a Phase 3 trial in December and potentially seek emergency use authorization in the United States by spring. The company announced plans to make up to one billion doses in 2021.

But on Dec. 11, Sanofi and GSK announced that their vaccine was proving disappointing. While it provided promising levels of antibodies in people under 50, older people did not respond as strongly as they had hoped. They will start a new Phase 2 trial in February with a different formulation. If they can get sufficiently high antibodies with the new vaccine, they will move on to Phase 3 studies. That could be a challenge, because they may not be able to test it against a placebo. Instead, they may have to test against one of the vaccines expected to receive emergency use authorization by then. Sanofi and GSK do not expect the vaccine to become available before the end of 2021. In the meantime, Sanofi decided in January to help Pfizer and BioNTech make 100 million doses of their vaccine.

Updated Jan. 28

PHASE 1 PHASE 2 COMBINED PHASES

spybiotech

SpyBiotech, a company spun off from the University of Oxford, announced in September that the first volunteers in an Australian Phase 1/2 trial were receiving their Covid-19 vaccine. The researchers created the vaccine from a mixture of proteins. Some of the proteins, from hepatitis B viruses, assemble themselves into hollow shells. The researchers decorated these shells with part of the coronavirus spike protein. The Serum Institute of India, which licensed the technology from SpyBiotech, is running the trials.

Updated Sept. 24

PHASE 1 PHASE 2 COMBINED PHASES

Baylor College of Medicine

Texas Children's Hospital

BE Biological E. Limited Celebrating Life Every Day

DYNAVAX INNOVATING IMMUNOLOGY

After the SARS epidemic in 2002, **Baylor College of Medicine** researchers began developing a vaccine that could prevent a new outbreak. Despite promising early results, support for the research disappeared. Because the coronaviruses that cause SARS and Covid-19 are very similar, the researchers revived the project in partnership with the **Texas Children's Hospital**. The researchers have found that the Covid-19 vaccine produces antibodies in mice.

The Indian company **Biological E** licensed it in August and launched a Phase 1/2 trial in November, combining the viral proteins with an adjuvant made by **Dynavax**. On Dec. 29, Biological E and the Coalition for Epidemic Preparedness Innovations announced a partnership to advance the development and manufacturing of the vaccine, with CEPI initially contributing $5 million to the effort. If trials confirm that the vaccine works, Biological E hopes to make a billion doses a year.

Updated Dec. 29

PHASE 1 PHASE 2 COMBINED PHASES

SHIONOGI

NIID 国立感染症研究所 NATIONAL INSTITUTE OF INFECTIOUS DISEASES

KYUSHU UNIVERSITY

Shionogi, a Japanese pharmaceutical giant, launched a Phase 1/2 trial of a coronavirus vaccine on Dec. 16. The company developed it in collaboration with the **National Institute of Infectious Diseases** and **Kyushu University**. The vaccine is based on a coronavirus protein which is produced in insect cells by genetically altered viruses.

Updated Dec. 17

PHASE 1

South Korean vaccine producer **EuBiologics** launched a Phase 1/2 trial of a protein-based vaccine in late January. Known as EuCorVac-19, the vaccine combines the spike protein with an adjuvant that stimulates the immune system.

Updated Jan. 28

PHASE 1

The Australian company **Vaxine** developed a vaccine that combines viral proteins with an adjuvant that stimulates the immune system. A Phase 1 trial began over the summer.

Updated Jan. 2

PHASE 1

A second plant-based vaccine is in development at **Kentucky BioProcessing**, an American subsidiary of British American Tobacco, the maker of Lucky Strike and other cigarettes. Like Medicago, Kentucky BioProcessing engineers a wild relative of tobacco called Nicotiana benthamiana to make viral proteins. The company previously used this technique to make a drug called Zmapp for Ebola. A Phase 1 trial launched in December.

Updated Dec. 17

PHASE 1

Taiwan-based vaccine manufacturer **Adimmune** got permission to launch a Phase 1 trial on Aug. 20. The vaccine contains the RBD section of the virus's spike protein. In December, the Taiwan press reported that Adimmune failed to find the right dose of their vaccine and needed to try a new formulation.

Updated Dec. 31

PHASE 1

COVAXX

New York-based **COVAXX**, a subsidiary of United Biomedical, has created a vaccine containing parts of several viral proteins. On Sept. 11 they registered a Phase 1 trial in Taiwan. They have reached an agreement with authorities in Brazil to run their Phase 2/3 trial there, which is slated to begin in February. On Nov. 25, Covaxx announced agreements with countries including Brazil, Ecuador, and Peru to deliver more than 140 million doses for $2.8 billion. In January, the company announced they were also starting preclinical research on a vaccine tailored specifically to newly emerged coronavirus variants that could potentially evade conventional vaccine.

Updated Jan. 21

PHASE 1

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

In the spring, researchers at the **University of Tübingen** in Germany created a vaccine made of eight parts of two viral proteins, along with an immune-stimulating adjuvant. In September they launched a Phase 1 trial.

Updated Sept. 15

PHASE 1

CENTRO DE INGENIERÍA GENÉTICA Y BIOTECNOLOGÍA

The **Center for Genetic Engineering and Biotechnology of Cuba** announced on Nov. 26 that it was beginning a Phase 1 trial of a vaccine delivered as a nasal spray. Known as Mambisa, the vaccine contains a piece of the coronavirus spike protein called the receptor-binding domain, along with a protein from the hepatitis B virus that stimulates the immune system. The name refers to women who fought in Cuba's nineteenth-century wars of independence.

Updated Nov. 30

PHASE 1

CENTRO DE INGENIERÍA GENÉTICA Y BIOTECNOLOGÍA

In addition to their nasal spray vaccine, the **Center for Genetic Engineering and Biotechnology of Cuba** also launched a separate trial at the end of November on a vaccine injected into the muscle. It contains a piece of the coronavirus spike protein called the receptor-binding domain. The vaccine is called Abadala, named after a poem by the nineteenth-century poet José Marti.

Updated Nov. 30

PHASE 1

SK Bioscience, a South Korean vaccine maker, designed a Covid-19 vaccine based on pieces of the spike protein of the coronavirus. In August they found that the vaccine triggers a strong production of antibodies in monkeys. They launched a Phase 1 trial at the end of November.

Updated Dec. 2

PHASE 1

On Dec. 10, **Nanogen Biopharmaceutical** in Vietnam began recruiting 60 volunteers for a Phase 1 trial of their protein-based vaccine Nanocovax. Nikkei Asia reported that Nanogen is considering Phase 3 trials in Bangladesh, India, and Indonesia. The company projects the vaccine will become available in Vietnam in mid-2021.

Updated Dec. 26

PHASE 1

VACCINE NAME: COVAC
EFFICACY: Unknown
DOSE: 2 doses, 4 weeks apart
TYPE: Muscle injection

The **Vaccine and Infectious Disease Organization** at the University of Saskatchewan has developed a vaccine candidate which uses protein subunits to develop immunity against the coronavirus. It was cleared for human testing late last year by the Canadian government. VIDO registered a Phase 1/2 trial on Jan. 8. If trials proceed as expected, researchers predict that at least one of their candidates will be ready by late 2021.

Updated Jan. 12

PHASE 1 ?

On July 18, **North Korea**'s State Commission of Science and Technology announced on their web site that they had started clinical trials on a vaccine based on part of the coronavirus spike protein. It's hard to independently evaluate the claim from the isolated dictatorship. The commission claimed to

have tested the vaccine on animals, but provided no data. Four months after their announcement, South Korean lawmakers said they had foiled an attempt by North Korea to hack South Korean companies developing coronavirus vaccines. So far, North Korea has not released any further information about the trials they supposedly are running.

Updated Dec. 2

ABANDONED

On Dec. 10, a vaccine from Australia's **University of Queensland** was the first to be abandoned after entering a clinical trial. Cancelling the vaccine meant the collapse of a $1 billion deal with the Australian government for 51 million doses.

The vaccine studies offered great promise at first. Experiments on hamsters showed that the vaccine protected them from the coronavirus. The university launched Phase 1 trials in July, combining coronavirus spike proteins with an adjuvant made by **CSL**. They were on track to move on to late-stage trials when they made an unwelcome discovery: some volunteers were getting positive tests for HIV, even though they were not actually infected with that virus.

According to early reports, the trouble appears to lie in the way the researchers designed the vaccine. If spike proteins are not anchored to a coronavirus, they can unfold. Antibodies to the unfolded spike protein may not work against folded proteins on real viruses. So the researchers made a small change to the protein, creating a little clamp at one end to hold the molecule in its proper shape.

Unfortunately, the clamp is similar to a protein on HIV, which can lead the immune system to make HIV-like antibodies. People who volunteered for the vaccine trial tested positive on HIV antibody tests, even though they were perfectly healthy. That discovery was enough to cause the Australian government to scrap the trial.

"It will no longer feature in Australia's vaccine plan," said Prime Minister Scott Morrison at a press conference to announce the cancellation.

Updated Jan. 21

PRECLINICAL

A vaccine in development by the **University of Pittsburgh**, called PittCoVacc, is a skin patch tipped with 400 tiny needles made of sugar. When placed on the skin, the needles dissolve and deliver virus proteins into the body. At the end of 2020, its creators applied to the F.D.A. for permission to begin clinical trials.

Updated Dec. 22

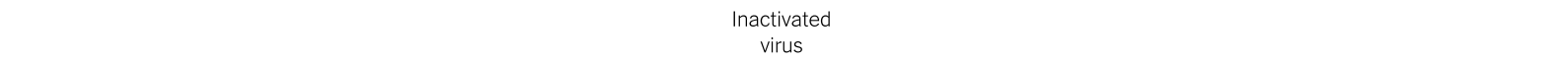
PRECLINICAL

Other protein-based vaccines in active preclinical development include vaccines from: AdaptVac and Bavarian Nordic; Akston Biosciences; Applied Biotechnology Institute; Artes Biotech; Baiya Phytopharm; BiOMVis and University of Trento; BioVaxys Technology; Chulalongkorn University; City College of New York and TechnoVax; EpiVax; Generex; GeoVax; Heat Biologics; Icosavax and University of Washington; ImmunoPrecise Antibodies; IMV; Instituto Buntantan; Intravacc; IrsiCaixa; Izmir Biomedicine and Genome Center; MIGAL Galilee Research Institute; Nanografi Nano Technology, Middle East Technical University, and Ankara University; Navarrabiomed; NidoVax; OncoGen; Oragenics Osaka University, BIKEN, and National Institutes of Biomedical Innovation, Japan; OSE Immunotherapeutics; Osivax; PDS Biotechnology; Quadram Institute; Saiba; Ufovax; University of Alberta; University of San Martin and CONICET, Argentina; University of Sao Paulo; University of Virginia; Vabiotech; Vaxform; Verndari; Voltron Therapeutics; Walter Reed Army Institute of Research.

Updated Jan. 14

Inactivated or Attenuated Coronavirus Vaccines

Vaccines created from weakened coronaviruses or coronaviruses that have been killed with chemicals.



PHASE 3

APPROVED IN CHINA, ELSEWHERE

VACCINE NAME: BBIBP-CorV

EFFICACY: 79.34%

DOSE: 2 doses, 3 weeks apart

TYPE: Muscle injection

The **Beijing Institute of Biological Products** created an inactivated coronavirus vaccine that was put into clinical trials by the state-owned Chinese company **Sinopharm.** On Dec. 30, Sinopharm announced that the vaccine had an efficacy of 79.34 percent, leading the Chinese government to give it approval. The

company has yet to publish the detailed results of their Phase 3 trial.

Last June, Beijing Institute researchers reported that the vaccine produced promising results in monkeys. A Phase 1/2 trial then showed that the vaccine didn't cause any serious side effects and enabled people to make antibodies against the coronavirus. In July a Phase 3 trial began in the United Arab Emirates in July, and in Morocco and Peru the following month.

On Sept. 14, the U.A.E. gave emergency approval for Sinopharm's vaccine to use on health care workers, and soon government officials and others were also receiving it. Less than two months later, on Dec. 9, the U.A.E. gave full approval to BBIBP-CorV, announcing it had an efficacy rate of 86 percent. The government rapidly set up clinics across the country where anyone could receive the vaccine. The neighboring country of Bahrain, which also participated in the Sinopharm trials, also gave full approval to the vaccine on Dec. 13. Egypt and Jordan gave it emergency authorization in January. On Jan. 14, Hungary announced they reached a deal to buy BBIBP-CorV, pending an authorization. That would make the country the first European nation to use a Chinese vaccine.

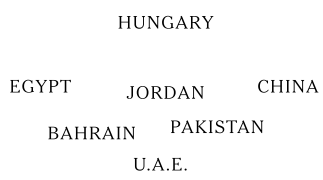
In China, meanwhile, the government gave Sinopharm emergency approval over the summer to inject its vaccine candidates into government officials, health care workers, and other select groups. By November, the chairman of Sinopharm said, almost a million people in China had received the vaccines.

Sinopharm did not initially comment on the U.A.E.'s announcement that BBIBP-CorV had an efficacy rate of 86 percent. When an executive with the company was later asked about the difference between the U.A.E. estimate and Sinopharm's own analysis, he said that both were "real and valid." The difference was the result of differences in how the trials were run. With China's approval, BBIBP-CorV looks likely to play a major role in the country's planned campaign to vaccinate 50 million people by mid-February.

For more details, see **How the Sinopharm Vaccine Works**.

APPROVED FOR USE IN: Bahrain, China, United Arab Emirates.
EMERGENCY USE IN: Egypt, Hungary, Jordan, Pakistan.
Updated Feb. 1

Sinopharm and Beijing Institute vaccine



Approved
Early, limited or emergency use

PHASE 3 EMERGENCY USE IN CHINA, ELSEWHERE

sinovac

VACCINE NAME: CoronaVac (formerly PiCoVacc)
EFFICACY: 50.38%
DOSE: 2 doses, 2 weeks apart
TYPE: Muscle injection
STORAGE: Refrigerated

Sinovac Biotech, a private Chinese company, developed an inactivated vaccine called CoronaVac in early 2020. In January, researchers in Brazil announced that it has an overall efficacy of just over 50 percent, the minimum threshold set by many regulatory agencies for authorizing a coronavirus vaccine. Despite the relatively modest efficacy, CoronaVac is being rolled out in a number of countries. Indonesia gave CoronaVac emergency authorization on Jan. 11, and two days later the president of Indonesia received an injection of CoronaVac on live television. Turkey authorized the vaccine on Jan. 13, and its president got vaccinated the next day. Brazil authorized CoronaVac on Jan. 17.

After creating their vaccine last spring, Sinovac ran a Phase 1/2 trials on 743 volunteers that revealed no severe adverse effects. Sinovac published the details of the trial in November in a medical journal, showing a comparatively modest production of antibodies. In July, Sinovac launched a Phase 3 trial in Brazil, followed by others in Indonesia and Turkey.

In that same month, Chinese government gave CoronaVac an emergency approval for limited use. In October, authorities in the eastern Chinese city of Jiaxing announced they were giving CoronaVac to people in relatively high-risk jobs, including medical workers, port inspectors and public service personnel.

The efficacy of CoronaVac has been the subject of uncertainty since December. Brazilian researchers initially announced that it was above fifty percent, but held off providing further details. On Dec. 25, the scientists running the CoronaVac trial in Turkey held a press conference to announce that the vaccine had an efficacy of 91 percent. Although a total of 7,371 volunteers were involved in the trial, the efficacy data was based on only 752 volunteers who got a real vaccine and 570 who received the placebo. Such a small number of volunteers may make the efficacy rate less accurate. The Turkish scientists did not share the results in writing.

Two weeks later, researchers in Brazil announced that CoronaVac has an efficacy of 78 percent. None of the vaccinated volunteers in their Phase 3 trial developed severe or moderate cases of Covid-19. However, shortly afterwards one of the scientists clarified that the efficacy estimate was based on the vaccine's performance in just one subgroup of volunteers. The overall efficacy turned out to be lower. The results were based on a study of 12,476 volunteers, over ten times the number of participants on which the Turkish researchers based their estimate. None of the Phase 3 trial results have yet appeared in a medical journal.

Meanwhile, Sinovac has been preparing to manufacture the vaccine for global distribution. In August they reached an agreement to supply Indonesia with at least 40 million doses, and later made a deal with Ukraine for 1.8 million doses.

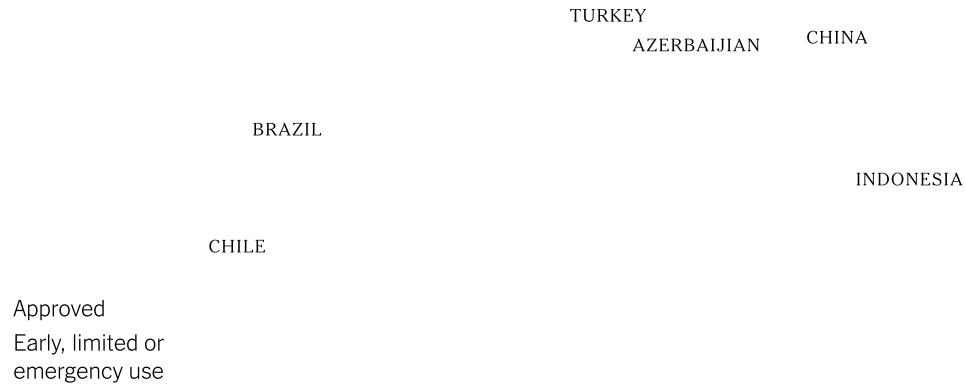
In September, Yin Weidong, the CEO of Sinovac, said the company planned on worldwide distribution of the vaccine in early 2021 — including the United States. Sinovac said in December that it expected to manufacture 300 million doses in 2020 and increase their capacity to an annual production of 600 million doses.

For more details, see **How the Sinovac Vaccine Works**.

EMERGENCY USE IN: Azerbaijan, Brazil, China, Chile, Indonesia, Turkey.

Updated Jan. 19

Sinovac vaccine



PHASE 3 LIMITED USE IN CHINA, U.A.E.

武汉生物制品研究所有限责任公司
WUHAN INSTITUTE OF BIOLOGICAL PRODUCTS CO.,LTD.

Along with their Beijing Institute vaccine, **Sinopharm** also tested an inactivated virus vaccine developed by the **Wuhan Institute of Biological Products.** The Phase 1/2 trial showed that the vaccine produced antibodies in volunteers, some of whom experienced fevers and other side effects. The Wuhan version of the vaccine is undergoing Phase 3 trials in several countries. In December, Peru briefly paused their Sinopharm trial to investigate neurological problems that one volunteer experienced, but determined that it had nothing to do with the vaccines. With the success of Sinopharm's BBIBP-CorV vaccine created by Beijing Institute, the fate of the Wuhan candidate was not clear.

LIMITED USE IN: China, United Arab Emirates.

Updated Dec. 30

Sinopharm and Wuhan Institute vaccine

U.A.E.

Approved
Early, limited or emergency use

PHASE 3 EMERGENCY USE IN INDIA

VACCINE NAME: Covaxin (also known as BBV152 A, B, C)
EFFICACY: Unknown
DOSE: 2 doses, 4 weeks apart
STORAGE: At least a week at room temperature

In collaboration with the **Indian Council of Medical Research** and the **National Institute of Virology**, the Indian company **Bharat Biotech** designed Covaxin, a vaccine based on an inactivated form of the coronavirus. Studies on monkeys and hamsters found that it provided protection against infection. Last June, Covaxin became the first coronavirus vaccine created in India to go into clinical trials.

The phase 1/2 trial showed that the vaccine didn't cause any serious side effects while producing antibodies to the coronavirus. On Oct. 23, the company announced they were initiating a Phase 3 trial. On Dec. 22, the company announced a partnership with Pennsylvania-based Ocugen to develop Covaxin for the United States market.

On Jan. 3, the Indian government granted Covaxin emergency authorization. The authorization came despite no release of Phase 3 data showing the vaccine is safe and effective. On Jan. 26, Bharat researchers reported that antibodies from the Covaxin vaccine can block B.1.1.7, the variant first identified in the United Kingdom in December.

For more details, see **How Bharat Biotech's Vaccine Works**.

EMERGENCY USE IN: India.
Updated Jan. 30

Bharat Biotech's Covaxin vaccine

INDIA

Approved

Early, limited or emergency use

PHASE 3

INSTITUTE OF MEDICAL BIOLOGY
CHINESE ACADEMY OF MEDICAL SCIENCES

Researchers at the **Institute of Medical Biology at the Chinese Academy of Medical Sciences**, which has invented vaccines for polio and hepatitis A, created an inactivated coronavirus vaccine. Last May, they launched a Phase 1 trial on 192 volunteers which indicated the vaccine was safe and produced an immune response. A Phase 2 trial followed on 750 volunteers, which led the researchers to select a two-week spacing between the two doses of the vaccine. In December the researchers launched a Phase 3 trial on up to 34,020 volunteers in Brazil and Malaysia.

Updated June 23

PHASE 3

RIBSP
Research Institute for Biological Safety Problems

The central Asian nation of Kazakhstan began research on a vaccine made from inactivated coronaviruses over the summer. On August 28, their **Research Institute for Biological Safety Problems** registered a Phase 1 trial on the vaccine, known as QazCovid. On Dec. 19, Kazinform reported that Phase 2 had been completed, showing that the vaccine was safe and produced a promising immune response. The researchers commenced a Phase 3 trial, anticipating approval by March.

Updated Dec. 27

PHASE 2

ERCİYES ÜNİVERSİTESİ
1978

On Nov. 5, Turkey's **Erciyes University** announced they had begun injecting volunteers with an inactivated coronavirus vaccine called ERUCOV-VAC. It is the first clinical trial of a coronavirus vaccine developed in Turkey. On Dec. 14, the president of the university said that the Phase 1 trial was complete. Sabah Today reported the following month that Phase 2 trials had begun.

Updated Jan. 21

PHASE 1 PHASE 2 COMBINED PHASES

Russian Academy of Sciences

The **Chumakov Center** at the **Russian Academy of Sciences** has developed an inactivated coronavirus vaccine. On Oct. 14, the TASS news agency reported that clinical trials of the vaccine would begin in Kirov and St. Petersburg on Oct. 19. On its web site, the center stated that it would finish the first phase of trials the following month.

Updated Oct. 14

PHASE 1 PHASE 2 COMBINED PHASES

valneva DYNAVAX INNOVATING IMMUNOLOGY

The French vaccine maker **Valneva** created a vaccine from chemically inactivated coronaviruses, using an adjuvant from **Dynavax**. It's currently the only Western company to be using this traditional method, which is also being pursued in China and India. On Dec. 16, it launched a Phase 1/2 trial in the United Kingdom, with hopes of reaching authorization in the second half of 2021. The British government has already reached an agreement to purchase 100 million doses of the vaccine should it prove safe and effective, with an option to acquire a further 90 million.

Updated Feb. 2

PHASE 1

康泰生物 BIOKANGTAI

Shenzhen Kangtai Biological Products is a Chinese company that makes vaccines for diseases such as hepatitis B and measles. In August, AstraZeneca reached an agreement with Shenzen to supply China with their mRNA vaccine, despite the reports of corruption and scandals that have the company. In October Shenzen Kangtai launched a Phase 1 trial on 180 volunteers of its own vaccine, based on inactivated coronaviruses.

Updated Jan. 21

PHASE 1

CODAGENIX INC.

New York-based **Codagenix** develops vaccines based on live attenuated viruses, but with a twist: they create the viruses from scratch. Researchers rewrite the genome of viruses, introducing hundreds of mutations. Then they manufacture RNA molecules encoding the rewritten genes. In special host cells, the molecules can give rise to full-blown viruses. But thanks to their

numerous mutations, they are too weak to cause Covid-19 when they're delivered in a vaccine. After successful experiments in animals, a Phase 1 trial was launched in the United Kingdom in January.

Updated Jan. 12

PHASE 1

Shafa Pharmed Pars

Shafa Pharmed Pars, an Iranian pharmaceutical company, developed a vaccine made of inactivated coronaviruses. Known as COVIran Barekat, it entered a Phase 1 trial at the end of December. COVIran Barekat is the first vaccine developed in Iran to go into clinical testing.

Updated Dec. 29

PRECLINICAL

Other inactivated or attenuated coronavirus vaccines in active preclinical development include vaccines from: Indian Immunologicals and Griffith University; KM Biologics; and Osaka University.

Updated Nov. 7

Repurposed Vaccines

Vaccines already in use for other diseases that may also protect against Covid-19. Repurposed vaccines are not included in our vaccine count.

PHASE 3

murdoch children's research institute

The Bacillus Calmette-Guerin vaccine was developed in the early 1900s as a protection against tuberculosis. The **Murdoch Children's Research Institute** in Australia is conducting a Phase 3 trial called the BRACE to see if the vaccine partly protects against the coronavirus.

Updated

OTHER CLINICAL TRIALS

Other repurposed vaccines are in clinical trials being conducted by: the Bandim Health Project; Crown Coronation (Washington University and partner universities); Hôpitaux de Paris; Louisiana State University Health Sciences Center New Orleans; the BADAS Study (Texas A&M University, Baylor College of Medicine, M.D. Anderson Cancer Center

and Cedars-Sinai Medical Center); India's National Institute for Research in Tuberculosis; BCG-CORONA (UMC Utrecht and Radboud University); University of Campinas; University Health Network, the Serum Institute of India, the Max Planck Institute for Infection Biology and Verity Pharmaceuticals; Oklahoma Medical Research Foundation and the University of Oklahoma; Vakzine Projekt Management.

Updated Sept. 25

Note: Vaccines will be added to the tracker when they reach **Phase 1**, and tracked until they succeed or fail.

Did we miss something? To notify The Times of new developments, send updates to vaccinetracker@nytimes.com.

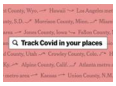
Tracking the Coronavirus

United States

Latest Maps and Data
Cases and deaths for every county

Vaccinations
Where shots have been given

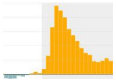
Your County's Risk
See guidance for your local area



Your Places
Build your own dashboard to track cases

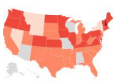
Hospitals Near You
Patients hospitalized and I.C.U. beds remaining

Restrictions
What is open and closed in each state



Deaths Above Normal
The true toll of the pandemic in the U.S.

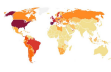
Cities and Metro Areas
Where it is getting better and worse



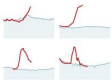
Nursing Homes
The hardest-hit states and facilities

Colleges and Universities
Cases at more than 1,700 schools

World



Latest Maps and Data
Cases and deaths for every country

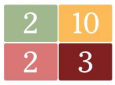


Deaths Above Normal
The true toll of coronavirus around the world

Global Vaccinations
Where shots have been given

Health

Vaccines
Track their development



Treatments
Rated by effectiveness and safety

Countries

Brazil
Canada
France
Germany
India
Italy
Mexico
Spain
U.K.
United States

States, Territories and Cities

Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
New Mexico
New York
New York City
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Puerto Rico
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
Washington, D.C.
West Virginia
Wisconsin
Wyoming

Data

Frequently Asked Questions About the Covid Data

Access the Open Source Covid Data

Additional reporting by Farnaz Fassihi, Denise Grady, Andrew E. Kramer, Matthew Kristoffersen, Hari Kumar, Cao Li, Jess Ruderman and Carlos Tejada.

Notes and corrections: Early versions of the tracker combined two vaccines by Sinopharm into one entry, before subsequent reporting confirmed they were two different vaccines. A previous version of the tracker stated that Pfizer had reached a deal with the E.U., when in fact the deal was made by AstraZeneca. A previous version of the tracker listed Canadian approval of the Pfizer-BioNTech and Moderna vaccines, when in fact they were conditional authorizations.

Sources: World Health Organization, National Institute of Allergy and Infectious Diseases, National Center for Biotechnology Information, New England Journal of Medicine, Rollins School of Public Health at Emory University. Cahill-Keyes map projection by Gene Keyes.