

COVID-19 Vaccine Frontrunners

Four vaccine candidates—two in the US, one in China, and one in the UK—have been approved for early testing in people. Several others are close on their heels.



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Early last month (March 3), National Institutes of Allergy and Infectious Diseases Director Anthony Fauci stated that it would take at least [a year to a year and a half](#) to get a COVID-19 vaccine approved for use in the US, and that estimate [may be optimistic](#), according to some experts. There are many unknowns this early in the game. How the early candidates will perform, which will be advanced to later stages of clinical development, what safety issues might arise, and how successful vaccine will be mass produced are among the questions that are now getting attention and funding.

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See [“Newer Vaccine Technologies Deployed to Develop COVID-19 Shot”](#)

The Coalition for Epidemic Preparedness Innovations (CEPI), a nonprofit dedicated to the development of vaccines against emerging infectious diseases, has been one source of cash for this endeavor, with a total of nearly \$30 million so far invested in several candidates, including the first to be injected into trial participants. The organization plans to advance the top six of these candidates into larger efficacy trials with thousands of participants.

Another bolus of funds comes from the Biomedical Advanced Research and Development Authority (BARDA) part of the HHS Office of the Assistant Secretary for Preparedness and Response, which is contributing hundreds of millions of dollars to two top vaccine candidates: one made by Johnson & Johnson’s Janssen division and another developed by Moderna in collaboration with the US government that was injected into the first [trial participants](#) last month at the Kaiser Permanente Washington Health Research Institute in Seattle. In their [announcement](#) this week, J&J and BARDA said that the funds would be put toward both ushering the potential vaccines through clinical development and setting up manufacturing capacity simultaneously.

See [“US Selects Two COVID-19 Vaccine Candidates for Huge Investments”](#)

Below, *The Scientist* rounds up those vaccine candidates that appear to be furthest along. But there are dozens more in preclinical development, and it’s still very early days. “Nobody knows which vaccines are going to work,” Moderna CEO Stéphane Bancel tells *Science* last week (March 31).

See [“Clinical Trial of COVID-19 Vaccine Begins in Seattle”](#)

Editor’s note: This table was updated on April 8, 2020.

DEVELOPER(S)	VACCINE METHOD	EVIDENCE	STATUS
Moderna and	Lipid nanoparticles	Moderna is developing similar	Phase 1 clinical trial

<p>the US government</p> <p><i>US</i></p>	<p>containing mRNAs for the SARS-CoV-2 spike protein are injected into the arm.</p>	<p>vaccines against Zika and other viruses, and other companies have RNA vaccines in clinical trials as well, but to date, no vaccine of this type has been approved for use. The SARS-CoV-2 mRNA-1273 was not tested in animals before the start of the ongoing Phase 1 trial.</p>	<p>underway in Seattle preparing for Phase 2 and 3 clinical trials to begin immediately upon successful completion</p>
<p>CanSino Biologics and the Academy of Military Medical Sciences</p> <p><i>China</i></p>	<p>Nonreplicating adenovirus 5 (Ad5) vector carrying the gene for the SARS-CoV-2 spike protein is injected into the arm.</p>	<p>Adenoviruses are well-established vaccine vectors, and CanSino produced an Ebola vaccine (approved in China in 2017) using the same Ad5 platform. The company says its Ad5-nCoV vaccine generated “strong immune responses in animal models” and has “a good safety profile.”</p>	<p>Phase 1 clinical trial underway in Wuhan, China</p>
<p>University of Oxford</p> <p><i>UK</i></p>	<p>A chimpanzee adenovirus vaccine vector (ChAdOx1) carrying the gene for the SARS-CoV-2 spike protein is injected into the arm.</p>	<p>A Phase 1 trial using the same adenovirus vector to target MERS is ongoing in Saudi Arabia. The ChAdOx1 nCoV-19 vaccine was not tested in animals before the start of the ongoing Phase 1 trial.</p>	<p>Phase 1/2 trial underway in the U</p>
<p>Inovio Pharmaceuticals</p> <p><i>US</i></p>	<p>A special device administers spike protein–encoding DNA molecules through the skin.</p>	<p>Mice and guinea pigs mounted immune responses against the virus, according to a recent preprint, and the company tells Nature that it is now testing the vaccine in monkeys.</p>	<p>Phase 1 trial underway with plans to manufacture 1 million doses of its candidate this year</p>
<p>BioNTech and Pfizer</p> <p><i>Germany</i></p>	<p>RNA vaccine; details not disclosed</p>	<p>BioNTech and Pfizer are also partnering on an RNA vaccine candidate for influenza.</p>	<p>Expected to start clinical testing in April</p>
<p>CureVac</p> <p><i>Germany</i></p>	<p>RNA vaccine; details not disclosed</p>	<p>CureVac reported in January that a Phase 1 trial of a comparable vaccine for rabies induced immune responses with just 1 microgram of</p>	<p>Expected to start clinical testing in early summer; company says it</p>

		mRNA, meaning it could be easy to scale up to produce mass quantities.	could manufacture 10 million doses by that time.
University of Pittsburgh School of Medicine <i>US</i>	Microneedle patch delivers pieces of the spike protein through the skin.	Vaccinated mice produced antibodies specific to SARS-CoV-2 at levels that would likely neutralize the virus, according to a study published in <i>EBioMedicine</i> on April 2.	Expected to start clinical testing in the next few months.
Janssen <i>Belgium</i>	Nonreplicating adenovirus 26 (Ad26) vector carrying undisclosed genetic material of SARS-CoV-2 is administered intranasally.	Janssen is also developing other Ad26-based vaccine candidates, including its Ebola vaccine that was deployed in the Democratic Republic of Congo in November 2019.	Expected to start clinical testing in September 2020 ; with BARDA's support, the company will scale up to produce up to 300 million doses of vaccine in the US each year.
Novavax <i>US</i>	Nanoparticles carrying antigens derived from the SARS-CoV-2 spike protein (with Matrix-M adjuvant)	In 2012, the company started development on a SARS vaccine that served as the basis for its new SARS-CoV-2 vaccine candidate.	Expected to start clinical testing in mid-May .
Generex Biotechnology <i>Canada</i>	Undisclosed synthetic viral peptides are combined with proprietary Ii-Key immune system activation	The company has had success with the Ii-Key technology for other infectious diseases and for cancer in clinical trials.	Expected to start clinical testing "within 90 days," the company announced on February 27.
Vaxart <i>US</i>	A pill containing different SARS-CoV-2 antigens	Five vaccine candidates based on different antigen combinations are being tested. The company has other oral recombinant vaccine candidates that have shown success in clinical trials.	Expected to start clinical testing early in the second half 2020 .

Imperial College London <i>UK</i>	Self-amplifying RNA molecules are injected into the muscle	The vaccine platform, which is designed to allow researchers to respond quickly to emerging pathogens, received \$8.4 million from CEPI last December. “We cannot predict where or when Disease X will strike, but by developing these kinds of innovative vaccine technologies we can be ready for it,” CEPI CEO Richard Hatchett said at the time.	Expected to start clinical testing in the summer
Medicago <i>US</i>	Virus-like particles that resemble SARS-CoV-2 are produced in a close relative of tobacco.	The company has a rotavirus vaccine in clinical trials that is based on virus-like particles, and another for norovirus in preclinical studies.	Expected to start clinical testing in July or August
Altimune <i>US</i>	Undisclosed vaccination delivered intranasally	The company is using the same technology to develop a flu vaccine that is in clinical trials.	Expected to begin clinical testing in August
Takis Biotech and Applied DNA Sciences <i>Italy and US</i>	The company is exploring five DNA-based candidates based on the SARS-CoV-2 spike protein.	The vaccine candidates contain PCR-produced pieces of linear DNA, as opposed to the more traditional circular plasmids, which could have several advantages including quick production. No vaccines using this approach have yet been tested in humans.	Expected to start clinical testing in the fall

Keywords:

coronavirus, COVID-19, disease & medicine, drug development, epidemic, infectious disease, outbreak, pandemic, SARS-CoV-2, vaccine, vaccine design, vaccine trials