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How Moderna is racing to a coronavirus vaccine

by Tam Harbert | Apr 3, 2020

Why It Matters

With messenger RNA, Moderna wants to develop and manufacture a vaccine in record time. With a public-private partnership, it could be even faster.

A Cambridge biotech company is developing a coronavirus vaccine that could be ready in limited volume as soon as this fall. The speedy timeline is bolstered by its unique technology using messenger RNA — a sort of platform for vaccine development.

That's according to Stéphane Bancel, CEO of the company, Moderna. Bancel was interviewed by MIT Sloan finance professor Andrew Lo in an April 1 webcast co-hosted by the MIT Laboratory for Financial Engineering and the MIT Golub Center for Finance and Policy.

"Finance and biomedicine are inextricably linked because you need money to develop drugs and devices," Lo said. "Part of the challenge of financing biomedical innovation is the underlying risks that are involved with these efforts."

And developing vaccines is especially risky. "The economic model for vaccines is broken," Lo said.

The financial engineering lab runs Project ALPHA, for Analytics for Life-Sciences Professionals and Healthcare Advocates. The project's mission is to use data analytics to assess the risks and rewards of drug development. It has analyzed data on hundreds of thousands of clinical trials for diseases and drugs, estimating the likelihood of success for each. Researchers there were shocked to find that, although

vaccines have by far the highest success rates — 40%, fewer and fewer companies are developing them, Lo said.

"In fact, right now there are only four big pharma companies that are focused on it," he said. "A number of them have left the space, and smaller companies have gone bankrupt or are not developing vaccines anymore."

To find out why, ALPHA researchers conducted a business simulation, looking at rates of return for investments in vaccine development. The results: very low, just a few million dollars. In fact, the internal rate of return on a portfolio of vaccines using today's typical pricing models is negative 60%, the lab estimated.

Messenger RNA and a platform for vaccine development

The COVID-19 pandemic has put a spotlight on this troubling problem, and Moderna's technology may point the way to a solution. The company is one of several firms now developing a vaccine to stem the pandemic.

Founded in 2010, Moderna uses messenger RNA, which carries genetic information from DNA to ribosomes to produce proteins. Moderna hijacks mRNA and uses it to carry a copy of the genetic sequence of the virus, which prompts the production of the antibodies to that virus.

63

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Using messenger RNA, Moderna took a coronavirus vaccine from sequencing to human trials in 63 days.

Messenger RNA is similar to computer technology in several ways that offer promise for lowering costs, Bancel said. For one thing, it's an easily replicable process. "We call mRNA the software of life," he said. "You can copy and paste the information into a lot of drugs by using the same technology." That means "the way we make mRNA for one vaccine is exactly the same way we make mRNA for another vaccine," he added. It just carries a different genetic sequence depending on the disease.

That means the same manufacturing process and facilities can be used for many different vaccines. Plus Moderna's process uses less expensive raw materials (water and enzymes) which lowers the overall costs. Bancel talked about building a platform. "We think if we digitalize and robotize [things], like in any platform, we could scale very quickly," he said.

The mRNA platform is promising, but new. A Q&A on the Moderna website notes that "we are still early in the story," with the company's most advanced vaccine in phase 2 clinical testing and "no approved drugs to date."

In the case of COVID-19, the disease caused by the new coronavirus, Moderna had already spent two years developing a vaccine for MERS (Middle East Respiratory Syndrome). When it saw the genetic sequence of the new coronavirus (technically SARS-CoV-2) that China published Jan. 11, Moderna scientists realized it was extremely similar to the MERS sequence and quickly shifted focus. By mid-March, the firm had a vaccine and had begun its first human trial in Seattle.

If all goes smoothly, the company could be producing millions of doses per month later this year, ramping up to "dozens of millions of doses per month toward next year," Bancel said. The initial production would likely go to inoculate health care professionals, especially because experts expect the virus to resurge in the fall, he said.

Moderna is also working with diagnostics companies to develop more effective tests to determine who has been infected with the new coronavirus. European economist Mathias Dewatripont of the Free University of Brussels and his colleagues have "pointed out that having a method for identifying people who are immune to COVID-19 would actually be part of the economic recovery, because if we can tell who's immune and can get back to work, we can actually begin restarting the economy with those individuals," Lo said. Bancel said he thinks the industry is a few months away from having such serology tests.

Enabling elasticity with a public-private partnership

Moderna's technology could improve the economics of commercial vaccine development. The company and its investors have been spending big on the technology for a decade, Bancel said, and yet the company is not yet profitable.

"The reason we were able to do the vaccine in 63 days from sequence to injecting the first human is because we have invested more than $2 billion of capital over the last 10 years," he said.

To help speed a COVID-19 vaccine to market, the government is providing funds to companies. The U.S. Department of Health and Human Services, for example, recently announced it was providing funding to Johnson & Johnson's Janssen Research & Development as well as Moderna.

Long and big picture, Bancel said industry and government should consider a permanent public-private partnership to help companies take the sort of financial risks that lead to vaccine breakthroughs.

Such a partnership could build a large facility that companies could use for producing commercial vaccines for commercial use but would switch 100% of capacity to the public good during a pandemic to manufacture whatever vaccine was required. A process technology like Moderna's could make such a quick switch possible, he said.

"Governments spend billions of dollars every year on nuclear weapons they hope never to use," he said. "How about spending a couple of billion dollars to build plants, teams and scientific projects to equip ourselves [to more effectively fight pandemics]?"

"We can do it," he said. "We just have to work together."

Watch the full webcast below:

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