Nobel Prize Awarded to Covid Vaccine Pioneers

The physiology or medicine prize for Katalin Karikó and Drew Weissman recognized work that led to the development of vaccines that were administered to billions around the world.


By Benjamin Mueller and Gina Kolata

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Katalin Karikó and Drew Weissman, who together identified a chemical tweak to messenger RNA, were awarded the Nobel Prize in Physiology or Medicine on Monday. Their work enabled potent Covid vaccines to be made in less than a year, averting tens of millions of deaths and helping the world recover from the worst pandemic in a century.

The approach to mRNA the two researchers developed has been used in Covid shots that have since been administered billions of times globally and has transformed vaccine technology, laying the foundation for inoculations that may one day protect against a number of deadly diseases like cancer.

The slow and methodical research that made the Covid shots possible has now run up against a powerful anti-vaccine movement, especially in the United States. Skeptics have seized in part on the vaccines' rapid development — among the most impressive feats of modern medical science — to undermine the public's trust in them.

But the breakthroughs behind the shots unfolded little by little over decades, including at the University of Pennsylvania, where Dr. Weissman runs a lab.

Dr. Weissman said that he found out about the prize at 4 a.m. when Dr. Karikó texted him, asking if he had heard from Thomas yet. "No. Who's Thomas?" he replied. Dr. Kariko told him that Thomas Perlmann was from the Nobel committee.

He was looking for Dr. Weissman's phone number.

Dr. Karikó, the 13th woman to win the prize, languished for many long years without funding or a permanent academic position, keeping her research afloat only by latching on to more senior scientists at the University of Pennsylvania who let her work with them. Unable to get a grant, she said she was told she was "not faculty quality" and was forced to retire from the university a decade ago. She remains only an adjunct professor there while she pursues plans to start a company with her daughter, Susan Francia, who has an M.B.A. and was a two-time Olympic gold medalist in rowing.

The mRNA work was especially frustrating, she said, because it was met with indifference and a lack of funds. She said she was motivated by more than not being called a quitter; as the work progressed, she saw small signs that her project could lead to better vaccines. "You don't persevere and repeat and repeat just to say, 'I am not giving up,'" she said.

She and Dr. Weissman had their first chance meeting over a copy machine at the University of Pennsylvania in 1998.

Dr. Karikó, the daughter of a butcher who had come to the United States from Hungary two decades earlier when her research program there ran out of money, was preoccupied by mRNA, which provides instructions to cells to make proteins. Defying the decades-old orthodoxy that mRNA was clinically unusable, she believed that it would spur medical innovations.

At the time, Dr. Weissman was desperate for new approaches to a vaccine against H.I.V., which had long proved impossible to defend against. A physician and virologist who had tried and failed for years to develop a treatment for AIDS, he wondered if he and Dr. Karikó could team up to make an H.I.V. vaccine.

It was a fringe idea that, when they began their research, seemed unlikely to work. The mRNA was delicate, so much so that when it was introduced to cells, the cells instantly destroyed it. Grant reviewers were not impressed. Dr. Weissman's lab

instead relied on seed money that the university gives new faculty members to get started.

“We saw the potential and we weren’t willing to give up,” Dr. Weissman said.

For years, Dr. Weissman and Dr. Karikó were flummoxed. Mice injected with mRNA became lethargic. Countless experiments failed. They wandered down one dead end after another. Their problem was that the immune system interprets mRNA as an invading pathogen and attacks it, sickening the animals while destroying the mRNA.

But eventually, the scientists discovered that cells protect their own mRNA with a specific chemical modification. So they tried making the same change to mRNA synthesized in the lab before injecting it into cells. It worked: The mRNA was taken up by cells without provoking an immune response.

The discovery “fundamentally changed our understanding of how mRNA interacts with our immune system,” the panel that awarded the prize said, adding that the work “contributed to the unprecedented rate of vaccine development during one of the greatest threats to human health in modern times.”

At first, other scientists were largely uninterested in taking up that new approach to vaccination. Their paper, published in 2005, was rejected by the journals Nature and Science, Dr. Weissman said. The study was eventually accepted by a niche publication called Immunity.

But two biotech companies soon took notice: Moderna, in the United States, and BioNTech, in Germany, where Dr. Karikó eventually became a senior vice president. The companies studied the use of mRNA vaccines for flu, cytomegalovirus and other illnesses. None moved out of clinical trials for years.

Then the coronavirus emerged.

Almost instantly, Drs. Karikó and Weissman’s work came together with several strands of disparate research to put vaccine makers ahead of the game in developing shots. That included research done in Canada that allowed fragile

mRNA molecules to be safely delivered to human cells, and studies in the United States that pointed the way toward stabilizing the spike protein that coronaviruses used to invade cells.

By late 2020, less than a year into a pandemic that would eventually kill at least seven million people globally, regulators had authorized strikingly effective vaccines made by Moderna and by BioNTech, which partnered with Pfizer to produce its vaccine. Both used the modification Dr. Karikó and Dr. Weissman discovered.

About 400 million doses of the Pfizer-BioNTech vaccine and 250 million doses of the Moderna vaccine have been administered in the United States. Hundreds of millions more have been given around the world. The use of mRNA has enabled both vaccines to be updated against new variants.

Dr. Karikó referred in an interview published by the University of Pennsylvania on Monday to her many years of clinging to the fringes of academia. In the interview, Dr. Karikó said that every October, her mother used to tell her, “I will listen to the radio that maybe you will get the Nobel Prize.” Dr. Karikó said she would answer: “Mum, you know, I never even get a grant.”

Dr. Karikó is the 13th woman to be awarded the Nobel Prize in Physiology or Medicine since 1901, and the first since 2015. Women represent a small fraction of the total of 227 people who have been awarded the prize, a reflection of how women are still largely underrepresented in the field of science and scientific awards, including the Nobel Prizes.

Vaccines using mRNA technology are now being developed against a number of diseases, including influenza, malaria and H.I.V., which remains difficult to inoculate against. Personalized cancer vaccines have also showed promise. They use mRNA tailored to an individual patient’s tumor to teach the person’s immune system to attack proteins on the tumor.

Drs. Karikó and Weissman's discovery, scientists said, remained critical in allowing mRNA vaccines to escape destruction by patients' immune systems and to trigger the efficient production of vaccine proteins.

"What is now recognized as a transformative technology required dedicated scientists to carry out fundamental research over many years to reach the position it was in 2020 when its rapid deployment as a vaccine technology was made possible by global collaboration," Brian Ferguson, an immunologist at the University of Cambridge, said. "The work of Katalin Karikó and Drew Weissman in the years prior to 2020 made this possible, and they richly deserve this recognition."

Who won the Nobel Prize in Physiology or Medicine in 2022?

The prize went to Svante Pääbo, a Swedish scientist who produced a complete Neanderthal genome and helped create the field of ancient DNA studies.

When will the other Nobel Prizes be announced?

The prize for physiology or medicine is the first of six Nobel Prizes that will be awarded this year. Each award recognizes groundbreaking contributions by an individual or organization in a specific field.

- The Nobel Prize in Physics will be awarded on Tuesday by the Royal Swedish Academy of Sciences in Stockholm. Last year, John Clauser, Alain Aspect and Anton Zeilinger each won for independent works exploring quantum weirdness.
- The Nobel Prize in Chemistry will be awarded on Wednesday by the Royal Swedish Academy of Sciences in Stockholm. Last year, Carolyn R. Bertozzi, Morten Meldal and K. Barry Sharpless shared the prizes for work on "click chemistry."

- The Nobel Prize in Literature will be awarded on Thursday by the Swedish Academy in Stockholm. Last year, Annie Ernaux earned the prize for work that dissected the most humiliating, private and scandalous moments from her past with almost clinical precision.
- The Nobel Peace Prize will be awarded on Friday by the Norwegian Nobel Institute in Oslo. Last year, the prize was shared by Memorial, a Russian organization; the Center for Civil Liberties in Ukraine; and Ales Bialiatski, a jailed Belarusian activist.
- Next week, the Nobel Memorial Prize in Economic Sciences will be awarded on Monday by the Royal Swedish Academy of Sciences in Stockholm. Last year, Ben S. Bernanke, Douglas W. Diamond and Philip H. Dybvig shared the prize for work that helped to reshape how the world understands the relationship between banks and financial crises.

All of the prize announcements will be streamed live by the Nobel Prize organization.

Emma Bubola contributed reporting.

Benjamin Mueller is a health and science reporter. Previously, he covered the coronavirus pandemic as a correspondent in London and the police in New York. More about Benjamin Mueller

Gina Kolata writes about science and medicine. She has twice been a Pulitzer Prize finalist and is the author of six books, including “Mercies in Disguise: A Story of Hope, a Family's Genetic Destiny, and The Science That Saved Them.” More about Gina Kolata