NATURE'S 10

Ten people who helped shape science in 2025.

Susan Monarez / Achal Agrawal / Tony Tyson / Precious Matsoso / Sarah Tabrizi / Mengran Du / Luciano Moreira / Liang Wenfeng / Yifat Merbl / KJ Muldoon

ILLUSTRATION: SHEHRYAR (SHAY) SAHARAN

The *Nature*'s 10 list explores key developments in science this year and some of the people who played important parts in these milestones. Along with their colleagues, these individuals helped to make amazing discoveries and brought attention to crucial issues.

Susan Monarez
Public-health guardian

This director of the US Centers for Disease Control and Prevention was fired after a month on the job.

By Max Kozlov

When Susan Monarez was sworn in to lead the US Centers for Disease Control and Prevention (CDC), the country's premier public-health agency, many researchers across the country breathed a sigh of relief.

Trained as a microbiologist and immunologist, Monarez had been a non-partisan government scientist for nearly 20 years. She was an unexpectedly uncontroversial choice by US President Donald Trump, who had previously put forward (but later withdrew the nomination for) Dave Weldon, a physician and vaccine sceptic who worked as a Republican member of Congress from 1995 to 2009.

But in August, less than a month after assuming the role of director, Monarez was out. "I was fired for holding the line on scientific integrity," she testified at a tense congressional hearing in September. According to her account, she refused orders from US health secretary Robert F. Kennedy Jr to fire leading scientists at the agency and to pre-approve vaccine recommendations without first considering the relevant scientific data.

Kennedy disputes this account, testifying that Monarez had told him that she wasn't trustworthy, so he ousted her.

Kennedy has made no secret of his contempt for the CDC, calling it perhaps "the most corrupt agency" in the US government. A long-time anti-vaccine advocate, he has attempted to fire about one-quarter of the agency workforce and has replaced all the members of a key panel of scientists that advises the federal government on vaccine policy, introducing several members who have publicly criticized vaccines.

Monarez is one of the highest-profile government scientists to raise concerns about policy changes by the Trump administration that threaten public health. These are part of a broader set of actions that have disrupted the US scientific enterprise. Over the course of the year, US officials have cancelled thousands of grants, fired hundreds of government researchers, blocked funding to universities and proposed unprecedented cuts to research. The administration has said its actions are meant to improve science and innovation and restore the country's confidence in scientific and public-health bodies.

> **"I was fired for holding the line on scientific integrity."**

"Susan has long established herself as someone who puts evidence in service of the country above all," says Jennifer Nuzzo, an epidemiologist and director of the Pandemic Center at Brown University in Providence, Rhode Island. "Susan did what any self-respecting scientist would do. No self-respecting scientist would agree to just rubber-stamp things without first scrutinizing the scientific evidence."

The CDC's top medical officer, Debra Houry, and three other senior CDC scientists resigned in protest of Monarez's dismissal. The conflict spilled into public view when Monarez, Houry and Kennedy presented their versions of events to US senators at hearings in September on Capitol Hill in Washington DC. Houry testified that Kennedy and his team had not consulted CDC's scientists on key decisions, including one in May to limit access to COVID-19 vaccines to children and pregnant people.

The US Department of Health and Human Services, which includes the CDC and which Kennedy leads, disputes Houry's testimony.

Monarez, whose previous government work spanned biosecurity, artificial intelligence and data analysis, had big plans for the agency that were focused largely on streamlining data to offer public-health recommendations tailored to each

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locality and state, she tells *Nature*. "I always challenge the status quo because that's what you do in science," Monarez says. "You challenge it to try to do better, but you don't compromise your moral and scientific integrity for expediency."

The future of the agency and its leadership remains uncertain. Jim O'Neill, a biotechnology investor working as Kennedy's deputy health secretary, is currently the CDC's acting director. It was difficult to find someone to permanently direct the CDC before Monarez's expulsion, says Nuzzo, but now it will be much harder.

The next director will inherit an agency workforce that has been demoralized by lay-offs and traumatized by a shooting at the agency's headquarters in Atlanta, Georgia. The attack, driven by the shooter's animosity towards COVID-19 vaccines, resulted in the deaths of a police officer and the gunman, and shattered 150 windows on its campus.

Despite the circumstances, Monarez says she offers her sincere best wishes to the next CDC director. The role "is an inherently political position, but that doesn't mean that it has to be politically compromised", Monarez told *Nature* in an interview in October. "The CDC is far too important to just give up on."

Achal Agrawal
Retraction detective

This scientist called out Indian universities' retraction rates, despite personal costs.

By Miryam Naddaf

Achal Agrawal had just finished giving a lecture when an enthusiastic undergraduate student approached him with an idea for a research project. Agrawal was delighted, until the student described how he had previously used software to paraphrase published work.

Agrawal explained that doing so was considered plagiarism — a serious violation of research integrity — but the student insisted that it was not, because the work passed the university's plagiarism checks. "I was shocked," recalls Agrawal, now a freelance data scientist in Raipur, India.

The interaction, in late 2022, made Agrawal realize how ingrained such misconduct had become — and it cemented his resolve to do something about the issue. He left his university job a month later and has since dedicated his time to raising awareness about research-integrity breaches in India. This unpaid work has placed him at the centre of the nation's conversation about academic incentives.

This year, Agrawal's efforts, as well as those of others, contributed to a landmark policy change in how higher-education institutions in India are ranked. In August, the Indian government announced that the National Institutional Ranking Framework (NIRF), which assesses universities yearly and influences their eligibility for some grant schemes, will penalize institutions if a considerable number of papers published by their researchers has been retracted. The move — a first for such a ranking system — aims to combat unethical practices. Some institutions have already had marks deducted from their current scores, and penalties are expected to be more stringent next year. "I was really happy that day," Agrawal says.

Previous rankings rewarded high publication counts no matter the quality. "He is on a mission to demonstrate that the wrong metrics are being targeted," says Matt Spick, a biomedical scientist at the

BHUMIKA BHATIA FOR *NATURE*

University of Surrey in Guildford, UK.

Agrawal earned his PhD in applied mathematics in 2016 at the University of Paris-Saclay in Orsay, France. In 2018, he returned to India, where he worked at various universities. There, he saw how publication targets affected research ethics and education. He recalls his colleagues abandoning their teaching responsibilities to chase publications.

After resigning from his university post in 2022, he launched India Research Watch (IRW), an online group of researchers and students who highlight integrity issues, including plagiarism and other types of publication misconduct. He also began posting analyses of retractions by researchers at Indian institutions on social-networking site LinkedIn, and wrote for the media about the alarming rise in research misconduct in the country.

For months, Agrawal felt like he was shouting into the void. But over time, his commentaries gained attention, and IRW's LinkedIn account now has more than 77,000 followers. The platform also offers a portal for whistle-blowers to report research-integrity breaches anonymously. Agrawal now receives around ten tips a day.

Last year, Agrawal and his colleagues added a dashboard to visualize countries' retraction numbers using data from the Retraction Watch Database. India ranked third, after China and the United States. Most of the country's retractions cited concerns related to research integrity.

Moumita Koley, a research-policy analyst at the Indian Institute of Science in Bengaluru, says that the IRW has stirred up discussions on research integrity among the nation's academics, and especially in early-career researchers. Koley first learnt about Agrawal's work on LinkedIn and has since co-authored several publications with him. "It's quite impressive," she says, praising Agrawal's data-driven approach.

In 2024, she and Agrawal showed that private institutions were climbing up India's NIRF rankings by massively increasing their publication output and citation counts (A. Agrawal and M. Koley Preprint at Zenodo https://doi.org/qbr3; 2024). But these gains in output, they suggest, might be happening without adequate checks by universities of the papers' quality and integrity.

Agrawal's work has resonated beyond his home country, too. Spick says that when Agrawal flags questionable research behaviours, integrity sleuths often begin to spot similar issues elsewhere.

But this progress has come at a high cost to Agrawal. He has been unable to find employment and is now facing a lawsuit filed by a private university against seven members of the IRW. Some days, the toll wears him down. "Once in a while I do have thoughts, thinking that maybe I should stop doing this," says Agrawal.

Still, he has kept going and has this year begun to run workshops for universities to raise awareness about research integrity. The overall goal, he says, is to promote accountability and help institutions to take action. He hopes to see some impact on the NIRF rankings next year.

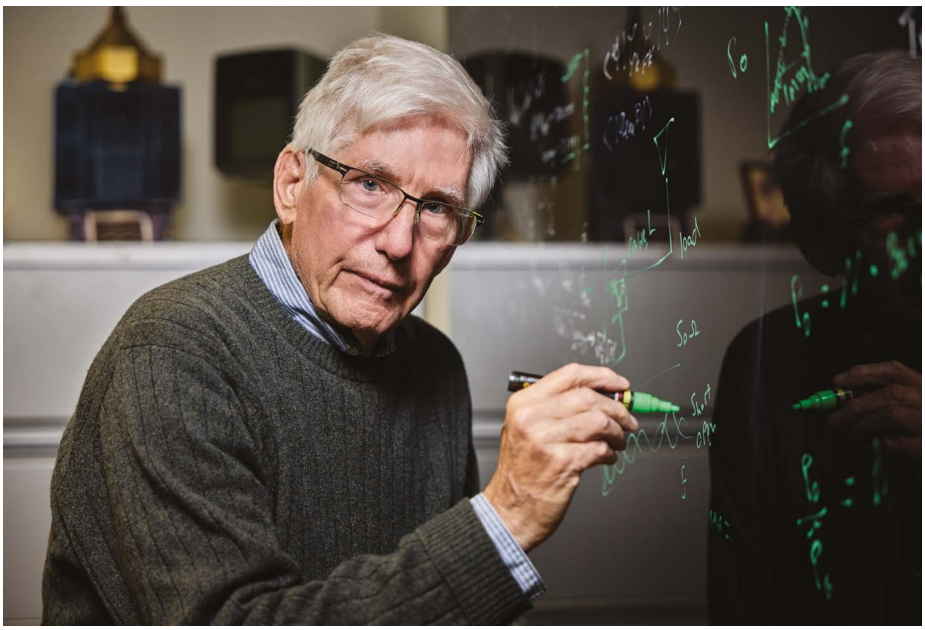
Agrawal knows that the effort to clean up Indian science will be a slow task. He likens it to a Hindu idiom about a pot that fills drop by drop. "It is difficult to predict when the pot is going to overflow. But we have to keep filling it."

Tony Tyson
Telescope pioneer

"It was high-risk, high-reward. We took the risk."

This physicist is the visionary behind the brand-new Vera Rubin Observatory.

By Davide Castelvecchi



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Earlier this year, Tony Tyson got a sneak preview of the first images taken by the brand-new Vera Rubin Observatory in Chile — a project he first dreamt up more than 30 years ago. After he and his team had spent months troubleshooting the telescope's hardware and control software, thousands of galaxies came into perfect focus. "It's one thing to know that everything is working, but it's another thing to see it with your own eyes," says Tyson. "When I saw that, I said 'wow'."

From its perch on Cerro Pachón in the Andes, the Rubin observatory will soon use the largest digital camera in the world to begin making a continuous video of the southern sky. Despite weighing some 350 tonnes, the telescope has a compact design that allows it to move nimbly, capturing a different exposure every 40 seconds. It will map the Universe's invisible dark matter in 3D, detect millions of pulsating or exploding stars and spot asteroids that could threaten Earth.

Its unprecedented design and the US$810-million cost made the Rubin a huge bet. "It was high-risk, high-reward. We took the risk," says Tyson, a physicist at the University of California, Davis.

Tyson not only conceived the project, but also pushed it forwards, despite early scepticism. "We wouldn't have the Rubin Observatory today if he hadn't had that vision, and also that dogged determination," says Catherine Heymans, an astrophysicist at the University of Edinburgh, UK, and the Astronomer Royal for Scotland.

Tyson's interest in science, and building electronic devices, started early. When he was five, a bout of pulmonary disease and rheumatic fever forced him to spend many hours in a steam tent, where he listened to shortwave radio. This experience, he says, kick-started his lifelong interest in getting information out of noisy signals. He also had an early interest in the science of gravity.

Soon after earning a PhD in physics, he joined AT&T Bell Labs in Murray Hill, New Jersey, in 1969. He worked on an early gravitational-wave detector, and then took an interest in charge-coupled device (CCD) sensors — which had just been invented "down the hall". He realized that the devices' ability to sense even tiny amounts of light could transform astronomy. He set out to use these sensors to reveal even the faintest, most distant galaxies.

Tyson's ultimate goal was to image large swathes of the sky, measuring how galaxies' shapes distorted as their light travelled across a Universe filled with immense lumps of dark matter. He started applying for telescope time to search for the effect in 1973. "I got turned down time after time," he says.

"A lot of people didn't think it was possible", particularly from the ground, says Heymans. But in 2000, Tyson was one of the first researchers to use the technique, called 'weak gravitational lensing', to reveal the presence of dark matter (D. M. Wittman *et al. Nature* **405**, 143–148; 2000).

Meanwhile, Tyson continued to use CCDs to build larger and larger digital cameras for telescopes. One that he built in the early 1990s with physicist Gary Bernstein, his postdoc at the time, was installed at a US telescope in Chile and was a key tool in the 1998 discovery of dark energy. While working on that telescope, Tyson got the idea for the Rubin telescope, which he led from the first proposal in 2000 until the main mirror was on its way to completion. He still holds the role of chief scientist, managing the tune-up of the complex apparatus.

Bernstein, who is now at the University of Pennsylvania in Philadelphia, says that Tyson's "incredibly imaginative" ideas did not always pan out — but often did. "He's not afraid to think big."

Digital cameras made of CCDs are now the standard tool for optical imaging in all of astronomy, but the telescope in the Rubin Observatory, called the Simonyi Survey Telescope, has the largest digital camera ever built. It's the size of a small car and can capture 3,200 megapixels in each shot. By covering the entire southern sky hundreds of times, it will bring incredibly faint objects into view, and it will create time-lapse maps of the cosmos. "It really is going to change the way we do astronomy," Heymans says.

Even at age 85, Tyson has no intention of slowing down. He expects the telescope he pushed for to deliver on his ultimate vision, conducting the largest-ever weak gravitational lensing survey of the Universe. He also expects it to reveal something surprising: "There's a large chance that we'll discover something that blows our minds."

Precious Matsoso
Pandemic negotiator

The first global pandemic treaty — and the woman who made it happen.

By Celeste Biever

In 2025, it often felt as if the world was tearing itself apart. Then, on 16 April at around 2 a.m. local time in Geneva, Switzerland, came a glimpse of unity. The 190-odd nations belonging to the World Health Organization (WHO) had reached a consensus on the draft text of the first global pandemic treaty. The fruit of more than three years of gruelling negotiations, the document lays out guiding principles for how the world should pull together to prevent, prepare for and respond to the next pandemic. "I'm overwhelmed, overjoyed," said Precious Matsoso, who co-chaired the WHO group that steered the negotiation, that morning.

A large source of friction during talks was how to make a plan that would be more equitable than the response to the COVID-19 pandemic had been. The open sharing of samples and data on the spread and evolution of the SARS-CoV-2 virus enabled the development of life-saving treatments and vaccines. But those benefits were not shared equally between nations. Low-income countries were forced to wait for life-saving drugs, and high-income nations were accused of hoarding them.

Matsoso, an experienced figure in global health, was well placed to navigate the sometimes fractious negotiations. At several points in her career, she had helped to expand access to HIV medications, including as director-general of South Africa's health department from 2010 to 2019. Based in Pretoria, she is currently at the Wits Health Consortium of the University of the Witwatersrand and has held various leadership roles at the WHO over the past two decades.

Steering the pandemic-treaty negotiation was punishing, says Roland Driece, a director at the Dutch health ministry in The Hague, who co-chaired the first 2.5 years of talks with Matsoso. "Everybody is unhappy with you because you never do what they want you to do," he says. "You always try to find a middle ground."

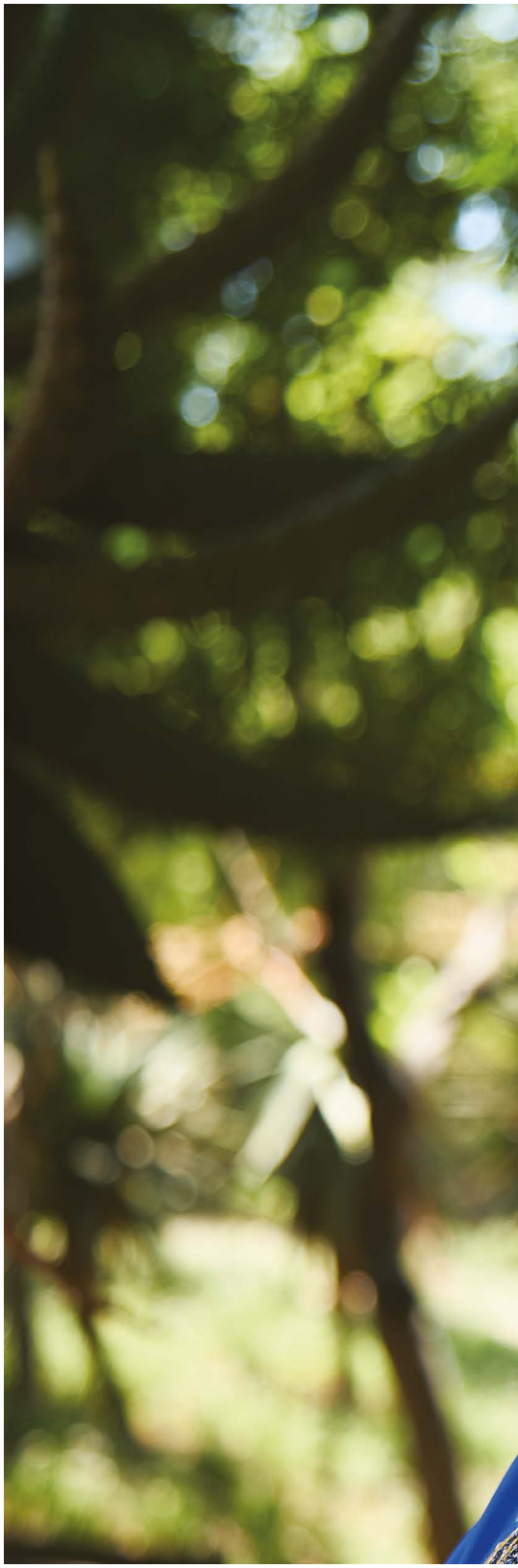
Matsoso used a variety of tactics to encourage compromise. At times, she had to be firm in the face of acrimonious debate. "I don't want to hear anybody's red line here," she recalls saying. "I think you need to tell me: how are we going to solve this problem?"

But she also brought a warmth and originality to the process that Driece admires. On at least one occasion she sang to delegates: 'All you need is love' by the Beatles carried the message of cooperation. "I had to use every trick in the book to get them to get the work done," she says.

Lawrence Gostin, a legal scholar at Georgetown University in Washington DC who advised the WHO on the treaty, says that her efforts were instrumental. "If it were not for her, we might not have a pandemic agreement."

The text was formally adopted by national governments in May, but several challenges remain before it can come into force. Details in the contentious section about pathogen access and benefit sharing are still being hashed out by a dedicated working group and are due to be finished in May 2026. Then, for it to be fully binding, 60 countries must ratify the treaty, which could take months or even years.

Some have argued that the deal is not generous enough to low-income countries. The treaty says that companies that make vaccines and other medications during a pandemic must provide at least 20% of those



"I had to use every trick in the book to get them to get the work done."

CHRIS DE BEER-PROCTER FOR *NATURE*

products to the WHO. "20% is better than nothing, but it does not equate to a truly equitable and just approach," noted a *Lancet* editorial in May (see *Lancet* **405**, 1555; 2025).

Matsoso argues that this criticism ignores other hard-won agreements, such as the promise to transfer technological know-how to low-income countries so that they can produce diagnostics and medications themselves. This is the first agreement of its kind that will enable local production, she says. "We have those provisions now."

The negotiations felt "like running a marathon, but while sprinting", says Matsoso. There was an arduous list of tasks to get through, and they all had to be done quickly. And, although nobody wants another pandemic, when the time comes to act, Matsoso is optimistic that the world will be better prepared than before. "I'm hoping that a few decades from now, when people look back, they'll say, 'You know, it was worth the effort'."

Sarah Tabrizi
Huntington's hero

This neurologist is leading clinical efforts to treat the devastating brain disease.

By Elie Dolgin

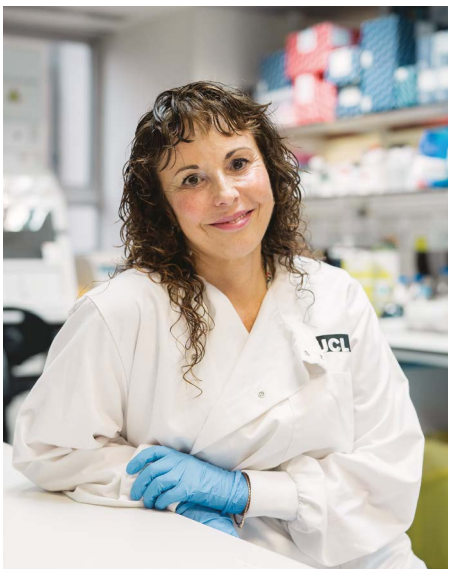
On a video call in early September, Sarah Tabrizi first saw the data that she and other researchers studying Huntington's disease had been chasing for decades: compelling evidence that a gene-targeting therapy could slow the relentless progression of the neurodegenerative brain disorder.

Before these results, "I was beginning to get a little bit worried that maybe, by the time people develop symptoms, that it was going to be too late to treat", says Tabrizi, a neurologist who directs the Huntington's Disease Centre at University College London. But here was powerful validation that the window for treating the rare, hereditary condition remains open — offering a chance for meaningful, disease-modifying interventions.

"It's a giant step forward," says Tabrizi, who was the trial's lead scientific adviser. "The dial has been shifted."

The first-in-class gene therapy — called AMT-130 and developed by uniQure, a biotechnology company in Amsterdam — uses a harmless virus to deliver strands of genetic material into affected brain regions. Once there, the therapy switches off production of the faulty mutant huntingtin protein that slowly destroys brain cells.

The clinical data set was small, involving just 12 people who received a high dose of the therapy. And the treatment is invasive, requiring lengthy brain surgery. But the results were striking. On a standard rating scale used to assesses motor and cognitive functions and other measures of daily living, the scores of participants receiving the high dose dropped by just 0.38 points over three years. That's compared with a reduction of 1.52 points for people in a control group, meaning that the treatment slowed the rate of decline by 75%. That clinical benefit was reinforced by molecular validation:



JESSICA HALLETT/*NATURE*

spinal-fluid levels of a protein linked to dying brain cells had gone down in the treatment recipients, the opposite of what typically occurs as the disease progresses.

After digesting the findings, Tabrizi and her close collaborator Ed Wild, a fellow neurologist at University College London, shared what Wild describes as a "massive hug". But, after that, it was right back to the daily demands of patient care and research. "We'll celebrate very unreservedly — but briefly," Wild says. "We're like an episode of *The West Wing*: it's always, 'What's next?'"

Next for Tabrizi and Wild are leading roles in evaluating five other huntingtin-lowering therapies in clinical development, along with several others poised to enter human trials soon. Tabrizi is also spearheading laboratory studies into the mechanisms of neurodegeneration — work that could yield many other drug candidates in the future.

"Sarah is amazing," says Hugh Rickards, a neuropsychiatrist at the University of Birmingham, UK. "She's the spider in the middle of the web. You name a disease-modifying therapy in HD — she's got her hand on it somewhere."

Plus, "she's one of the nicest people you'll ever meet", says Samuel Frank, a neurologist at the Beth Israel Deaconess Medical Center in Boston, Massachusetts, who, like Rickards, has worked with Tabrizi on Huntington's trials.

Playing a part in nearly every important clinical advance means that she also carries the scars of the field's most agonizing disappointments. Only four years ago, another promising huntingtin-targeted therapy, tominersen, faltered in late-stage trials. Overall, the drug failed to improve people's outcomes compared with those of the control group and it came with dangerous side effects at higher doses. As principal investigator of the nearly 800-person study, the unenviable task of explaining the results to participating families fell to Tabrizi. "It was heartbreaking," she says.

She recalls her message to the distraught community: "Trials are scientific experiments," she says. "Through failure, as painful as it is, is often how you learn."

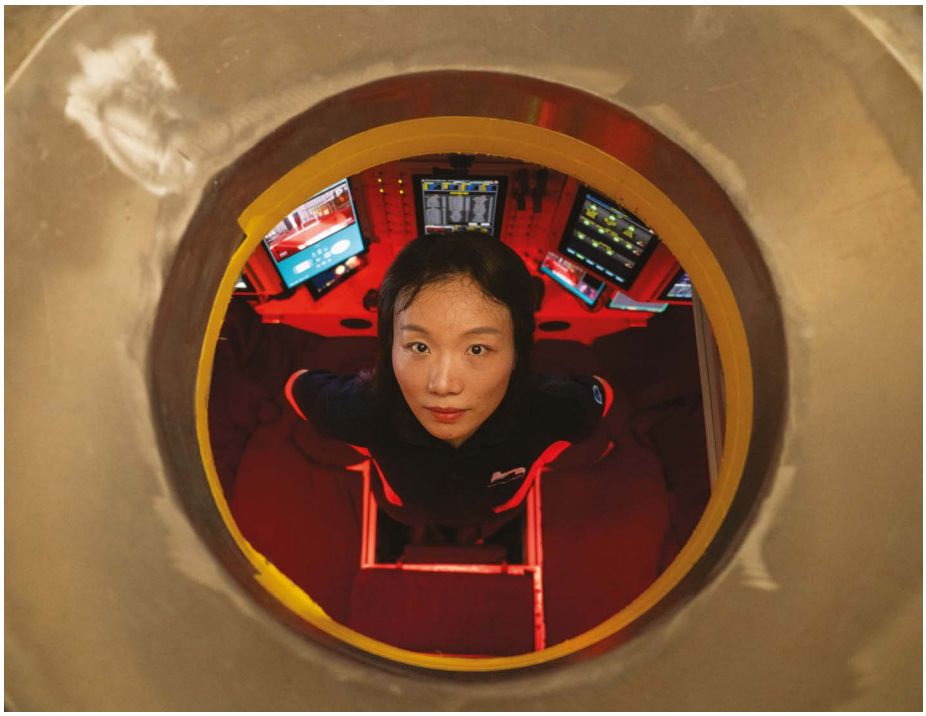
Tabrizi took her own advice to heart. She helped to chart a path forwards for tominersen, contributing to the design of a trial with a new dosing regimen in relatively young individuals with a milder form of the disease. Early indications suggest the dosing regimen is safer. She also led a field-wide push to refine clinical-trial designs for Huntington's research.

Lessons learnt along the way informed the development of AMT-130, a drug now hailed by many as the most promising advance in Huntington's treatment so far. Although regulators might require further data before the therapy can be evaluated for market approval, enthusiasm for the science behind it remains strong. What's more, AMT-130's success marks an important victory for the gene-therapy field more broadly, which in recent months has been shaken by the deaths of several people, including children, in clinical trials and in early-access settings.

But Tabrizi is focused not just on treating Huntington's: she is working to prevent it. For the past eight years, she has led one of the largest studies of brain health in young adults who carry the disease-causing mutation but are still decades away from developing symptoms. In January, her team reported that these individuals already show subtle changes in their brains and molecular signs of neuronal stress — a finding that Tabrizi hopes will justify intervening at an earlier stage (R. I. Scahill *et al. Nature Med.* **31**, 807–818; 2025). "It's all part of a big plan," she says. "I want to see if we can prevent Huntington's from ever occurring."

Mengran Du
Deep diver

"The best way to know the unknown is to go there."



BILLY H. C. KWOK FOR *NATURE*

How a Chinese researcher discovered the deepest animal ecosystems on Earth.

By Rachel Fieldhouse

Looking out of the *Fendouzhe* submersible, more than nine kilometres below the ocean surface, Mengran Du knew she was seeing something totally new to science. The vessel's lights illuminated a thriving ecosystem in which ghostly bristleworms swim among fields of blood-red tubeworms.

Du and her colleagues were exploring the hadal zone — the lowermost layer of the ocean, found beyond depths of six kilometres. Here, at the bottom of the Kuril–Kamchatka Trench northeast of Japan, Du and her team discovered the deepest-known ecosystem with animals on the planet during dives in 2024, which they described this year (X. Peng *et al. Nature* **645**, 679–685; 2025). "As a diving scientist, I always have the curiosity to know the unknowns about hadal trenches," says Du, a geoscientist at the Chinese Academy of Sciences' Institute of Deep-sea Science and Engineering in Sanya, China. "The best way to know the unknown is to go there and feel it with your heart and experience, and look at the bottom with your bare eyes."

The ecosystem discovered by the *Fendouzhe* crew relies on an unusual source of energy. Unlike most life at the surface, which depends on sunlight, this hadal-zone ecosystem derives energy from methane, hydrogen sulfide and other compounds dissolved in fluids that seep up from the ocean floor. Chemosynthetic microbes use these energy-rich molecules to convert inorganic carbon into carbohydrates that then support the rest of the ecosystem. Du was the first to observe several species of gastropods, tubeworms, clams and other creatures in these 'cold seeps', several of which are likely to be new to science, she says.

"Mengran has made a great contribution to these expeditions," says Xiaotong Peng, deputy director of the Institute of Deep-sea Science and Engineering, who was also in the submersible. He says Du's experience in coastal research allowed her to identify species found in chemosynthetic communities while they were still on the sea floor, an important skill for determining the significance of findings. "She has a great passion for deep-sea science, and that is one of the reasons why we can find such amazing phenomena at the sea floor," he adds.

The discovery prompted the team to change its plans during the 2024 expedition, says Peng. The researchers took the *Fendouzhe* submersible to search for chemosynthetic ecosystems at more sites, including in the nearby Aleutian Trench.

Du, who was the chief scientific officer for the expedition, and her colleagues completed 24 dives in the submersible, which last an average of around 6 hours. Built out of titanium to withstand crushing pressures of 98 megapascals — about 1,000 times the air pressure at sea level — the submersible has an area for the crew that is just 1.8 metres and holds three people.

This year, Du, Peng and their colleagues conducted expeditions to another trench in the southern Pacific Ocean, where they found ecosystems that are similar to those they found in the northern part of the ocean last year. This offers strong evidence that there is a global corridor of chemosynthetic ecosystems across Earth's oceans, say the researchers.

The findings suggests that chemosynthesis might play a larger part in the deep sea than previously thought, says Zanna Chase, a chemical oceanographer at the University of Tasmania in Hobart, Australia. Researchers once thought that life on the ocean floor depended on food sources that sank from much higher up in the water column, such as dead whales and other organisms. Chase says the existence of heterotrophic organisms, which feed on other organisms, is also significant, and it might indicate that chemosynthetic organisms could support a food web, much like photosynthesizing organisms do on the surface.

Du is eager to make more dives to this dark world to discover its secrets. While others might find the space in the submersible claustrophobic, Du says she is always excited to get in, likening it to a time machine that "can take you to different doors that direct you to a brand-new world".

Luciano Moreira
Mosquito rancher

This scientist is breeding billions of insects to fight disease in Brazil.

By Mariana Lenharo

Inside a massive factory in the industrial district of Curitiba, Brazil, millions of *Aedes aegypti* mosquitoes are breeding in a climate-controlled room filled with mesh cages. Every week, the facility produces more than 80 million mosquito eggs.

At the heart of this effort is Luciano Moreira, a soft-spoken agricultural engineer and entomologist, who opened the factory in July as part of an effort to fight mosquito-borne illnesses in the country.

At the Curitiba facility, mosquitoes are infected with a bacterium called *Wolbachia*, which curbs the transmission of harmful human pathogens. Their offspring are being released in Brazilian cities to help to control dengue, a deadly viral disease transmitted mainly by *A. aegypti*.

Until recently, *Wolbachia*-carrying mosquitoes were released only as part of small-scale research projects. The new factory marks a shift towards nationwide adoption of the method after Brazil's federal government recognized it as an official public-health measure to combat dengue and other mosquito-borne diseases. People credit Moreira for making the case.

"He has succeeded not only in carrying out the academic work, running experiments to demonstrate the model's effectiveness, but also in convincing political decision-makers to implement the technology," says Pedro Lagerblad de Oliveira, a molecular entomologist at Brazil's Federal University of Rio de Janeiro. "This is a skill that not all scientists have."

Moreira's interest in mosquitoes started in the late 1990s, when he was a postdoctoral fellow in the laboratory of molecular entomologist Marcelo Jacobs-Lorena, then at Case Western Reserve University in Cleveland, Ohio. There, Moreira contributed to the development of the first mosquito genetically engineered to block malaria transmission.

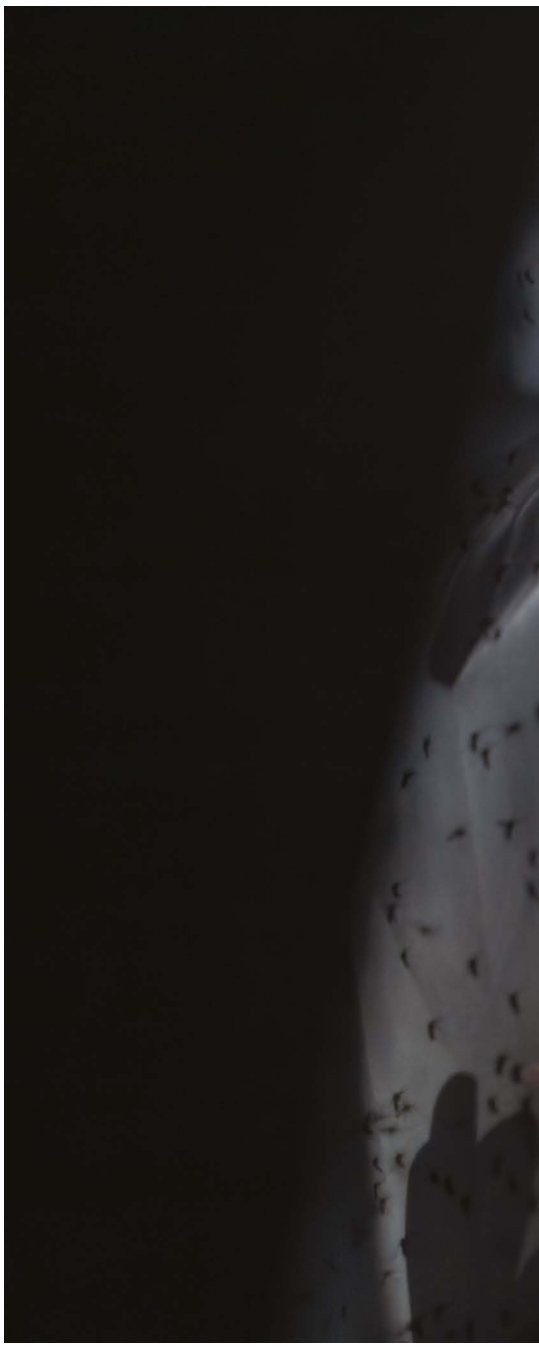
Several years later, he joined the lab of entomologist Scott O'Neill at Monash University in Melbourne, Australia, as a visiting scholar. O'Neill's team had managed to infect *A. aegypti* with *Wolbachia*, a relatively harmless bacterium that infects reproductive cells in many arthropod species. Moreira set out to test whether *Wolbachia* affected the insects' ability to transmit human pathogens.

It did. *Wolbachia*-carrying mosquitoes were less likely to pick up dengue from blood containing the virus than were uninfected ones (L. A. Moreira *et al*. *Cell* **139**, 1268–1278; 2009). Scientists don't yet understand the mechanism, but the bacterium might be competing with the virus for resources or it could be stimulating the production of antiviral proteins. The researchers found that it had the same protective effect against other viruses as well.

O'Neill started field testing the mosquitoes in Australia, and Moreira returned to Brazil for a research position at the Oswaldo Cruz Foundation (Fiocruz) in Belo Horizonte, a scientific institute affiliated with the country's health ministry. He assembled a small team to start tests in Brazil.

"Mosquitoes were first produced in a kind of artisanal way in a tiny, heated room, using pipettes and manual processes," Moreira says. But convincing public-health authorities to release millions of mosquitoes into their cities was a tough sell.

"This is never going to work," Moreira recalls one health official in Niterói saying. But after he explained that the strategy had already curbed dengue in other locations, the official came around. And their decision paid off. Dengue incidence in Niterói has dropped by 89% since the mosquitoes were introduced.



These positive results sparked broader interest, and Moreira and his colleagues decided to scale up the operation.

He helped to set up a partnership between the World Mosquito Program, led by O'Neill, and the Molecular Biology Institute of Paraná, a Fiocruz spin-off company based in Curitiba. Their collaboration gave rise to

"Mosquitoes were first produced in a kind of artisanal way."

GABRIELA PORTILHO FOR *NATURE*

Wolbito do Brasil, which runs the factory supplying the country's growing demand for the *Wolbachia*-infected mosquitoes, called wolbitos. Moreira is the company's chief executive. In August, the factory's first batch of mosquitoes was released in the southern state of Santa Catarina, where the weekly deployments will continue for a total of six months.

The mosquito factory, which needs more than 70 litres of human and animal blood a week, is humming along and on track to meeting its goal of producing five billion wolbitos a year, says Moreira. He has turned down requests from other countries interested in mosquitoes to focus on meeting demand for Brazilian cities, where dengue killed more than 6,300 people last year. The company now has 75 staff members. "They are all very engaged because they share my vision that we are working to improve the health of the population," Moreira says. "It's gratifying to see my commitment multiplied by 75."

Liang Wenfeng
Tech disruptor

After making his name in investing, the Chinese finance wizard founded DeepSeek, which released a game-changing AI reasoning model.

By Elizabeth Gibney

In January this year, an announcement from China rocked the world of artificial intelligence. The firm DeepSeek released its powerful but cheap R1 model out of the blue — instantly demonstrating that the United States was not as far ahead in AI as many experts had thought.

Behind the bombshell announcement is Liang Wenfeng, a 40-year-old former financial analyst who is thought to have made millions of dollars applying AI algorithms to the stock market before using the cash in 2023 to establish DeepSeek, based in Hangzhou. Liang avoids the limelight and has given only a handful of interviews to the Chinese press (he declined a request to speak to *Nature*).

Liang's models are as open as he is secretive. R1 is a 'reasoning' large language model (LLM) that excels at solving complex tasks — such as in mathematics and coding — by breaking them down into steps. It was the first of its kind to be released as open weight, meaning that the model can be downloaded and built on for free, so has been a boon for researchers who want to adapt algorithms to their own field. DeepSeek's success seems to have prompted other companies in China and the United States to follow suit by releasing their own open models.

Despite R1 having many capabilities that are on a par with the best US models, including those powering ChatGPT, its training costs were much less than those of rival companies, say AI experts. Training costs for Meta's Llama 3 405B model, for example, were more than ten times greater. DeepSeek's bid for transparency extended to publishing the details of how it built and trained R1 when, in September, the model became the first major LLM to undergo the scrutiny of peer review (D. Guo *et al. Nature* **645**, 633–638; 2025). By releasing its recipe, DeepSeek taught other AI researchers how to train a reasoning model.

In many ways, "DeepSeek has been hugely influential", says Adina Yakefu, a researcher at the community AI platform Hugging Face, which is based in New York City.

The heights of AI are a far cry from the village in Guangdong province where Liang was raised as the child of two primary-school teachers. Higher education took him to the prestigious Zhejiang University in Hangzhou, where he graduated with a master's in engineering in 2010; his thesis involved crafting algorithms to track objects in videos. He soon applied his love of AI to financial markets and, in 2015, co-founded the hedge fund High-Flyer, spinning off DeepSeek in 2023.

At that time, China faced a hurdle in developing LLMs. US export controls prevented Chinese firms from buying certain powerful computer chips known as graphics processing units (GPUs) made by the US chip manufacturer NVIDIA, which are suitable for training LLMs. But Liang was already well provisioned. He had spent the previous decade purchasing 10,000 NVIDIA GPUs, fuelled by curiosity about what research could be done on them. In a 2023 interview with Chinese media company 36Kr, he likened their purchase to someone buying a piano for their home: "One can afford it, and there's a group eager to play music on it."

Like many Western AI entrepreneurs, Liang has set his sights on achieving artificial general intelligence — AI systems as adept as humans in cognitive tasks — and he has shaped his company around this, says Benjamin Liu, a former researcher at DeepSeek. The company prioritizes a person's potential over their level of experience when hiring (one author on the DeepSeek R1 paper is still in secondary school) and it operates with little hierarchy, with researchers deciding what to work on themselves. Liang is said to be closely involved in research, and "even interns like myself were treated as full-time employees with meaningful responsibilities", says Liu.

Researchers from outside the company are impressed with how DeepSeek operates. Rather than exploit its popularity for commercial success, "it's remarkable how DeepSeek has remained committed to solving pretty difficult foundational problems" in AI research, says Kwan Yee Ng, who leads international AI governance at Concordia AI, a Beijing-based consultancy that focuses on AI safety.

DeepSeek models have become deeply enmeshed in Chinese life: local governments are using them to operate chatbot hotlines and to help citizens fill out forms, and tens of millions of people use them every day as part of the country's social-media platform, WeChat. In part, this trend is thanks to a government drive to build AI into the economy through a range of applications, from smart cities to health care.

DeepSeek has also become a symbol of a transition in the country's reputation — from master imitators to true innovators, according to Liang and other Chinese researchers. "The shift is real, and it's accelerating," says Yu Wu, a researcher at DeepSeek. Now the world is eagerly awaiting the firm's next reasoning model, R2, which is rumoured to have been delayed by issues with hardware and training data. One good bet is that Liang's company plans to give R2 to the world for free. "We're committed to open source forever," says Wu.

VCG/GETTY

Yifat Merbl
Peptide detective

"This was literally where you have the goosebumps."

DANIEL ROLIDER FOR *NATURE*

This scientist found a new facet of the immune system hiding in cellular rubbish.

By Cassandra Willyard

Detectives often find important clues by digging through rubbish. That approach paid off tremendously for systems biologist Yifat Merbl. When she and her team investigated cellular recycling centres known as proteasomes, they uncovered an entirely new part of the immune system.

"Up 'till now, we couldn't detect it," Merbl says, "because we didn't look at the garbage cans of cells."

From her office at the Weizmann Institute of Science in Rehovot, Israel, she holds up a blue plastic model of a proteasome, a barrel-shaped structure with a hollow core. The function seems simple: proteins enter the chamber, where they are shredded and then exit as smaller peptide fragments. But the machinery is surprisingly elaborate. The core comprises more than two dozen protein subunits and can associate with a variety of regulatory caps. If the goal is to slice and dice proteins, Merbl wondered, why the need for such complexity?

Merbl and her team used mass spectrometry to identify the peptides created by proteasomes in a variety of cells. They then compared the sequences of these peptides to those with known functions, using public databases. Many, they found, matched ones known to obliterate bacteria, such as by piercing their membranes. The team identified other fragments — about 1,000 in total — with sequences that, according to an algorithm, make them likely to be antimicrobial.

There might be more. When Merbl and her colleagues used computer models to chop up all human proteins into all possible peptide fragments, they found that there are more than 270,000 possible antimicrobials. The team had uncovered what seemed to be a new immune defence mechanism.

"This was literally where you have the goosebumps, because you realize that you may have found something fundamental," Merbl says. Further experiments revealed that when cells are infected with bacteria, the proteasome swaps its regulatory cap for one that favours the production of bacteria-fighting peptides. It's a first line of defence, Merbl says, one that operates independently of immune-cell activation.

The results were published in March (K. Goldberg *et al. Nature* **639**, 1032–1041; 2025) and they have many people in the field excited, says Ruslan Medzhitov, an immunologist at the Yale School of Medicine in New Haven, Connecticut. "There's something that we thought is so familiar and so well understood, and then boom — something totally unexpected and exciting comes out of it." What's most surprising, he says, is that the peptides come from "regular run-of-the-mill cellular proteins" rather than ones specifically involved in immune defence.

This means that processing by the proteasome vastly increases the number of jobs that a single protein can have, says Cesar de la Fuente, a bioengineer at the University of Pennsylvania in Philadelphia. "It's a very smart way, evolutionarily, of encoding a lot of functionality in a single gene," he says.

Such success was not something that Merbl had ever dreamt she would achieve. Her attention-deficit/hyperactivity disorder had made school especially challenging. She loved computer science and biology as a child, but struggled to attend classes and didn't graduate from high school with her peers. Over the years, however, she has come to accept that the way her brain works is an advantage, not a flaw. It gives her a different perspective.

Marc Kirschner, a biochemist and systems biologist at Harvard Medical School in Boston, Massachusetts who served as Merbl's doctoral adviser, remembers her passion, her brilliance and her dedication. She liked embarking on scientific fishing expeditions and not knowing what she would catch. "She's made some terrific discoveries," he says.

She and her team faced a setback this summer when their lab was destroyed by an Iranian missile strike. Merbl, who lives on campus, waited out the attack in a bomb shelter, then rushed to her lab. The building next door was on fire, and the power was off. She made her way through the building, navigating broken glass while wearing flip-flops, and closing freezer doors to keep samples cold. Merbl lost her mass spectrometer, but importantly, she says, no one was injured. Now the team is in a new space on campus and ready to keep looking for other secrets hiding in proteasome-produced peptides.

"It's not going to be only antimicrobials," she says. "It's not the end of the story."

ONES TO WATCH 2026

Reid Wiseman
Mission commander, Artemis II, NASA
The crew members of Artemis II will take a trip around the Moon as they test the Orion spacecraft and pave the way for future missions to the lunar surface.

Georgina Long
Medical oncologist, Melanoma Institute Australia, University of Sydney
She helped to develop an immune therapy for an aggressive, difficult-to-treat type of brain tumour. It is now going into clinical trials.

Amadou Sall
Virologist, Pasteur Institute of Dakar, Senegal
The MADIBA (Manufacturing in Africa for Disease Immunization and Building Autonomy) complex, which he helped build, should start pumping out high-quality vaccines for diseases including Ebola and measles.

Alice Xiang
Global head of AI governance, Sony AI, Seattle, Washington
Xiang has shown that it is possible to train AI models on an image data set that is ethically sourced and reduces biases. Will others follow suit?

Colette Delawalla
Chief executive and founder, Stand Up for Science, Decatur, Georgia
She has been focusing on building resistance to the US government's targeting of the nation's scientific enterprise ahead of the 2026 mid-term elections.

KJ Muldoon
Trailblazing baby

As a six-month-old, KJ Muldoon received the first hyper-personalized CRISPR gene-editing therapy.

By Heidi Ledford

To the research team working to save him, KJ Muldoon was first known only as Patient Eta.

But within months, KJ's name — and megawatt, chubby-cheeked smile — would be splashed across newspapers and broadcasts around the world as the first known person to receive a personalized CRISPR-based genome-editing therapy.

Soon after KJ was born in August 2024, doctors noticed that he was sleeping too much and eating too little. After a bevy of tests, they found that KJ has an ultra-rare genetic condition, called carbamoyl-phosphate synthetase 1 (CPS1) deficiency, that impairs the body's ability to process protein.

When the body breaks down proteins, it produces ammonia — a toxic substance that is usually processed by enzymes in the liver and excreted in urine. CPS1 deficiency compromises one of these enzymes, causing ammonia to accumulate in the blood, which can eventually damage the brain. The condition can be treated with a liver transplant, but about half of all babies with CPS1 deficiency die in early infancy.

One of KJ's doctors, paediatrician Rebecca Ahrens-Nicklas at the Children's Hospital of Philadelphia in Pennsylvania, wondered whether there might be another solution — correcting the faulty enzyme in his liver. She and Kiran Musunuru, a cardiologist at the Perelman School of Medicine at the University of Pennsylvania in Philadelphia, had a bold plan to treat children with rare genetic disorders using gene-editing therapies tailored to unique DNA sequences. KJ could be their first candidate.

Previous gene-editing therapies were designed to treat many people. The first approved CRISPR therapy, called Casgevy, could potentially treat tens of thousands of people with one of two blood disorders. By contrast, KJ's therapy would work only for him.

The team used an offshoot of CRISPR genome editing, called base editing, to target the problematic mutation — one faulty DNA letter out of the three billion in the human genome — and correct it (K. Musunuru *et al. N. Engl. J. Med.* **392**, 2235–2243; 2025). Such a hyper-personalized editing therapy had never been made so quickly; KJ might only have a few months before ammonia overwhelmed his small body.

In the end, it took a large team of researchers in academia and industry to make it happen. While KJ charmed everyone he met at the hospital, Musunuru and his lab members shielded themselves from learning any personal details about him, even his name. "There were certain go or no-go points where key decisions had to be made," Musunuru says. "We had to be objective with respect to the data."

Manufacturing companies worked around the clock to make the gene-editing components needed to treat KJ. "We estimated that it would take 18 months," says Sandy Ottensmann, a vice-president at Integrated DNA Technologies in Coralville, Iowa. "We did it in six."

On 25 February, KJ received the first of three infusions. His tolerance for protein in his diet has increased, but he still needs medication and regular monitoring to ensure that his ammonia levels stay in check.

After spending the first 307 days of his life in the hospital, KJ went home in June. As he left, hospital workers lined the hallways and the road outside, clapping. At home, KJ continued to hit his developmental milestones: eating solids and working towards taking his first steps. "He's always smiling," says his mother, Nicole Aaron.

The question now is how to ensure that other children will have the same opportunity. It costs millions of dollars to treat one person with Casgevy, and investors

"Such a hyper-personalized editing therapy had never been made so quickly."

CHILDREN'S HOSPITAL OF PHILADELPHIA

have been shying away from genome-editing companies. Several firms have laid off staff and discontinued programmes. "Now it seems to come down, a lot of times, just to the money," says Joseph Hacia, a medical geneticist at the Keck School of Medicine at the University of Southern California in Los Angeles. But there is fresh hope, he says: two programmes announced by the US Advanced Research Projects Agency for Health aim to bring "precision genetic medicines" to people with rare diseases.

Ahrens-Nicklas and Musunuru have been crafting a clinical trial of their approach in more children — as quickly as they can, says Ahrens-Nicklas. "Everyone saw the possibility and thought, 'Why isn't this available for my child?'"