such as genetic sequencing, have become cheaper and lab work has become automated. The cost of starting biotech companies is falling, lowering the risk for investors to fund new science-based companies. IndieBio and Y Combinator — an information-technology incubator in Mountain View, California, that started accepting biotech companies in 2014 — provide funding and mentoring to entrepreneurs in exchange for shares in the companies.

FORK IN THE ROAD

Y Combinator, which provides US$120,000 in seed funding per company, invested in Perlara this year; IndieBio, which provides $250,000 per start-up, has funded 42 companies in a variety of fields. Last year, biotech firms in the United States and Europe raised $3.5 billion in early-stage financing — more than in any previous year, according to the consultancy Ernst & Young. Much of this was from investors who have already made money in technology.

"Most of the venture guys I know want to change the world for the better," says Dan Widmaier, co-founder and chief executive of Bolt Threads in Emeryville, California, which uses genetic engineering to manufacture textiles. Widmaier went to work for the company three days after completing his PhD in 2010. "As they see it, being able to serve up an ad faster probably isn't changing the world for the better as much as being able to solve climate change or cure disease."

Conventional academic paths are also becoming less appealing. On average, young scientists earn their first US National Institutes of Health R01 grant — the bread-and-butter support for most biomedical scientists — at the age of 42. When Anitha Jayaprakash earned her genetics PhD from the Icahn School of Medicine at Mount Sinai in New York City in 2014, she saw scientists all around her stuck in postdocs. Many had no hope of finding their own tenure-track academic jobs — a phenomenon that Perlstein has dubbed the "postdocalypse". "It gave me a very depressing feeling about the whole academic space," says Jayaprakash. So she started Girihlet, a genetic-sequencing company in Berkeley, California, that has received funding from IndieBio and other investors.

"Most of the venture guys I know want to change the world for the better."

Alexander Lorestani felt the same way when he left a joint graduate and medical-degree programme in 2015 to co-found Geltor in San Leandro, California, which makes a vegan alternative to animal gelatin. He and his co-founder are 29 and 30 years old, and felt ready to use science to serve humanity. "I couldn't imagine waiting another five to ten years to dive into doing what I think of as my life's work," Lorestani says.

It's not an easy road. Most young biotech firms fail. Widmaier says that he never expected Bolt Threads to raise $90 million and last for 6 years. He says it has been rewarding to thrive long enough to be doing groundbreaking science — and to have a rare degree of independence. "Anywhere else, you join someone else's vision for what a perfect workplace is," he says. "The most valuable thing about building a company is that you get to build the place where you go to work every day." ■

HELIOPHYSICS

Hiccups for US satellite

Cosmic rays may be inducing glitches in space-weather probe's computer.

BY ALEXANDRA WITZE

A space-weather satellite that is supposed to alert Earth to incoming solar storms has temporarily dropped offline six times in the year since it became operational. The US craft's onboard computer may be experiencing hiccups caused unexpectedly by Galactic cosmic rays.

The Deep Space Climate Observatory (DSCOVR) went out of action most recently on 30 October. In each case, it unexpectedly entered a 'safe hold', in which scientific data stopped flowing and engineers had to scramble to try to recover the spacecraft. In total, DSCOVR's space-weather forecasting instruments have been offline for more than 42 hours since 28 October 2015, when the US National Oceanic and Atmospheric Administration (NOAA) took the spacecraft over from NASA, which built and launched it.

NASA

Workers test solar arrays on the DSCOVR satellite, which is now used to monitor space weather.

Each outage lasts for only a few hours, and the total downtime amounts to more than 0.5% of its time in space — well within NOAA's requirement that the spacecraft operate at least 96% of the time. The 11 October outage did not significantly affect predictions of a minor geomagnetic storm that arrived a few days later, says Robert Rutledge, head of the forecast office at NOAA's Space Weather Prediction Center in Boulder, Colorado.

But the outages mean that DSCOVR could be offline when a major solar storm erupts, leaving Earth essentially blind to the incoming onslaught. "Are they problematic? Yes," says Douglas Biesecker, a solar physicist at the Boulder centre.

Other heliophysics spacecraft monitor solar eruptions, but DSCOVR delivers unique information from its location at ▶

the gravitationally stable L1 point, about 1.5 million kilometres from Earth in the direction of the Sun. The spacecraft's instruments measure the speed, magnetic field and other properties of the charged particles streaming off the Sun. Those data translate into better forecasts of what could happen when a solar storm hits Earth, such as disruptions to satellite electronics or fluctuations in electrical power grids.

DSCOVR is NOAA's main tool for forecasting space weather, but it began life as Triana, a NASA Earth-observing spacecraft built in the late 1990s to gaze constantly at the planet. A pet project of Al Gore, then the US vice-president, Triana was shelved in 2001, then repurposed in 2008 for space-weather needs. "It was never designed from the beginning to be a space-weather satellite," says Steven Clarke, head of NASA's heliophysics division in Washington DC.

The satellite launched on 11 February 2015 and experienced its first outage four months later, when its onboard computer spontaneously rebooted. On average, the safe holds happen every 74 days, but two came just 8 days apart. They are not correlated with solar storms.

A NASA internal review board convened to study the problem could not definitively pinpoint the cause, but concluded that it was most likely to be Galactic cosmic rays randomly striking the spacecraft, causing high-energy ionization that reboots the computer. The computer, which was built by NASA in 2000, contains a processor card that is similar to those flying aboard many other missions and is meant to withstand the radiation hazards of deep space.

NOAA does have a back-up data stream, from the Advanced Composition Explorer (ACE) spacecraft that is also orbiting the L1 point. That was the primary source of solar-wind data until NOAA forecasters switched to DSCOVR in July. But ACE is 19 years old, and intense solar storms can swamp its forecasting instruments.

NOAA has requested an extra US$1.5 million from Congress to improve how it handles DSCOVR data, including its responses to the outages. The satellite is supposed to last until 2022, when a follow-up mission is slated for launch. Historically, NOAA has cobbled together its space-weather observations where and when it could, but the US government is starting to demand a more coherent approach. On 13 October, President Barack Obama signed an executive order that, among other things, requires NOAA to "ensure the continuous improvement of operational space weather services". ■

Crop yields and water efficiency could be improved with the use of better gene-editing techniques.

AFP/GETTY

BOTANY

A better way to hack plant DNA

As gene editing opens doors, crop researchers are hamstrung by the need for more-modern tools.

BY HEIDI LEDFORD

When crop engineers from around the world gathered in London in late October, their research goals were ambitious: to make rice that uses water more efficiently, cereals that need less fertilizer and uberproductive cassava powered by turbocharged photosynthesis.

The 150 attendees of the Crop Engineering Consortium Workshop were awash with ideas and brimming with molecular gadgets. Thanks to advances in synthetic biology and automation, several projects boasted more than 1,000 engineered genes and other molecular tools, ready to test in a researcher's crop of choice. But that is where they often hit a wall. Outdated methods for generating plants with customized genomes — a process called transformation — are cumbersome, unreliable and time-consuming.

Asked what hurdles remain for the field, plant developmental biologist Giles Oldroyd of the John Innes Centre in Norwich, UK, had a ready answer: "The big thing would be to improve plant transformation," he said.

"What we're all facing is this delivery problem," says Dan Voytas, a plant biologist at the University of Minnesota in Saint Paul. "We have powerful reagents, but how do you get them into the cells?"

At issue is the decades-old problem that it is difficult to modify plant genomes and then regenerate a whole plant from a few transformed cells. Genome-editing techniques such as CRISPR–Cas9 hold out the promise of sophisticated crop engineering that would once have been unthinkable — making it all the more frustrating when researchers run up against an old roadblock.

On 28 September, the US National Science Foundation (NSF) recognized this frustration by announcing that it would fund research into better transformation methods. That focus is one of four in a new plant-genome research programme that will receive a total of US$15 million.

"Everybody agrees that it really is the bottleneck for genome engineering," says Neal Stewart, a plant biologist at the University of