Fast-track talent

A look at the impressive output from prolific researchers seeking solutions for disease treatment and climate-change mitigation.

Among the fastest-rising researchers in the Nature Index, these four scientists are ones to watch. From investigating strategies for reducing greenhouse-gas emissions to understanding the nuances of the human immune system, they are tackling some of the most pressing challenges in global science.


PADDY MILLS

DANIELA WEISKOPF
VIRUS SLEUTH

Daniela Weiskopf wants to understand the wide range of responses that viruses illicit in the human body. "For any virus, there are people who are asymptomatic and there are those who end up in the intensive-care unit, or eventually die," she says. "The virus is always the same, so why do people react so differently?"

It's a question that guides the work of Weiskopf's virology lab at the La Jolla Institute for Allergy and Immunology in San Diego, California. Her team studies T cells, a key part of the body's immune system.

T cells are activated by proteins made by the human leukocyte antigen *(HLA)* gene during an infection. With more than 7,000 known versions, or alleles, *HLA* is the most diverse gene in the human genome. Weiskopf suspects that this diversity is key to better understanding the nuances of human responses to viral infections. Each person has a unique set of *HLA* genes, which dictates their response to a pathogen. "It is the common belief that this extraordinary *HLA* diversity in the human population evolved as a broad defence mechanism," she says.

Weiskopf focuses her research on emerging infectious diseases, particularly those transmitted by mosquitoes. But regardless of which virus she is studying, Weiskopf always considers three angles: looking at the T-cell response of patients; investigating patients with mild or no symptoms; and assessing the level of protection that is provided by a vaccine, if available, in contrast to the natural immunity that is acquired after an infection.

One of Weiskopf's projects involves analysing blood samples of patients in Colombia with chikungunya, a mosquito-borne viral disease. She is comparing the T cells of patients who have recovered from the disease with those who have lingering symptoms six years after infection. The aim is to explain how T cells recognize and respond differently to virus proteins and how this might influence future treatment options.

Weiskopf is also studying Nicaraguan schoolchildren with dengue[1], another mosquito-borne viral disease, who remain asymptomatic. "I'm a big believer that if we want to find protection, we need to study the people who do not get sick," says Weiskopf.

When the COVID-19 pandemic was gaining momentum in 2020, Weiskopf's lab was able to pivot quickly to studying the disease. "We already had the methods set up and we knew what questions to ask," says Weiskopf. She has since published more than 130 papers investigating the SARS-CoV-2 virus that causes COVID-19, including a high-profile study published in *Science*[2] that demonstrated how T cells that react to common-cold coronaviruses can also recognize SARS-CoV-2. Weiskopf is now working on a COVID-19 study that aims to pinpoint the ideal number of vaccine booster shots to administer to different populations.

Weiskopf is passionate about communicating her findings beyond the scientific community. "I'm very interested in making sure that what we study is accessible to the bigger population," she says. "Because if I'm the only one to know about it, it doesn't help anybody."
Sandy Ong

NOAH PLANAVSKY
CARBON REMOVER

Noah Planavsky is investigating techniques to remove carbon dioxide from the atmosphere on a massive scale. He's interested in how atmospheric CO_2 is absorbed and stored by plants, rocks and sediments – and how these processes can inform approaches to mitigate the climate crisis. "If we want to meet climate goals, we're not only going to need dramatic cuts in emissions, we need to remove atmospheric carbon dioxide," says Planavsky, who studies geochemistry at Yale University in Connecticut.

Silicate rocks, for instance, which make up more than 90% of Earth's crust and upper mantle, play a key role in removing CO_2 from the atmosphere. During the process of weathering, as rainwater hits the surface of these rocks and wears them down, atmospheric CO_2 is converted into bicarbonates, which are dissolved and washed into the ocean before being processed by organisms such as plankton and algae. "Using oceans to store carbon, we can undo some harm that we're already doing to these systems," says Planavsky.

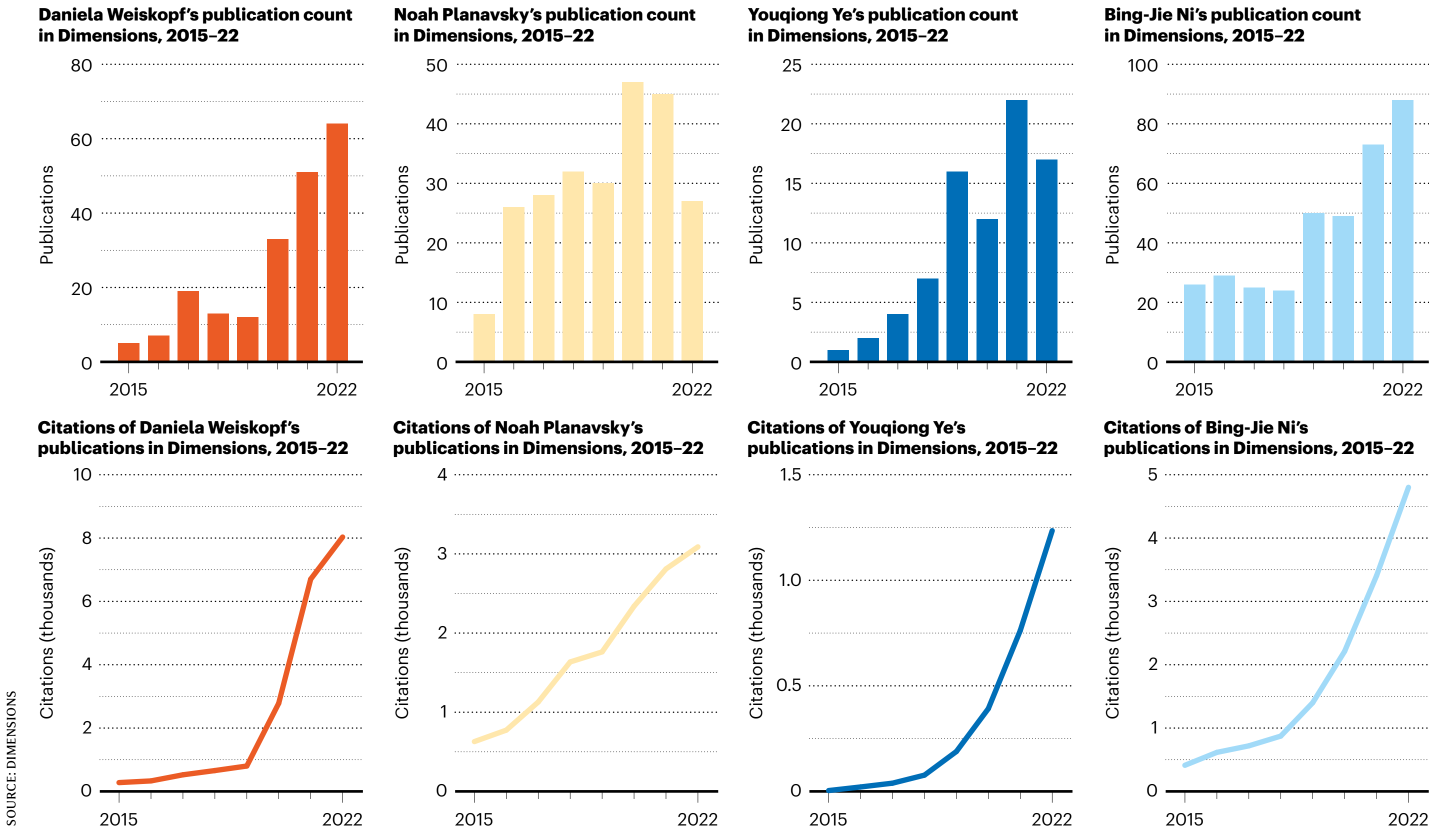
Planavsky is investigating how to speed up the process of weathering – which typically occurs over tens of thousands of years – by industrially milling silicate rocks to increase their surface area and spreading them across farmland. In a study[3] carried out in the Corn Belt region of the midwestern United States from 2016 to 2019, he and his colleagues found that 'enhanced weathering' using crushed basalt – a heavy volcanic rock that contains roughly 50% silica – removed an average of 15.4 tonnes of CO_2 per hectare of land over four years, up from 4.3 tonnes in the first year. The crushed basalt also improved soil fertility, boosting maize and soya-bean yields by up to 16%, while introducing minerals to the soil and neutralizing its pH. "There's a lot of excitement right now" about using basalt and other silicate rocks for carbon removal, says Planavsky.

Planavsky is also interested in removing carbon from marine ecosystems. In a 2023 *Nature*

PADDY MILLS

ON THE UP

The four researchers featured in these charts are among the fastest risers in the Nature Index for the biological sciences and Earth and environmental sciences. Their overall publication and citations records, drawn from Digital Science's Dimensions database, are shown for the period 2015 to 2022.



Sustainability paper[4], he and his co-authors used simulations to model how restored mangrove forests and seagrass meadows could make for excellent carbon sinks – sites that absorb more carbon than they release – with the added boon of increasing pH levels to help moderate acidification caused by global warming. The authors hope that the work will inform decisions around restoration projects for these ecosystems.

Reflecting on his work, Planavsky says that "being able to play a part in helping us move towards a society that is less destructive, while doing something that you love, is very motivating". **Sandy Ong**

YOUQIONG YE
PUSHING BOUNDARIES

Youqiong Ye studies the ecosystem that develops on the thin boundary that exists between a cancerous tumour and its host. She wants to understand how conditions within these margins affect treatments such as immunotherapy, which uses a patient's immune system to attack cancer cells. "The tumour boundary can act as a barrier to therapy, but it remains understudied," says Ye, who is based at the Shanghai Jiao Tong University in Shanghai, China.

Ye's interest in tumour microenvironments was spurred by work[5] she published with colleagues in 2019 as a postdoctoral researcher at the University of Texas Health Science Center in Houston. The team analysed 10,000 human-tumour samples to observe their response to hypoxia, a low-oxygen state that is often associated with fast-growing cancers. Hypoxia alters which tumour genes are turned on, creating a moving target that can be difficult to treat using standard methods such as chemotherapy. Against expectations, Ye and her colleagues identified some cases in which tumours might actually be more vulnerable to treatment when starved of oxygen, pointing to the possibility of new therapeutic approaches that target these weaknesses.

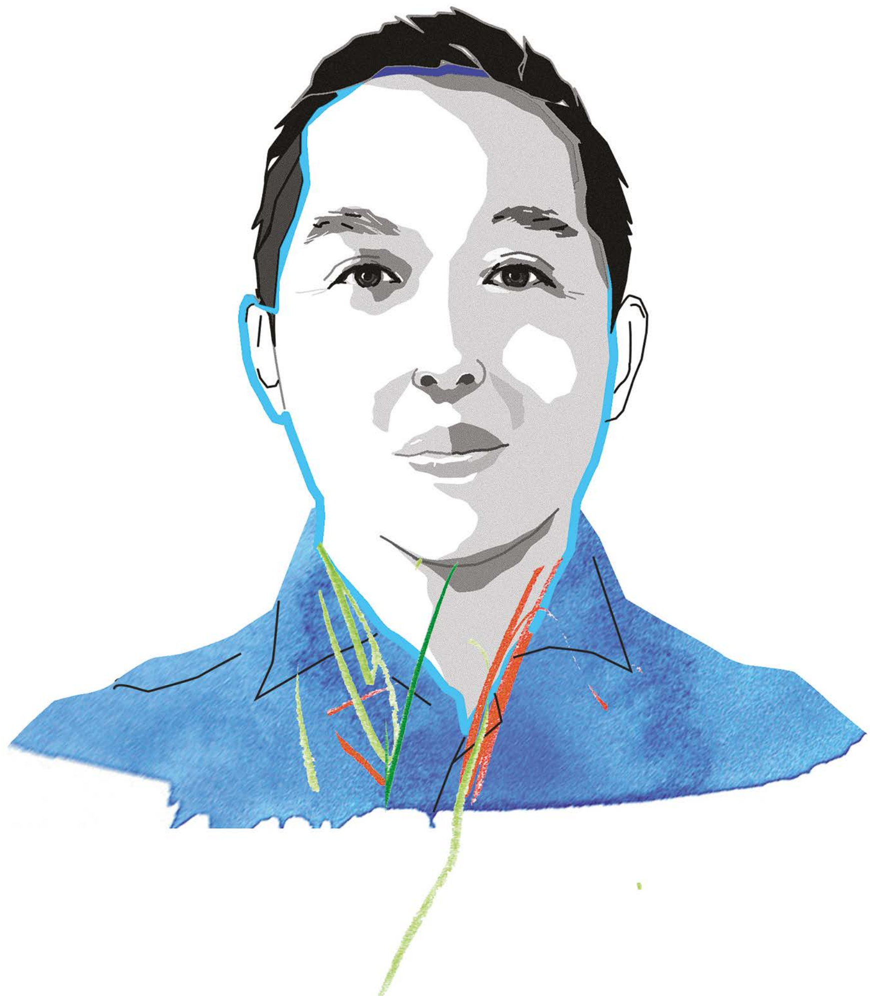
Ye hopes to identify other nuances related to the margins of tumours that could impact therapy. With her group at Shanghai Jiao Tong University, she found that colon-cancer patients who had fibroblast and macrophage cells – regulators of basic cellular functions such as repair and immunity – that turn on certain genes at the tumour boundary tended to respond poorly to immunotherapy. The *SPP1* gene, for example, was singled out in a 2022 *Nature Communications* study[6] co-authored by Ye.

> **"There is a lot of excitement right now about using basalt and other silicate rocks for carbon removal."**

In early 2023, Ye and her team published the results of a study[7] that investigated samples from six different tumour types and identified a structure formed by cancer-associated macrophages and fibroblasts. Called the tumour immune barrier, the structure seems to hinder the efficacy of immunotherapy. The researchers have since linked the immune barrier to previous studies by showing that macrophages in the structure that express the *SPP1* gene thrive in hypoxic environments. Ye thinks it might be possible to weaken the tumour immune barrier by blocking the actions of *SPP1*, thereby enhancing the efficacy of immunotherapy.

Ye's prolific publishing record reflects the breadth of her research and value as a collaborator. She hopes to use a deeper understanding of tumour boundaries to improve outcomes for patients. "We want to study other cancers, such as liver cancer and pancreatic cancer, to see if cell types at the boundary affect the function of cancer treatment," she says. "We're heading in a very interesting direction." **Chris Woolston**

BING-JIE NI
WASTEWATER WASHER



PADDY MILLS

Bing-Jie Ni wants to harness the processing power of microscopic organisms to slow the inadvertent release of greenhouse gases and other pollutants from wastewater treatment plants. By exposing anaerobic bacteria – microbes that thrive in low- or zero-oxygen environments – to sewage sludge, Ni and his colleagues have demonstrated the potential to break down wastes to produce methane gas that can be captured and used as an energy source.

There is one major complication, however: a build-up of plastic in the sludge is clogging the process. "Wastewater plants are not designed to remove plastics, so particles accumulate in the sludge at high levels," says Ni of the challenges that he and his team are facing in establishing robust anaerobic-digestion methods. "Nanoplastics and microplastics can cross bacterial membranes and damage the entire system."

Ni, an engineer at the University of New South Wales in Sydney, Australia, sounded the alarm on wastewater plastics in a 2019 study[8] that demonstrated how high levels of polyvinyl chloride (PVC) microplastics in sewage sludge can markedly reduce the efficiency of anaerobic-digestion systems.

For example, toxic levels of the chemical bisphenol A – a chemical that is often used in PVC-based food and beverage packaging – leaching from plastic was found to slow the anaerobic digestion of sludge and the harvesting of methane by as much as 25%.

Microplastics can also complicate efforts to control the release of another potent greenhouse gas, nitrous oxide, from sewage sludge. Wastewater plants have long depended on bacteria to convert ammonia in human waste into harmless nitrogen gas. But in a 2022 study[9], Ni and his colleagues reported that plastic contamination hampered the activity of ammonia-oxidizing bacteria. This could potentially increase the release of nitrous oxide into the atmosphere.

Reducing the flow of plastic into waterways and sewage systems would help the bacteria do their work, but there might be other solutions. Ni and his team have discovered that biochar – a type of charcoal – can bind with plastic particles and make them easier to filter out. "With biochar, we can separate plastics from the water system and protect the microbial activity," says Ni.

> **"Nanoplastics and microplastics can cross bacterial membranes and damage the entire system."**

Ni is interested in working with government regulators and industry to ensure that his findings can be put into practice. In 2019, the Intergovernmental Panel on Climate Change used Ni's research on nitrous oxide to update its Guidelines for National Greenhouse Gas Inventories, which provides methods to help countries estimate their emissions levels. He now hopes to draw attention to the increasingly urgent challenge of microplastics.

"Some people think that microplastics are a problem [only] for the future," says Ni, "but that's the wrong impression. They're already having a huge impact." **Chris Woolston**

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