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NEW YORK UNIVERSITY



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Distilations

Food Fight

Food is the stuff of life—except when starch, sugar, trans fat, and artificial color or flavor are added to it. Then it becomes a health menace linked to several chronic diseases. Unfortunately, the intake of ultraprocessed foods, which are typically shelf-stable and ready to eat or heat, has increased for nearly all Americans. So found School of Global Public Health faculty fellow Filippa Juul, who analyzed 18 years of dietary habits of nearly 41,000 adults. "Nutritional science tends to focus on the nutrient content of foods and has historically ignored the health implications of industrial food processing," which is far removed from whole foods, says Juul. Those aged 60+ fared the worst, consuming the lowest percentage of ultraprocessed foods and greatest percentage of whole foods at the study's start but eating the most ultraprocessed foods and least whole foods by the end. Juul recommends revising dietary guidelines and labeling, restricting marketing, taxing ultraprocessed foods, and improving access to affordable whole foods, particularly for disadvantaged people. -Dulcy Israel





SMOOTH TALKERS

How hard must the brain work to understand mixed-language expressions? Not very, says linguistics and psychology professor Liina Pvlkkänen. She and a team of neuroscientists investigated the little-understood process of language switching by mapping the neural activity of bilingual people. They found that moving from one tongue to another is seamless because the brain isn't even aware the language has switched. Instead, says Pylkkänen, bilinguals' brains "readily combine words from different languages together, much like when combining words from the same language."

Climate Control

Natural gas, predominantly methane, has been heralded as a cleaner alternative to crude oil. While it is extracted from underground reservoirs by drilling and fracking, the greatest methane stores remain untouched in the arctic permafrost and deep ocean, the latter holding about 500 gigatons. Methane is stored in the ocean in gas hydrates—crystalline cages that trap hydrocarbon molecules. The amount of natural gas stored in this way is twice that of all other fossil fuels combined. But whether they remain safely locked in their ice cages or instead are released as harmful greenhouse gases depends on a delicate sea-floor symbiosis between feather duster worms

and their microbial neighbors. Tandon School of Engineering researchers led by Ryan Hartman, associate professor of chemical and biomolecular engineering, discovered that this symbiotic relationship is pivotal to keeping the underwater hydrates frozen and the vast amounts of methane trapped. Subsisting on these stored gases are two types of an ancient bacteria known as archaea: the methanotrophs, which consume methane to produce carbon dioxide and give off heat in the process, and the methanogens, which absorb heat while they consume carbon dioxide to produce methane. But the overzealous heat-generating methanotrophs risk melting the

gas hydrates, which can only withstand a 0.001 K temperature increase. Fortunately, the feather duster worms consume the heat-generating methanotrophs, maintaining the lower temperatures needed to sustain the hydrates. "The worms are one of nature's ways of monitoring and controlling the system because they're eating the bacteria that generate the heat that would melt the hydrates," says Hartman, who cautions that warming oceans due to climate change could put this fragile equilibrium at risk. "We're sitting on massive reserves of greenhouse gases that could either be used in a clean. safe wav-or they could be released if we're not responsible." -Melanie Fine

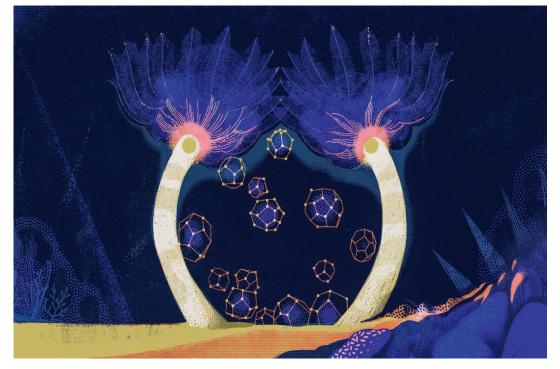


Illustration by Juan Berna

A recently hospitalized adult with dementia is at lower risk of readmission if the same nurse provides care once at home. according to a new study from the Rory Meyers College of Nursing. Researchers found that in older adults with dementia, those with low or moderate continuity of care were 30 to 33 percent more likely to land back in the hospital than those who were visited by one provider. Says Meyers assistant professor Chenjuan Ma: "Having the same person delivering care can increase familiarity, instill trust, and reduce confusion for patients and their families."



What Makes a Better Batter?

How does a baseball player consistently connect with a 100-mile-per-hour fastball, while another hitter can only whiff? NYU Shanghai neural science and psychology professor Li Li aimed to answer a question that has dogged talent scouts since the pastime's beginnings. Her team compared the visuomotor skills of batters on the Hong Kong national team with those who had never played competitive ball sports. At every level of experience and training, the athletes exhibited superior manual control performance and ocular tracking (following a moving target with one's eyes). Both capabilities became even more correlated with slugging accuracy as experience increased, but the eye movement metrics in particular were highly

predictive of success. Li, who admits she's not much of a fan but will tune in to the Hong Kong national team's games "because they're so good," attributes these disparities to the players having lower levels of "noise" in their motor systems. "With experience, the extraneous nonvisual sources of performance noise and inefficiencies in batting performance are trained out," she says, "thus ocular tracking—a basic visuomotor control ability that has very low noise to start with—becomes more predictive of batting accuracy." She likens the athletes' skills to innate intelligence: "You have two kids. You can teach them the same thing, give them the same training, but the kid with higher internal intelligence is going to do better." —D. I.



Digging Up the Past

A group of anthropologists and paleontologists from NYU, South Africa's University of the Witwatersrand, and other institutions around the world are fired up about locating some distant kin. Their discovery of fossilized back bones from an extinct relative of modern humans called Australopithecus sediba in South Africa's Malapa Cave at the Cradle of Humankind World Heritage Site is the missing link that settles a long-debated question as to whether early hominins climbed like apes or walked like humans. The 2-million-year-old fossils fit like perfect puzzle pieces with previously unearthed lumbar vertebrae from the same female (known as Issa), creating one of the most complete lower spines ever discovered in the early hominid record and providing an unprecedented look at the species' anatomy. Of particular note is the reassembled back's forward curve, or lordosis, indicating an adaptation to bipedalism—which means Issa could walk on two legs in addition to spending plenty of time in trees, as evidenced by her powerful back muscles.

Whoops. There It Is

The first sections of Issa's lumbar vertebrae were previously found in 2008 after the 9-year-old son of University of Witwatersrand paleoanthropologist Lee Berger stumbled upon some remains in the same location as the more recent discoveries. They were exploring the fossil-filled cave of Malapa when "Lee's son basically tripped over the site's first fossil and brought it to his dad's attention," says NYU evolutionary morphologist and paleoanthropologist Scott Williams. "Lee immediately recognized that it was a fossil hominin, found the original site, and started working at that."

Human, Kinda

"A big question in the field is, 'When do we start calling these [fossils] human?' " says Williams. Do Issa and her peers qualify? "Probably not," he says. "Their brains aren't much bigger than chimpanzees'. They wouldn't



have been doing a lot of stuff that we do aside from walking on two legs and probably using tools. I think we'd wait to call things human until much later."

Sitting on a Gold Mine

The Malapa Cave hasn't always been treated with the care it deserves. "This is a 2-million-year-old site that was originally blown up by gold miners," says Williams. Blocks blasted out of the pit were used to build a mining road, and "the lumbar vertebrae actually came out of one of those blocks." In preparation for extracting the closely positioned bones, the team used Micro-CT scans to "get a good picture of what's inside" without damaging the delicate fossils.

What's in a Name?

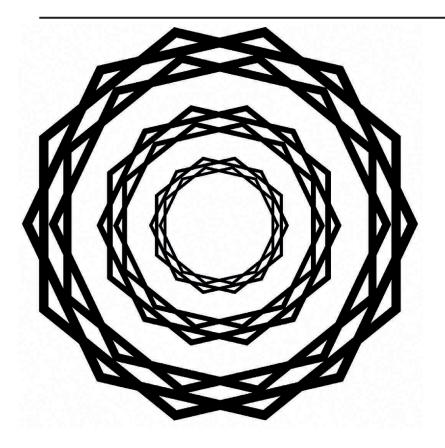
Assigning monikers to fossils is a time-honored tradition. There's the 2.5-million-year-old Mrs.

Ples—the most complete Australopithecus africanus skull ever found—and well-known Lucy, a 3.2-million-year-old Australopithecus afarensis skeleton exhumed in Ethiopia. Issa, which means "protector" in Swahili, was so named because scientists believe her remains are linked to another fossil discovered at Malapa—"a juvenile male, thought to be her son," says Williams.

Evolving Ideas

"Associated series of lumbar vertebrae are extraordinarily rare in the hominin fossil record," says Williams. And while the discovery is surely a scientific breakthrough, "the one thing that you can take away—from a historical perspective—is that you're almost certainly wrong about everything," he adds. "We're going to find new things that will change the story." —Paula Akpan





All in Your Head

Visual illusions are not just a neat trick. According to psychologist Pascal Wallisch at NYU's Center for Data Science, they "allow you to probe in a noninvasive way what's going on in your brain." He and visual artist Michael Karlovich, his student, recently discovered a new illusion, which they call Scintillating Starbursts. Looking at the image above, most people see a set of illusory light rays emanating from the center that aren't actually there. The researchers believe this is because each ring has diamond-shaped gaps that look to our low-resolution peripheral vision like bright spots. Because the diamonds align, the brain's instinctive pattern-matching assumes a common cause and imagines bright lines connecting them.

For most people, the rays also flicker or shimmer, which results from what Wallisch calls a "tug-of-war" between a high-resolution brain system that identifies objects in central vision and the low-res peripheral system used to track placement and motion. When the researchers showed 162 versions of the sets of rings to study participants, they found that the effect depended on particular combinations of shapes, contrasts, and arrangements, which may explain why the illusion had not been previously reported. Wallisch says visual illusions teach us not just about the brain but also about intellectual humility and our subjective reality. What you see or believe is not necessarily real outside your head—which, he notes, "is an important message in our current world that is so polarized." —Matthew Hutson

LEVELING THE LEARNING FIELD

Evaluating rates of attendance, high school graduation, and college enrollment is the traditional method for assessing a school system's success, but it doesn't tell the whole story. Despite overall gains in these outcomes over the past two decades in New York City, inequities abound based on race, ethnicity, and income level. Kathryn Hill, a senior research associate at the NYU Steinhardt-housed Research Alliance for New York City Schools, is looking beyond the usual monitoring practices. Her Indicators of Education Equity Project team is focusing on how unequal resources and opportunities play into these disparate outcomes. They're following kids in grades pre-K to 12, before and after the pandemic—"which disrupted schooling for all students but particularly for students who have been historically marginalized," says Hill. Indicators include access to rigorous coursework such as AP and honors classes, effective teachers, different disciplinary practices, and a supportive school climate. "One unique thing about our organization is that we have a data-sharing agreement with the NYC Department of Education, so we house and curate an archive of administrative records," says Hill. "We have individual-level student data that goes back into the '90s. We use that archive in a lot of our work." -D. I.



DESIGNING WOMAN

How does someone on society's fringes become a successful entrepreneur? Stern professor Gino Cattani's study found that Gabrielle "Coco" Chanel perfectly illustrates the answer. Born into poverty in France in 1883, her outsider status paradoxically created an opportunity for her to revolutionize fashion. "Her position was an advantage because she could see things from a different perspective ... things that others don't see," he says. Also key was her knack for cultivating the right connections. And timing—in her case a culture-convulsing war—offered an entry point for her radical ideas.

SISTER ACT

When her mother died, 12-year-old Chanel was sent to the Aubazine Abbey orphanage, where she remained for seven years. A recurring personality trait of outliers like Chanel, says Cattani, "is their ability to endure hardships that others cannot endure" as well as an "ability to accept negative feedback."

HAUTE STUFF

The black-and-white nuns' habits worn at the abbey later inspired Chanel's austere designs. In 1926, Vogue characterized Chanel's iconic "little black dress" as "the frock that all the world will wear."

IT CROWD

"Chanel understood the importance of searching for like-minded people who shared similar values and were willing to embrace [her] vision but also willing to support [her] work," says Cattani. Among those with whom she collaborated, hobnobbed—and sometimes dallied—were Jean Cocteau, Igor Stravinsky, Salvador Dalí, and Pablo Picasso.



MOONLIGHTING

Chanel adopted the name Coco during her brief stint as a cabaret singer. She abandoned that pursuit (reportedly for lack of vocal talent) and in 1910 opened her first shop, a hat boutique. By her late 40s, her business was grossing about \$70 million in today's dollars.

COPY THAT

Chanel refused to join the fight against piracy waged by the Chambre Syndicale, a French association of couture design houses. She argued that counterfeit designs were actually a form of flattery and free publicity. "Being copied is the ransom of success," she once said.

LOOSE THREADS

As WWI emancipated women from traditional roles, Chanel emancipated a receptive female public from their constrictive, cumbersome garments. When it comes to opening a door, explains Cattani, "events don't have to be macro" to make "a particular field more receptive towards novelty, more permeable." —D. I.

46% of women are "interested" or "very interested" in sports, with **Female** fandom is nothing new interested in watching them live and interested in watching Game" was written about a sports on TV baseball-loving girl named Katie Casey beseeching her beau to bring her to a ballfield instead of a show In the most lucrative North American pro leagues, women Women buy account for between of the total of official NFL market merchandise and spend of all sports apparel dollars

Female Fandom by the Numbers

It's not just female athletes who are deprived of a level playing field; female fans of professional sports don't get much respect either. "Common assumptions are that women only go to sporting events to be with their husbands or boyfriends, only watch sports to socialize, and are only superficial fans who [don't] understand the games," says Brianna Newland, a

clinical associate professor at the School of Professional Studies' Preston Robert Tisch Institute for Global Sport. Conducted with her SPS colleague Ted Hayduk, their survey of 1,796 demographically diverse women who followed a wide range of pro sports "confirms that these assumptions are false," says Newland. Among the takeaways: young women

reported stronger fan behavior than older women, urban female fans used more technology than those outside of cities, and working women and fans with kids consumed more sports. According to the researchers, teams and brands looking to maximize attendance and merchandise sales should make it their business to understand female sport fandom. —D. I.





Star Search

Understandably, for a long time no one knew where they came from. That is, until two NYU physicists, Glennys Farrar and Andrei Gruzinov, showed the theoretical feasibility of one source, so-called tidal disruption events. The name, however, undersells the phenomenon, which is the violent shredding of a star as it is consumed by a supermassive black hole. And now Farrar and her fellow researchers have concrete evidence connecting a tidal disruption event (TDE) to a neutrino, a particle that was presumably derived from an

ultrahigh-energy cosmic ray (UHECR).

At their center, most large galaxies host supermassive black holes, objects with millions or billions of times the mass of the sun whose gravitational pull is so strong that even light cannot escape. Every once in a while, an orbiting star gets too close. The gravitational pull on the side nearer the black hole is stronger than that on the far side, and this "tidal" force stretches the star, the way the moon tugs on Earth's oceans and creates tides. Eventually it strings the star out into an orbiting halo of gas and plasma that collides into itself, emitting extreme energy.

Farrar and Gruzinov recognized that these rare and brief TDEs were powerful enough to be the source of UHECRs. "The existence of these cosmic rays is just astounding," says Farrar, "that nature finds a way to accelerate particles to such high energies." UHECRs, however, are charged and interact with other charged particles and magnetic forces in space. If

they were ever to make their way to us, it would be through circuitous routes, arriving long after light from their associated TDEs, making it hard to connect them temporally. But if they were to collide with other matter surrounding the black hole, they might generate neutrinos—electrically neutral particles that interact very weakly with other matter. Meaning that black holes could be dropping clues, if only the right detectives were looking for them.

Fortunately, the astronomical survey at Caltech's Palomar Observatory detected a TDE, labeled AT2019dsg. The responsible black hole is an estimated 750 million light-years away and contains roughly 30 million solar masses. Then Antarctica's IceCube Neutrino Observatory detected a neutrino likely arriving from space, and from the same small patch of sky where AT2019dsg was observed.

The research groups compared notes and calculated that the chance of a mere coincidence was well below 1 percent; the neutrino was likely generated by a UHECR from the TDE. And since then, additional researchers have detected two more neutrinos likely coming from TDEs.

The discovery, published in *Nature Astronomy* and coauthored by Farrar, is only the second time high-energy neutrinos have been traced back to their source. While questions remain about how UHECRs generate neutrinos in the vicinity of black holes, further observations could clarify their origins. TDEs and their emissions might then help us address other mysteries of the universe, Farrar says: "Once we've understood them, they become more a tool for understanding things like the properties of supermassive black holes." — *M. H.*





Breathing Space

Telling kids to go out and play could be hazardous to their health. That's because 93 percent of children worldwide are exposed to air pollutant levels deemed unacceptable by the World Health Organization, In 2016. more than half a million people under the age of 15 died from exposure to air pollutants, which can result in cancer and respiratory, cardiovascular, and neurological diseases.

"Air quality is growing worse in many parts of the world, particularly countries like India and China where industrialization is in the early stages and coal-fired power plants are being built," says Laura Gladson, a doctoral researcher at NYU's Marron Institute of Urban Management, "Many US businesses, meanwhile, have relocated their polluting activities overseas to avoid regulatory penalties, exposing the world's

most disadvantaged populations to dangerous levels of air pollution."

To help mitigate this danger, NYU partnered with UNICEF and a crew of atmospheric scientists at NASA to develop a first-of-its-kind air quality monitoring index that allows local and regional governments, particularly those in low- and middle-income countries where they're most needed, to issue outdoor air quality alerts.

Crucial to the project is NASA's GEOS-CFshort for Goddard Earth Observing System Composition Forecast—a global air quality model that uses air pollution chemistry and meteorological data to provide high-resolution forecasts as far as five days out. "The GEOS-CF model has lots of different chemical species in it," explains clinical associate professor Kevin Cromar. director of Marron's Health. Environment, and Policy program. "One of

the things we helped [NASA] understand is of all the many chemical species in that model, which one should they focus on in terms of health-relevant pollutants." The index focuses on three key pollutants associated with respiratory disease in children: fine particulate matter, ground-level ozone, and nitrogen dioxide. The pollutants were combined into a single number between one and 10 to represent a particular day's risk level.

The team is now evaluating the index in Ecuador and Brazil and has started partnerships in Uganda and Rwanda. "Every child's life we can save matters," says Gladson. "NASA data-forecasting products are critical to this work, providing the air pollution estimates that cities can integrate into their daily index calculations going forward." -D. I.

AD HAWKS

Ad Observatory—a free web-based tool that identifies who is funding political ads on social media, how much they are spending, and what audience they are targeting—"was motivated by the 2016 elections and what we saw in terms of misinformation being weaponized by Russians with the intention of undermining the election process," says Tandon School of Engineering associate professor Damon McCov. During the Senate hearings that followed, Facebook, Google, and Twitter promised to improve transparency, but their efforts felt "half-hearted." savs McCov. So researchers at NYU's Cybersecurity for Democracy decided to collect data from Meta's Ad Library and present it in what McCoy calls a "more transparent and useful" format. Ahead of the 2022 midterm elections, they launched an enhanced version of Ad Observatory with Spanish availability and more visualizations of data. Users can search by topic, sponsor, candidate, region, and more. The dashboard is invaluable to researchers and journalists, particularly local reporters who lack the resources for their own analyses. "If you want to know how much money is being spent on immigration ads on Facebook," says lead researcher Laura Edelson, "there really isn't any other source of that data other than us." -D. I.

Freedom Through Expression

The artwork in Nicole Fleetwood's *Marking Time* offers a rare view of the shrouded lives of those impacted by the penal system

Tea bags. Prison uniforms. Yard soil. Those are some of the materials the artists interviewed in Nicole Fleetwood's Marking Time; Art in the Age of Mass Incarceration (Harvard University Press) repurposed to create paintings, dioramas, and other haunting works. The book and traveling exhibition explore the penal system's devastating impact on people who are imprisoned or residing in communities "where the threat of punishment structures everyday life," she says. The project is deeply personal for Fleetwood—a MacArthur Fellow and Steinhardt professor of media, culture, and communication—who grew up in Hamilton, Ohio, a postindustrial town where she watched cousins and neighbors get sentenced to decades in prison.

You write about visiting relatives in prisons as a child. How did that influence your work?

It was traumatizing not only for me, but for my family and for the entire community. You would watch your loved ones disappear. It was daunting and scary and alienating. I didn't have the context or analysis as a child to fully understand it, but I had a response to it for sure. And so from an adult perspective, I tried to provide both scholarly perspective and a context for what I was experiencing and what my family was experiencing during that period.

You also talk about putting up photographs of your incarcerated relatives as a way to deal with grief.

I realized that by my not really sitting with those images of incarcerated relatives, I was unwittingly playing into the very system that was erasing them. I started by hanging photographs of them around my home, speaking to those

photographs, and just trying to resist that experience of incarceration as the evisceration of these precious relationships. When I was invited to give talks, I decided to share about my cousins in prison. For me it was a way of bringing my loved ones into my current life. Afterward, I would inevitably have someone come up to me and say, "My experience is very similar." I started doing programming around that shared experience.

How did the book and exhibition come out of that initial work?

When I began researching what became Marking Time, something felt very odd to me about how prisons were so normalized in my life, and in the lives of so many working-class and working poor folks. And not just prisons, but the entire criminal legal system, being surveilled, the constant threat of punishment in all kinds of institutions. But it felt like that experience was so separate from my life

as a professor. It literally started with me, as a way of wanting as a scholar, a person of the world, and an activist to bridge those spaces.

What guided you when choosing the art for Marking Time?

I tried to make sure there was a range of artistic media featured, that there was art that was highlighting certain things. I talk a lot about the conditions under which incarcerated people make art, like penal space, penal time, penal matter. So I was making sure those ideas were being visualized through the art. But people will often misidentify this project as one that features the work of currently and formerly incarcerated artists. And I see it as more expansive than that. It's looking at the ways that a range of artists are using visual media to investigate, critique, and resist carcerality.

How has having their work exhibited affected the incarcerated artists?

About two-thirds of the work is made by people who are or have been in prison. and about a third is from socially engaged artists who have not been in prison, from photographers to sculptors to video makers. One of the most moving experiences has been to see people who were in prison when the project started be released, and to see them being embraced by a growing community of system-impacted artists. Some are entering higher education. Many are represented by galleries. They're doing public lectures.

Do you maintain relationships with these folks over time?

The way that I'm most active when it comes to people's legal cases is that



attorneys will ask me to write letters. I have written many letters to get people out on parole or for clemency. There's one pretty high-profile person who was on death row in Arkansas—Kenneth Reams. He's now moved [from decades in solitary confinement] to the general population, but we're trying to get him released. He's represented by the NAACP Legal Defense Fund. There's an artist, Jerome Washington, who has spent a lot

of time in prison in Pennsylvania and has suffered a lot. He sees his artmaking as part of his therapy, and he loves to be in touch with us about his art.

What has been the public's response to the exhibition?

People are not only wowed by the art but are also walking away with a sense of urgency about the need to change the criminal legal system and to understand that they do have some power in terms of how they engage with policing, how they engage with crises in their communities, how they engage with unhoused people. All of these are ways that people activate carceral structures without even recognizing it.



Take a look inside Fleetwood's Marking Time exhibition at nyu.edu/scope/fleetwood

Survival Secrets of Desert Plants

To engineer crops for a fast-changing climate, scientists at the Center for Genomics and Systems Biology are identifying the adaptive strategies of plants in Chile's forbidding Atacama Desert

The first time Rodrigo Gutiérrez set foot in the Atacama Desert of northern Chile, he was struck by a thought: "You're the only thing alive for miles around." In a landscape of sand and rock perched nearly 8,000 feet above sea level, not a plant or animal was visible. "It's completely devoid of life," he says. But as Gutiérrez, a molecular biologist at the Pontificia Universidad Católica de Chile, began ascending the desert's mountains, reaching an elevation where the ground receives just a drop of water once or twice a year, he "saw these green things growing." He was captivated. "How do they survive?" he wondered.

That question is at the heart of an international study co-led by Gutiérrez and NYU Center for Genomics and Systems Biology professor Gloria Coruzzi, whose lab Gutiérrez worked in as a postdoc nearly two decades ago. The goal is to identify the genes that allow these plants to grow in an especially harsh environment. The Atacama Desert is the driest place on Earth (aside from the poles) and battered by high UV radiation, its soil nearly bereft of the nitrogen that most plants require to thrive. So extreme are the conditions that NASA uses the site to simulate expeditions to Mars. The team's findings could allow scientists to modify crops for

increasingly dry and unforgiving environments, says Coruzzi, which in turn "would solve the world hunger problem."

Small farmers in Asia and Africa already struggle to coax yields from nutrient-poor soils, while rising tempera-

The desert's soil is nearly bereft of the nitrogen that most plants require to thrive. So extreme are the conditions that NASA uses the site to simulate expeditions to Mars.

tures are turning farmland to desert at an alarming rate. The US Department of Energy, seeing desert grasses as a potential source of biofuel, gave the researchers a \$7 million grant. "The idea was to try to identify genes that we could introduce into grasses that are used for biofuel and grow biofuel species on marginal soils," says Coruzzi, "so that you wouldn't be wasting fertile soils where we grow our crops to eat. This would help with the biofuel production without damaging or harming our food supply."

Thirteen years ago, Gutiérrez began

leading teams of ecologists, botanists, and microbiologists to the desert every spring, "using the Atacama as a natural laboratory to try to understand mechanisms of adaptation in plants," he explains. Flying from Santiago to Calama, a northern mining town, they set up base in a nearby resort village of San Pedro. Then, in their all-terrain trucks, they would follow the dirt roads up the pristine Atacama landscape. "We always had somebody with altitude sickness," he recalls, and they were always armed with oxygen tanks and protocols for bringing the sick people back to lower ground.

Each year, they visited the same 22 sites, spanning elevation levels reaching as high as 15,100 feet, where perennial grasses carpet the ground. They collected samples of 32 dominant plant species covering the major plant families—grasses, tomatoes, legumes—that thrive in the Atacama. This offered the researchers a snapshot of the ecosystem as a whole, something that is possible because the ecosystem is "simpler, in the sense that there are a lot less species than in other places, like the jungle," says Gutiérrez. Dropping the samples in thermoses of liquid nitrogen, they transported the flash-frozen plants back to their lab in Santiago. Among some species, they found bacteria near the roots that helped the plants absorb more nitrogen. Next, they sequenced the genes for each of the plant species.

Coruzzi's team then sought to identify which genes within the sequences had been adapted, allowing the desert plants to flourish. To do this, botanists at the New York Botanical Garden were enlisted to identify California plant



species that are genetically similar to the plants collected from Atacama, which are known as sister species. Then, by comparing the sister genomes, they could identify the genes where the plants had diverged, a way of reconstructing a species' evolutionary history called phylogenomics. Yet while previous studies have compared the genomes of one or two species, Coruzzi's ambition was to "find the *general* mechanism that all of the plants, all of these different plant families, use," she says.

This task involved crunching heaps of data. So Coruzzi turned to Gil Eshel, who conducted this analysis using the High Performance Computing Cluster at NYU. Eshel plugged the nearly 1.7 million

protein sequences, across more than 70 species, into the supercomputer. "Comparing whole genomes," instead of the usual one or two genes, says Coruzzi, "was a huge computational endeavor," one that had not previously "been scaled on the genome level, to this extent." Together, they identified 265 genes that had potentially adapted for the Atacama's environment. They even pinpointed the portion of the genes that had evolved and then published the results in *Proceedings of the National Academy of Sciences*.

Coruzzi is now working to compare each of the Atacama species to two California counterparts: one from the desert, where the soil is dry but nitrogenrich, and one that is not adapted to either drought or low nitrogen. The analysis will hopefully reveal "whether or not the California species that are adapted to drought might share those gene adaptations with a Chilean species," she says, and whether crop breeders can then apply the research to develop new seeds that thrive in inhospitable environments. "The ultimate goal would be to identify the Atacama genes that make them resilient and transfer them into the California species." Adds Gutiérrez: "As some Atacama plants are closely related to staple crops, the genes we identified represent a genetic gold mine to engineer more resilient crops—a necessity given the increased desertification of our planet."

In Living Color

The geneticists in NYU's Boeke Lab are uncovering the mysteries of the genome—and creating art made of yeast in the process

Ask a painter about their go-to medium and they'll likely say watercolor, acrylic, or oil. Pose the question to the folks at NYU Langone's Boeke Lab and they're bound to answer "yeast." Yes, that microorganism that brings us beer and bagels is at the heart of a project pioneered in the lab of biochemistry and molecular pharmacology professor Jef Boeke, who also directs NYU Langone's Institute of System Genetics. For the past decade, his team has been unleashing the beauty that lies dormant in the seeming chaos of the natural world by growing yeast into beautiful colored patterns using a process they call biopointillism. What has resulted is a better understanding of the yeast genome and a varied collection of portraiture, landscapes, and even reproductions of famous paintings that pushes aesthetic and educational boundaries. The medium is, in fact, the message.

The Yeast Art Project began as a proof-of-concept attempt to increase the nutritional value of bread by genetically modifying baker's yeast to produce beta-carotene, the compound converted by our bodies into vitamin A. While yeast is normally off-white, this modification turned it orange or yellow, an incidental discovery that supercharged the group's artistic aspirations. Additional modifications generated new colors that could be used to construct grids of biopixels—

visual building blocks comprising strings of yeast colonies assembled in specific arrays. Their first artwork was printed in just three colors with 384 biopixels of resolution, but the evolving process has now resulted in 25 colors and up to 24,576 biopixels, used to render such works as Vermeer's *Girl with a Pearl Earring* as well as luminous sunsets.

"This method of making art highlights how being a scientist and being an artist are not mutually exclusive—there is a lot of creativity in research."

The procedure shows how living chemistry can be nudged in unlikely directions by 21st-century technology. Using genes derived from organisms as diverse as jellyfish, bacteria, and mushrooms to modify the yeast cells to form pigments, the researchers produce a color palette. Next, they digitally create or source an image—be it a portrait of Marilyn Monroe or an original abstract pattern—and feed it into an algorithm that translates it into a visual map. This map functions as a paint-by-numbers instruction set for a printer called the Labcyte Echo, which uses sound waves to

blast tiny droplets of color-producing yeast onto the living canvas of an agar plate. These yeast-coated plates are then left in incubators for the final images to grow on them over several days.

The project has been widely celebrated: it was featured in Science, made the covers of *Yeast* and *Genetics* journals, and won multiple art competitions. The goals, however, stretch beyond the artistic and into the educational. "We use these strains for fun, outreach, and to make nonscientists go, 'Ooh, that's pretty,' " says lab supervisor Aleksandra Wudzinska. Researchers have held workshops with high school biology students using traveling-kit versions of yeast color palettes. Community engagement is a priority; anyone can commission their own yeast artwork through the lab's website. Jasmine Temple, one of the original architects and a former assistant research technician at the lab, adds that playing with yeast cells can help students grasp more complicated concepts. "Yeast has well-understood genetics that can stand in for much more complex organisms," she explains. "The pigmented yeast can be used as a pathway visualization technique to study the way genes are assembled, pathways interact, and chromosomes behave."

Yeast's illustrative properties are useful in many ways. Another major Boeke Lab initiative—the Synthetic Yeast Genome Project—involved designing and building an entire yeast genome. All living cells carry an inherited genome, a blueprint for life. Building a genome puts us on the path to rewriting them, a development that could offer paradigm-shifting evolutionary shortcuts. The lab made thousands of



strategic changes to their yeast genome's core DNA sequence to observe which alterations helped the cell to thrive. Why? "To tackle big problems in how genes are switched on and off in a much bigger genome-ours," says Boeke. His team demonstrated that complex mammalian DNA could be built in yeast. "Now we have assembled more than 30 huge swaths of human genome," he says. "Some of them have been transferred to mouse cells and used to make partially humanized mice, like the COVID mouse, which respond more similarly to the virus than regular

mice which do not get infected." These advances set the stage for more effective pharmaceutical research and even the development of designer genomes that could revolutionize medicine.

The science-art connection doesn't surprise the team. "Research and artistic creativity are very linked-it's about exploration and trying new things," says Temple. "This method of making art highlights how being a scientist and being an artist are not mutually exclusive—there is a lot of creativity in research."

The Yeast Art team is now tackling the

issue of durability. The living canvases last only up to six months, although filter paper placed on top of the agar can be peeled off and embedded in epoxy to create more durable hard copies. "We are working on trying different preservation techniques to increase the longevity of the pieces," Wudzinska says. "However, the fact that it is living ephemeral art adds to the beauty of it all."



See more of the yeast pigment paintings and portraits at nyu.edu/scope/yeastart



Psilocybin is enjoying a psychedelic renaissance as NYU Langone researchers reveal its near-miraculous ability to treat addiction, depression, anxiety, and more

> By Jenny Comita Illustrations by Tim McDonagh



o put a human face on the potential of psychedelic drugs to address mental health disorders—and in the process change or even save lives—psychiatrist Michael Bogenschutz, the director of NYU Langone Health's Center for Psychedelic Medicine, likes to share the story of a man named Jon Kostas. In 2015, when Bogenschutz first met

him, Kostas was 25 years old and had a very severe binge drinking disorder, regularly consuming, in his own estimation, upwards of 20 alcoholic beverages in a single sitting. "He'd been in inpatient rehabs, he'd been on every medication, and still he felt—and his physicians really felt—that he was drinking himself to death," says Bogenschutz. "He just couldn't stop."

Desperate for a solution, Kostas enrolled in a study that Bogenschutz and his colleague Stephen Ross—the center's associate director and, like Bogenschutz, an addiction psychiatrist by training—were conducting to investigate whether psilocybin, the active ingredient in magic mushrooms, could be used as a treatment for alcohol use disorder. Kostas received two doses of the psychedelic drug—under medical supervision—over the course of three months, sandwiched between a dozen sessions of psychotherapy. "And ever since that first medication session, he has not had another drink," says Bogenschutz. "He reported that his craving was completely gone and that he doesn't even think about drinking."

Not every patient in the study, which was published in the journal JAMA Psychiatry, had such a dramatic and immediate transformation, but the results were incredibly promising. In the double-blind randomized clinical trial of 93 men and women with alcohol use disorder, half of whom received psychotherapy plus psilocybin and half psychotherapy plus an active placebo medication (in this case, a big dose of antihistamine), the psilocybin group decreased their heavy drinking days by 83 percent following the trial, compared with 49 percent in the control group. "Both groups decreased their drinking by roughly half during those first four weeks of psychotherapy, before getting the study medication," Bogenschutz explains. "But then the psilocybin group cut their drinking again by about half after receiving medication, while the other group continued to drink just about the same." Remarkably, eight months after the first dose, almost half (48 percent) of those who received psilocybin stopped drinking altogether compared with 24 percent of the placebo group. Now Ross and Bogenschutz are testing the protocol in a much larger study, with 216 participants.

"We know the effects of the high dose of a psychedelic like psilocybin enhances the ability of the brain to change. At the same time, people have these experiences that they interpret as being profoundly healing," says Bogenschutz. "They carry with them a memory of an experience that continues to support and organize their efforts to change, because they can remember what it was like to feel at peace and to feel freed from their addiction."

The idea of using what most of us know only as a recreational drug to treat addiction to what is essentially another recreational drug might sound counterintuitive. But the practice is far from new. From the 1940s through the early '70s, researchers treated more than 40,000 subjects for mental health disorders with LSD. But for many years afterward, the data from those studies disappeared from mainstream scientific discourse. "There was this huge body of research that was hidden in plain sight," says Ross. "Psychedelics had been an important part of psychiatry for three decades, and yet, in all of my years of medical school, fellowship, and training, the subject had never once come up."

That omission is not particularly surprising, given the troubled history of psychedelic drugs—a class of psychoactive substances that have the power to alter consciousness—in Western medicine, which includes not only potential breakthroughs but questionable ethics, covert operations, and even government cover-ups. Indigenous cultures have used psychedelics, most notably plant-derived drugs like peyote and ayahuasca, in religious ceremonies and healing rituals for millennia. But modern psychiatry's first introduction to

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psychedelics didn't come until 1943, when Swiss chemist Albert Hofmann, while studying a grain fungus called ergot, combined one of its components with an ammonia derivative and then unwittingly ingested the compound: lysergic acid diethylamide. The accidental dosing—possibly by absorption through his fingertips—launched him on what is widely considered the world's first acid trip, and, soon after, Hofmann's Sandoz Laboratories began manufacturing what became known as LSD, sending samples to research facilities around the world. At first, scientists thought studying LSD could help them learn more about schizophrenia, since the drug can induce the sorts of hallucinations associated with the disease. But participants in early experiments reported an unexpected side effect: taking LSD had helped them quit drinking. "Starting in the 1950s, it



was hailed as a wonder drug for treating alcohol use disorder," says Ross. "There were entire American Psychiatric Association conferences devoted to it."

But at the same time, there was more sinister psychedelic research underway. In 1953, the CIA launched Project MKUltra, an attempt to weaponize psychedelics. Over the course of 20 years, the agency experimented on volunteers and, in a particularly disturbing turn, unsuspecting citizens to determine whether LSD could erase memories and be used for the purposes of mind control and psychological torture. Among the people who first tried the drug as volunteers in those studies were *One Flew Over the Cuckoo's Nest* author Ken Kesey, the Grateful Dead's Robert Hunter, and Beat poet Allen Ginsberg. Afterward, all three became vocal proponents of what became known as acid, ushering in an era of widespread recreational use.

Soon, academic research also began to go off the rails. In 1960, psychologist Timothy Leary started working with psychedelics at Harvard after a transformative experience taking magic mushrooms in Mexico. For three years, he ran studies in which he took the drugs alongside his subjects—a huge scientific

taboo-and allegedly pressured undergrads to partake. In 1963, when word of his practices reached the administration, the university fired Leary and his colleague Richard Alpert, who later became known as the spiritual teacher Ram Dass. Leary continued to promote the use of psychedelics and, in 1967, at the Human Be-In, a gathering of an estimated 30,000 hippies in San Francisco, famously told the crowd that it was time to "Turn on, tune in, drop out," which became the unofficial motto of the countercultural revolution. In the years that followed, Washington became increasingly incensed by Leary and the psychedelic-fueled movement that was springing up around him. In 1970, after a protracted legal battle, Leary was incarcerated for marijuana possession. That same year, Congress passed the Controlled Substances Act, wide-ranging legislation that enacted stiff penalties for the possession of psychedelics and a host of other drugs. In 1971, President Nixon declared drug use "public enemy number one" in his famous war on drugs speech, and not only was scientific research into psychedelics shut down, but also, says Ross, its very existence was "buried in the history books" for the better part of a generation.

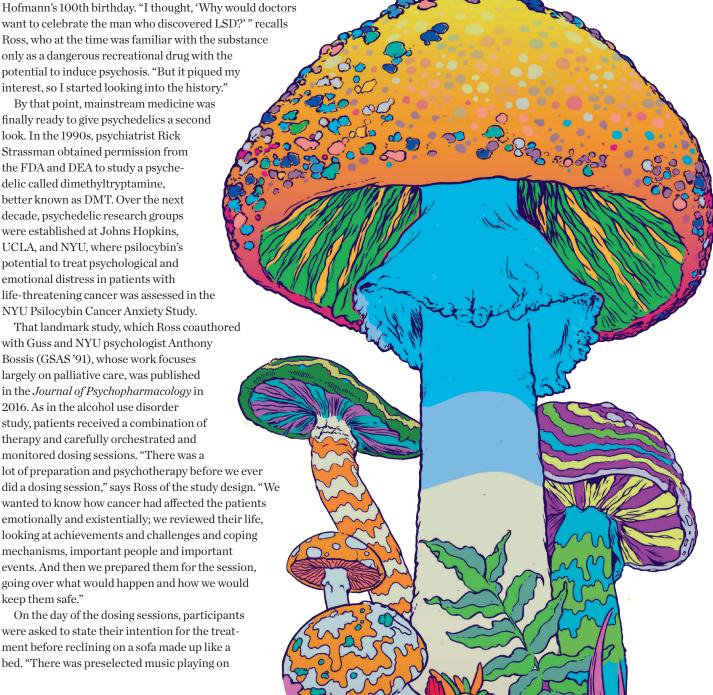
oss first started learning about psychedelic medicine only in 2006-mostly, he says, through serendipity. He was running an inpatient psychiatric unit at NYU when his colleague Jeffrey Guss (GSAS '05) happened to mention that he was traveling to a conference commemorating

Hofmann's 100th birthday. "I thought, 'Why would doctors want to celebrate the man who discovered LSD?" recalls Ross, who at the time was familiar with the substance only as a dangerous recreational drug with the potential to induce psychosis. "But it piqued my interest, so I started looking into the history."

By that point, mainstream medicine was finally ready to give psychedelics a second look. In the 1990s, psychiatrist Rick Strassman obtained permission from the FDA and DEA to study a psychedelic called dimethyltryptamine, better known as DMT. Over the next decade, psychedelic research groups were established at Johns Hopkins, UCLA, and NYU, where psilocybin's potential to treat psychological and emotional distress in patients with life-threatening cancer was assessed in the NYU Psilocybin Cancer Anxiety Study.

That landmark study, which Ross coauthored with Guss and NYU psychologist Anthony Bossis (GSAS '91), whose work focuses largely on palliative care, was published in the Journal of Psychopharmacology in 2016. As in the alcohol use disorder study, patients received a combination of therapy and carefully orchestrated and monitored dosing sessions. "There was a lot of preparation and psychotherapy before we ever did a dosing session," says Ross of the study design. "We wanted to know how cancer had affected the patients emotionally and existentially; we reviewed their life, looking at achievements and challenges and coping mechanisms, important people and important

On the day of the dosing sessions, participants were asked to state their intention for the treatment before reclining on a sofa made up like a bed. "There was preselected music playing on



keep them safe."

headphones, and we gave them eyeshades and asked them to focus internally," says Ross. "And then they tended to have these experiences that were strange and interesting, often challenging. After six or seven hours, we sat them up and started talking about what happened. Often patients reported having transformative, mystical-type experiences that were highly meaningful—among the most spiritual of their lives." And afterward, despite their health challenges, many reported feeling a profound and lasting sense of peace, some with their fears of cancer recurrence having disappeared completely. As study participant Dinah Bazer recalls, "I saw my fear. All of my fear turned into anger—

"Patients reported feeling a profound and lasting sense of peace, some with their fears of cancer recurrence having disappeared completely."

I *will not* be eaten alive by this fear. And once that happened, the fear was gone. I felt that I was bathed in love. Just all-encompassing love."

Says Ross: "These were terminally ill patients for whom life had lost meaning. Their cancer was this horrible trauma, and, coming into the study, many said they wished they were dead already." After a single dose of psilocybin, 80 percent of the 29 subjects saw relief from emotional distress that lasted more than six months. And in the researchers' long-term follow-up study with a subset of participants from the original trial, they found that the effects persisted nearly five years after that single dose. Those who received the psilocybin-assisted therapy overwhelmingly—71 to 100 percent—attributed positive life changes to it and rated it among the most personally meaningful experiences of their lives.

"It was such an epiphany for me," explains study participant Gail Thomas. "To feel separate and to feel alone is just a falsity. Because it's not how it is. That's very comforting, and I've felt that way ever since. Understanding that death will happen and being fully aware of its reality enables you to have a happier life. I'm one of the luckiest unlucky people—I was unlucky that I got cancer, but I was lucky that I was chosen to be in this study. And it did change my life."

or Ross, the experience of working with cancer patients was, he says, "very rewarding and moving. To see them get better so quickly and see it last really motivated me to do more." This past July, he received the first grant ever from the National Cancer Institute to do a much bigger study involving

200 patients with advanced cancer using psilocybin-assisted psychotherapy to treat anxiety, depression, and existential distress. At the same time, NYU researchers are looking into other possible applications for psychedelics. The cancer anxiety study—which spawned the country's only psychedelic psychotherapy training program—was the first to find that psilocybin can function as a rapidly acting antidepressant, with effects lasting for several months or even years. Out of that finding grew a recently completed multicenter study, with NYU serving as the lead site, that looked at using psilocybin to treat major depression. Depending on what the data shows, the FDA could approve psilocybin as a treatment for that disorder sooner rather than later.

"Major depression is probably the leading application in terms of FDA approval," says Ross. "It's exciting because depression is arguably one of the most disabling brain-based illnesses in the world, and it's very common. The current treatments we have work only to a degree; at least 30 percent of people with depression don't respond at all to them. So there is a lot of room for novel therapeutics."

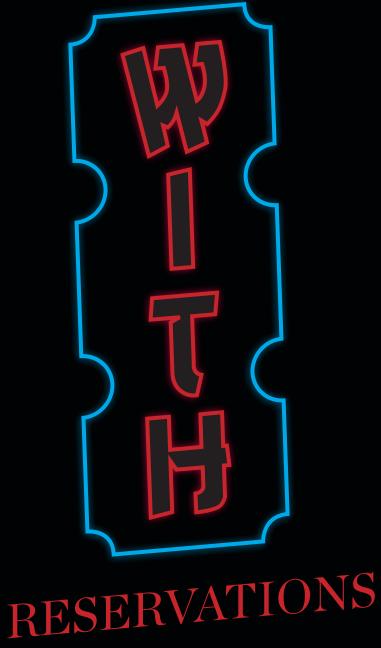
Now, after half a century, the federal government—the largest single source of funding for scientific research—finally seems ready to reconsider the merits of psychedelics. In October 2021, the National Institutes of Health awarded the first federal grant in 50 years to study a psychedelic drug as a possible treatment. NYU Langone Health will be one of three sites for the trial, which is led by scientists at Johns Hopkins and will investigate whether psilocybin can help people quit smoking.

The timing of this psychedelic research revival couldn't be better, according to Bogenschutz, who says he is also very interested in studying psychedelics as a possible treatment for opioid addiction. "With COVID and other stresses and the fragmentation and lack of connection that people experience with the way the world works today, more people are turning to drugs and alcohol," he says, pointing out that, in addition to the opioid crisis, addiction to stimulant drugs is also on the rise. "It really costs people a lot of their years, and we really have very limited treatments." The hope? That while mushrooms might not actually be magic, they might just be something almost as elusive: efficacious medicine for mental health.



Watch study participants explain how psilocybin relieved their cancer anxiety at nyu.edu/scope/psilocybin





Historian Heather Ruth Lee explores how the US developed an appetite for Chinese cuisine in a time of extreme anti-China sentiment

By Andrew Postman





hether taken out or eaten in, the cuisine of China has graced the plates and pleased the palates of Americans for more than a century. Why Chinese restaurants are so popular—they outnumber all the McDonald's, Burger Kings, Wendy's, and KFCs in the United

States combined—is no mystery to the millions who love their flavors, convenience, affordability, and ambience.

But how they survived and even proliferated in the face of a late-19th-century law—one that was in force for more than six decades-formulated expressly to keep Chinese people from entering the country is a question that Heather Ruth Lee, assistant professor of history at NYU Shanghai, has been investigating since pursuing a master's at Emory and writing her doctoral dissertation, "Entrepreneurs in the Age of Chinese Exclusion," at Brown, Chinese restaurants were largely collective enterprises, with owners enlisting family members from the homeland to help with the business. "One thing I found puzzling was that the number of Chinese restaurants was [rising] in a period when few Chinese people were allowed into the United States, so that creates a labor conundrum," says Lee, who took a deeper dive into the subject for her forthcoming book, Gastrodiplomacy: Chinese Exclusion and the Ascent of Chinese Restaurants in New York, 1870–1949 (University of Chicago Press). "How do you expand, or recruit laborers into a field that's growing?" Lee discovered that information on the subject was hard to come by: "There's not much data on the restaurant industry, period." So she had to be creative.

In so doing, Lee and her students not only retrieved a compelling piece of history about a forgotten people, but they also contributed to an increasingly exciting, digitized datadriven method of research where facts, figures, and trends translate to actual human beings.

UNPALATABLE PERSPECTIVES

ee scoured the immigration records of Chinese people entering the United States between 1882, the year the Chinese Exclusion Act passed, and 1943, the year it was repealed (when China was an ally in WWII). "I wanted to write a history of Chinese restaurants from the perspective of those who built the industry," she says, "The impact of Chinese

who built the industry," she says. "The impact of Chinese restaurants is obvious to almost anybody. They're everywhere. It's most likely part of your takeout [routine]. We know what it's like as a consumer. But we know very little about the individuals who went into the industry, to work those long hours, to teach Americans about Chinese food. How did Americans even get

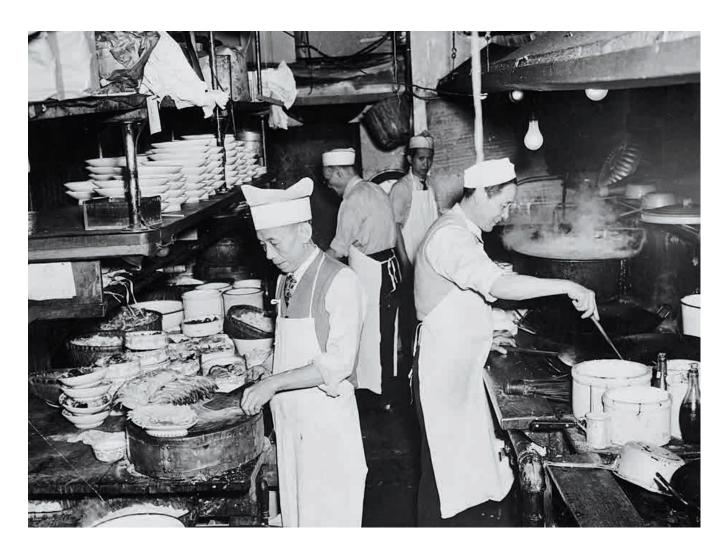
interested in Chinese food? To use chopsticks? To pronounce anything on the menu? To know what they liked? To even find these restaurants? To have demand for a product or service is at best one half of the story. The other side of the story had become invisible." Those unseen players included cooks who stood before roaring ranges in brutal heat, often for 10 or more hours at a stretch, their limbs sweating under woolens worn to keep their skin from blistering. And employees who mopped floors for 12 hours a day, seven days a week, with one day off per year.

But those harsh conditions must have paled in comparison to the psychological toll that rampant racism took on them. Resentment, even hatred, was widespread by the second half of the 19th century, when more than a quarter-million Chinese people were in the United States farming, mining, and working in factories. Primarily employed in lower-wage jobs, they were viewed as a threat to non-Chinese workers. This bias inspired, in part, "one of the first [US] laws that attempted to criminalize drug use—an 1875 ordinance that focused on opiate bans because it was part of anti-Chinese sentiment," says NYU Law

By early in the 20th century, the attitude toward Chinese food—if not Chinese people—was shifting, as it became a more accepted, appealing part of urban life.

professor Alina Das, author of No Justice in the Shadows: How America Criminalizes Immigrants. If that legislative message wasn't clear enough, it would be made shockingly so seven years later, in 1882, when President Chester Arthur signed the federal Chinese Exclusion Act, "the only race-based immigration law in US history," adds Lee. It barred Chinese laborers from immigrating or becoming US citizens. Only merchants, teachers, tourists, students, and US citizens of Chinese heritage (and sometimes their wives and children) could travel between the United States and China. US citizens were frequently stopped when returning from home visits to China. "Chinese were treated as guilty first, before they were proven [eligible]," says Lee. "Even if you had the papers showing you were a teacher or student, say, often you were not allowed into the country, [at least not easily. Though there were exemptions to the law, the way it was enforced meant there really were no distinctions, if you appeared Chinese."







Top: Chefs at work in a New York City Chinatown restaurant kitchen, circa 1940. Above: Horse-drawn carriages along Chinatown's Mott Street in 1905.

That wasn't all. In 1893, the McCreary Act "expanded the grounds of exclusion and narrowed the grounds of exemption," says Lee, by granting the government more power to determine the kind of business owner to be deemed a merchant or skilled laborer. "By the early 20th century, very few businessmen qualified for merchant status, except for those who owned an import/export business," she says.

Yet "between 1882 and 1918, the number of Chinese restaurants in New York went up twentyfold," says Lee. "In the Northeast region, between 1920 and 1930, the number of Chinese restaurants tripled." How? Some Chinese business owners were granted special merchant visas to travel to China and "sponsor" family members to return with them to work. If a person was able to show they had managed a restaurant full-time for a year-no cooking, waiting tables, or working the cash register-they could earn merchant status. Lee explains that Chinese immigrants found ingenious ways to work around the merchant visa rules. They'd pool their money to start luxury "chop suey palaces," with each investor taking turns running the establishment for a year, thereby winning merchant status and the ability to bring over more and more relatives. And by early in the 20th century, with more and larger Chinese restaurants dotting the New York landscape, the attitude toward Chinese food—if not Chinese people—was shifting, as it became a more accepted, appealing part of urban life. Despite the Chinese Exclusion Act, it got easier for family members to enter the country for the purpose of providing labor (though it was rarely, at least at first, skilled).

DISHING UP SOMETHING DIFFERENT

t's no surprise that New York City was a hot spot for Chinese fare. According to Lee, the first Chinese restaurants in New York City opened in the 1870s. The majority of customers were immigrants seeking out the dishes of their rural, southern China homeland. With some detective work, she unearthed stories of individual immigrants who contributed to the restaurants' spread. Tom Lee (no relation to Heather), known unofficially as the "mayor of Chinatown," had enough clout to introduce members of Tammany Hall to Chinese food at lavish multicourse banquets. A bilingual journalist named Wong Chin Foo served as a sort of ambassador to Chinese food for the fellow journalists he took to Chinatown.

In a 1925 New York Times column about the city's shifting cultural landscape, columnist Bertram Reinitz observed that "[chop suey] is no longer merely a casual commodity. It has become a staple.... It rivals coffee-and-two-kinds-of-cake as the recess repast of the sales forces of West Thirty-fourth Street department stores. At the lunch hour there is an eager exodus toward Chinatown."

One discovery Lee and her students made poring through historical records: areas of Manhattan with a high concentration of restaurants did not always map to the location of immigrant Chinese communities, suggesting that Chinese food was increasingly being consumed by non-Chinese groups. As Americans became more affluent following World War I, they dined out more often. They were trying out food they hadn't grown up with. Chinese cuisine, says Lee, was seen as "the opposite of comfort food"—dangerous, unusual, an adventure, a social occasion. People wanted to talk about it and to experience it with others. "[It] was about challenging yourself to be worldly, to be open to the world beyond your narrow confines," she adds. This "gastro liberalism," as she calls it, enabled Chinese immigrants to run thriving businesses even where they had no real community—in places such as Oshkosh, Wisconsin,

which had its first Chinese restaurant by 1903. Similar dynamics of immigration and entrepreneurialism could be found around the country, and certainly in cities with large Chinese communities, like San Francisco and Chicago.

And when Prohibition shuttered restaurants that could no longer serve cocktails, Chinese restaurants, which had never relied on the sale of alcohol, remained unaffected. Chinese restaurants also often stayed open later, lending them a certain cool. By 1910, as Lisa Stoffer and Michael Lesy write in *Repast*, "going out for chop suey made middle-class Americans feel pleasantly naughty."

Of course, the reliance on (cheap) family labor—so long as one could keep importing fresh blood—helped to make a narrow-margin business consistently profitable.

FACTS AND REAL-LIFE FIGURES

efore embarking on her research, Lee intuitively felt there was a relationship between exclusion laws and the growth of Chinese restaurants. Immigration records "confirmed this in a way that no other set of sources would," she says. "Chinese immigrants were fairly well net-

worked—there were organizations in the South, the West, the Midwest, along the North Atlantic, where communication could easily circulate." But looking at the immigration records alone enabled Lee to only "lay out a rough sketch of a timeline." When the names of certain restaurants and individuals connected to the establishments came up again and again, however, she expanded her range, scouring publicly available tax and property records, business incorporation files, city directories, court cases, mayoral papers, anti-vice records, census records, newspapers, and more. She was after more than a database or fact sheet. She aimed, she says, to "understand the set of actors"—the exceptional immigrants who represented Chinese

"As a historian, it can be frustrating to want to study people who are excluded from conventional archives, whose thoughts and experiences weren't considered important by historical institutions."



restaurant history. She wanted to breathe life into the story of those "who struggled to integrate themselves economically into an environment that wasn't so willing to give them space."

Lee was aided in her academic sleuthing by the Humanities Research Lab, a student-driven research project that she and NYU history professor David Ludden launched in 2018. "As a historian, it can be frustrating to want to study people who are excluded from conventional archives, whose thoughts and experiences weren't considered important by historical institutions," Lee says of the lab's formation. Students from all three portal campuses helped to offset the omission by digitizing, analyzing, and dot-connecting US Census entries in the millions, as well as other sources—business directories, licensing records, historical maps, and other population surveys. This opened them to seeing patterns in the life paths of immigrants, which offered persuasive, evidence-supported

interpretations of individual lives.

And sometimes Lee got lucky. The data led her to a cook named Chin Shuck Wing, who'd received little formal schooling and was likely not very literate, but had written letters to keep in touch. When he died in 1987, he had no living friends or relatives and his possessions were removed from his home at 111 Mott Street and forgotten until employees from the Museum of Chinese in America salvaged them. That correspondence proved invaluable. "His words and the words of people who wrote to him helped me understand who he was outside of the restaurant, as well as who and what mattered to him," says Lee. "I learned about his aspirations, his errors, and his family's reproach. The letters, as well as the other things in the collection, like his dictionary, give depth to a man who was literally forgotten by history as just another Chinese cook."



Disaster Artist

Archaeologist and volcanologist Karen Holmberg has spent much of her career consumed with catastrophic thinking. She wonders why the rest of us aren't paying more attention too

By Alison Gwinn

cientists are supposed to be dispassionate—but not Karen Holmberg. She has been infatuated with volcanoes ever since she was in grade school. The NYU volcano expert and archaeologist sees them as foundational to our lives on the planet: not only a potential source of early life and the atmosphere

we breathe, but also the cause of every major extinction-level event Earth has ever experienced. "Volcanic landscapes provide a proxy for the sudden, radical environmental changes that humans have experienced for millions of years," Holmberg says, "and also a way to study how messy the nature-culture divide is in the past, present, and future."

Holmberg passes such lessons onto her students at the Gallatin School of Individualized Study, where she is the only research scientist as well as codirector of the Gallatin WetLab, an experimental space housed on Governors Island that's part exhibition gallery and part laboratory where art meets science. And as an environmental science teacher, Holmberg has developed a wide range of sui generis courses, like Volcanoes: The Sublime and Scientific as well as NYC Coastlines: Past, Present, and Future, a mashup of archaeology, climate change, science, and science fiction.

Holmberg's efforts, both in the classroom and in the field, are a natural outgrowth of her childhood on a Chesapeake Bay farm, when her mother was an early environmentalist and her father was one of NASA's first aerospace engineers. In that intellectually rich environment, she says, "there were lots of books on our shelves." One that caught her fancy at age 7: explorer Richard Halliburton's *Complete Book of Marvels*, particularly its chapter on Vesuvius. "I literally said, 'That's it. I want to be an archaeologist and a volcanologist,' " she recalls.

After high school, Holmberg did fieldwork at Thomas Jefferson's Monticello before earning her undergraduate degree in archaeology at the University of Virginia, then took a two-year break to work as a model—and travel the world. She later earned a combination MA, MPhil, and PhD at Columbia, with a focus on the long-term intersections between human life and radical environmental changes.

That focus continues in Holmberg's projects today, including her research at two volcanic sites: one at Chaitén, Chile, where she is the principal investigator for a National Geographic Explorer grant, and one at Campi Flegrei, near Naples, Italy. Both reflect her contextual view of volcanoes: "They are not just geophysical entities but also have great resonance as cultural touchstones for the communities around them," she says.

The Chaitén volcano's unexpected eruption on May 2, 2008, was dramatic. The ash and steam rose up to 55,000 feet, higher than the cruising altitude of commercial airliners, disrupting air traffic in South America and prompting the largest evacuation in Chile's history. Residents in nearby Chaitén—unaware that the volcano

wasn't just a mountain until it suddenly erupted—were whisked away in navy boats. "The entire town was evacuated within two days without direct loss of life," Holmberg says, "but people still lived as environmental refugees for multiple years before resettling." Since then, conservation has been ongoing to keep a record of the destruction, including preserving a row of houses that were buried in ash as local heritage sites. "It is complicated to conserve ruins as the degradation process continues," Holmberg says. "Do you return the houses to the state they were in the day after the eruption or at the point when conservation began?" One possibility, in lieu of preserving entire structures, she says, is maintaining the facades of the houses and turning the area behind them into an open museum safe for visitors.

"You're not supposed to be able to see somebody's bread from 2,000 years ago, to read their graffiti, to see their furniture. It slams you in the face that these were real people."

While surveying the site near the volcano, a prehistoric complex of four rock art caves was discovered. Within them were dozens of designs (including dots, lines, and a sun) painted in red iron oxide, piles of shells, ceramic and stone materials, human and animal remains, and triangular etched designs archaeologically interpreted as vulvas. Holmberg's work at Chaitén has included standard archaeological excavation of the caves, innovative 3D digital imaging, acoustic data collection, and cultural and geological heritage work.

Holmberg also serves on the board of a new museum at Chaitén that commemorates the 2008 eruption, conveys the area's prehistoric human presence (through her findings in the field), and highlights the future risk to residents, as the rebuilt town is in the path of possible volcanic flows. The museum includes a spot where visitors can immerse themselves in 3D visualizations showing the regrowth of trees on the volcano's slopes, the coastline leading to the cave, and the rock art within the cave. "Including the cave imagery is important to me because it increases the accessibility to the cave for those who cannot get there," she says. The museum also includes a model of the volcano that allows for digital recreations of different stages of the eruption, and a residency space for artists and scientists.

Such ventures have long-term implications. "Disasters can accelerate or lay bare social processes and inequalities that already exist," Holmberg says. "They can be points of utter







destruction but also provide the chance to create new ways of being. What I find interesting is the creative or imaginative element of catastrophic events. In the past, disasters were often recorded through various art forms. In the contemporary and future, art science and citizen science can be powerful tools to better understand and convey the natural world and how it intersects with our human perception of it."

Holmberg's work at Campi Flegrei, or "burning fields," takes place less than an hour west of one of history's most infamous volcanic disasters: the burying of Pompeii in 79 AD. "Pompeii was so important in the Western imagination," she says, "because it was culture threatened by nature: Vesuvius, which was hovering over the city like a monster." Why do the town's artifacts, many of them since uncovered, still fascinate us? To Holmberg, the answer has less to do with science and more to do with humanity: "You're not supposed to be able to see somebody's bread from 2,000 years ago, to read their graffiti, to see their furniture. It slams you in the face that these were real,

embodied people, not some sort of fever dream."

But Campi Flegrei is actually much more dangerous than Vesuvius, she says. "With Campi Flegrei, you have 360,000 people living inside a gigantic volcanic crater, two-thirds of it underwater, who don't even understand it is a risk because it's so large they don't see it. And that is a metaphor for climate change." Along with collaborators, Holmberg is thinking about how environmental risks are perceived and how to better convey scientific understandings of possible future events. "Drawing from the well-developed literature around the Theatre of the Oppressed, we are thinking toward something we're tentatively calling a Theatre of Urgency," she says. "I see this as a test case for climate change writ large: the problems feel so massive and insurmountable that it becomes easier to push them aside."

Holmberg sees similarities between those volcanoes and the megacity she calls home, where she is working with Gallatin students doing citizen science (water quality testing, ovster monitoring, and species identification); studying remains at the New York City Archaeological Repository, especially from landfilled parts of Manhattan; and looking at the various flood mitigation plans under consideration by the city. "What do you do in a coastal city that's dependent on outdated infrastructure when much of Lower Manhattan will be potentially submerged within a generation?" she asks. "The changes are happening fast, and looking at the differences is really interesting when the problems are human-induced as opposed to a volcanic eruption."

In other words, how humanity has reacted to volcanoes in the past can inform how we deal with climate crises now and in the future. "Sites of past disasters, like Chaitén, can regenerate and become sites of resilience and renewal," she says. "The crises we face in the 21st century are quite literally existential and yet the future is not predetermined. We have the agency, intelligence, and creativity to redirect the current climate narrative. We have a responsibility to one another and to our planet to do so."



Scope 2023 211X



Smoke Screening

Dental detectives investigate the concerning connection between vaping and periodontal disease

For a pair of molecular pathobiology professors at NYU, the e-cigarette issue felt personal from day one.

Back in 2014, Deepak Saxena and Xin Li were College of Dentistry colleagues whose kids also happened to be elementary school classmates and close friends. Just a block away from their school was an eye-catching ad proclaiming that e-cigarettes were so "cool" you could smoke them in bed. Saxena remembers his 8-year-old son sounding out the words of the sign aloud and asking his father if smoking indeed was "cool."

At the time, vaping was largely unregulated and its proponents were touting it as a healthy alternative to conventional smoking for adults—even as a means to quit tobacco. But Saxena and Li were appalled at the schoolyard-adjacent recruitment of their children. The more they learned about e-cigarettes' marketing—cotton candy flavors, Hello Kitty vaping pens—the more they felt, says Li, that "it's pretty evil who they were targeting."

Because Li and Saxena were dentistry professors, their professional curiosity quickly kicked in. It had long been established that cigarette smoke caused problems in the mouth, even before it reached the lungs.



Although there were differences between the two habits, how harmless, they wondered, could e-cigarettes really be?

Vaping was still so new that no one in any field of medicine or drug use prevention was studying it. "There was no funding," says Saxena, "because nobody was even aware of it." But the two researchers procured some seed money from NYU and, in 2016, theirs was among the first projects on the topic to receive a grant—of \$1.6 million—from the National Institutes of Health.

Their team divided 119 test subjects into three groups—cigarette smokers, e-cigarette smokers, and nonsmokers—and compared their oral health at six-month intervals. They also used a "smoking machine" developed by Terry Gordon of the NYU Grossman School of Medicine to pump e-cigarette vapor into laboratory mucosa cells to replicate the effects of those substances onto oral tissue. Li and Saxena's research confirmed their suspicions that the nicotine vapor ingested from e-cigarettes is problematic for oral health, although not necessarily in the exact same way as cigarettes.

In a 2020 paper in iScience, they reported that test subjects' exams and saliva samples revealed that gum disease and oral infection were highest among cigarette smokers (72.5 percent) and lowest among nonsmokers (28.2 percent). E-cigarette users were in the middle at 42.5 percent. The researchers found that the microbiome of e-cigarette smokers was different from that of the other groups. Users had more Porphyromonas bacteria (a marker for gum disease) than smokers and nonsmokers, plus elevated amounts of certain cytokines associated with inflammation. While periodontal disease overall remained higher among the combustible tobacco smokers, Li and Saxena reported in a 2021 Frontiers in Oral Health paper that only the e-cigarette smokers had a markedly high incidence of clinical attachment loss—the syndrome in which the gums separate from the tooth, forming pockets that then become breeding grounds for bacteria.

Nonetheless, as the study has progressed, the

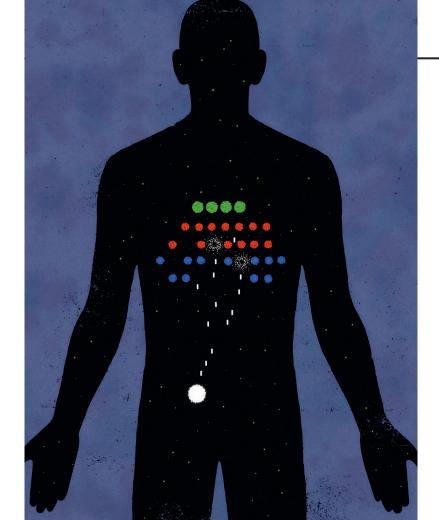
The lure of e-cigarettes among the young is clear. Since this research began, e-cigarettes have become more popular with young people than with adults, and more popular than tobacco with youth who smoke.

dental environments of the two kinds of smokers have become more alike. Our mouths contain hundreds of varieties of bacteria, and rather than labeling them as "good" or "bad," Li explains, it's helpful to think of them as a community—"and as with our human society, we need diversity." As some types of bacteria expand their numbers, others get crowded out—the dental equivalent of coyotes or raccoons going from playing a useful role in nature to taking over an urban park. These types of imbalances were seen in both groups.

One explanation is that the cigarette smokers are older and have been smoking longer, so the effects appeared early in the study. With time, however, the e-cigarette smokers seem to have caught up. "For patients at the same periodontal disease stage," the researchers note in a 2022 *Molecular Oral Microbiology* paper, "cigarette smokers and e-cigarette smokers shared more similarities in their oral bacterial composition."

Their bacteria profiles still have some differences, so the jury is out on whether the e-cigarette users will end up with all the same oral issues that come from cigarettes. "You need to have follow-up studies for many years [to know if] this change in the microbiome or the changes in the bacterial profile in your mouth is causing any major diseases" like ulcers or oral cancer, says Saxena. "We have no idea about that, because this is a very new product." As part of this ongoing research, he and Li have applied for funding to examine the dental effects of vaping marijuana.

For all the scientific unknowns, the lure of e-cigarettes among the young is crystal clear. In the seven years since Li and Saxena began their research, e-cigarettes have become more popular with young people than they are with adults, and more popular than tobacco with youth who smoke. According to the Centers for Disease Control and Prevention, 14.1 percent of high school students and 3.3 percent of middle school students were users in 2022. "For everybody who's quitting," says Saxena, "there are 10 junior high school kids who are taking it up." —Lindsy Van Gelder





Search and Destroy

Scientists are supercharging the immune system to fight tumors that have resisted other treatments

The last decade has seen profound advancements in cancer therapies, especially in the treatment of blood cancers. Some patients who might have received a one-size-fits-all drug with a slim chance of slowing down or eradicating the disease are now getting a new treatment, in which the "drug" is actually made up of their own immune system's T cells. The extracted T cells are engineered to make proteins called chimeric antigen receptors (CARs). When returned to the body, they find and bind to specific proteins or antigens on the cancer

cells, which they then destroy. "The great news," says associate professor of biology Neville Sanjana, "is that in many kinds of blood cancers it's been quite durable. There are people who have not only gone into remission, but have remained in remission. Even many years later, they can sample their blood and see these engineered T cells are still there. It's almost like they installed a security surveillance system that's running around, making sure that cancer doesn't come back."

Yet despite CAR T-cell therapy's game-changing status, little progress has been made in its use against solid tumors such as those in the lungs, bones, breasts, liver, and pancreas, which make up 95 percent of all cancers. This led Sanjana and his team, including researchers at the Grossman School of Medicine, to try something radically different. Rather than search for new CARs, the focus of past efforts, they looked at about 12,000 individual genes-driving high levels of expression in each—"to see what genes, when overexpressed, increased T cell proliferation," says Sanjana. Some dramatically increased CAR T-cell therapy's ability to destroy cancer cells, he says: "They enhance T cells in several ways. They are more resilient and better able to divide and proliferate. They make the T cells better at their job."

The team also discovered that combined with CAR T-cell therapy, the enhanced T cells not only did a better job of eradicating leukemia, but they also destroyed pancreatic cancer cells, a finding that could lead to even more effective blood cancer therapies and long-sought success against solid tumors. While identifying which genes best maximize T cell potential is key, understanding the mechanism behind the process is critical to the development of future therapies. So the scientists developed a screening method called OverCITEseq, which allows them to look inside a cell for a detailed picture of how each modifier gene boosts T cell activity. When will these supercharged T cells become standard care? "My hope," says Sanjana, "is that we can have a first in human trial within the next few years." -Melanie Fine



Memory Serves

For Mitchell Joachim, memorializing COVID is key to finding a way forward

NYU Gallatin's Mitchell Joachim remembers the 7:00 pm clanging of pots across New York City in the early days of the pandemic-a way of thanking frontline workers. As codirector of the COVID Memory Research Group, Joachim wants to ensure that the world will remember what we've endured over the last three years. Working with coprincipal investigator and fellow Gallatin professor Peder Anker, plus DJ Spooky, MIT's Sarah Williams, and computational designer Sky Achitoff, the idea is to create a memorial, "a device for spatial storytelling and social solidarity in the aftermath of COVID-19." The memorial could take various forms—like a structure or a wearable pin-and is meant to be not just about loss but also about hope. "Part of the reason for a memorial is not only to remember those who died," says Joachim, "but also to suggest a path forward."

The memorial will be about creating closure and community

"I was at Harvard when 9/11 happened. As an architect, it seemed ridiculous to work on anything else except for what 9/11 would and could mean. My thesis was on the idea of matter and memory and how architects work to create memorials for historical reasons and to bring closure to communities. With COVID, we need some way of building a community of people to deal with what we're all experiencing. We're calling it a research project on memorialization. We're doing a large-scale survey of memorialization, everything from Indigenous burial grounds to temples in parts of Asia. [Now] the thesis question is 'What is a global memorial?' The idea is to eventually hold a global competition, and I imagine for each locale there will be their own citywide or region-wide memorial project."

The memorial could be more than a physical space—something like the AIDS Memorial Quilt or the breast cancer pink ribbon

"COVID is so ubiquitous, such an everyday, quotidian event that you experience in many different spaces, in many different kinds of shapes and volumes and geometries. But some of the things we're thinking would not be spatial at all. They would be a universal ring or brooch or trinket or ribbon."

We might want to move on, but there is work to be done to fully understand the pandemic and learn from it

"Some major phase of this pandemic is over, and the idea that we would still be working on this in some ways is a bit problematic because we all want to move on with our lives. There is this feeling of helplessness, and we want to retreat and move on to other positive things. But I think somewhere in this is a bright burning star of a kind of an answer, or a way forward. And so that's what research is: you just don't know until you get down there, roll up your sleeves, and do the dirty work of trying to answer these questions."

We need to be prepared for the next big event that will affect us all

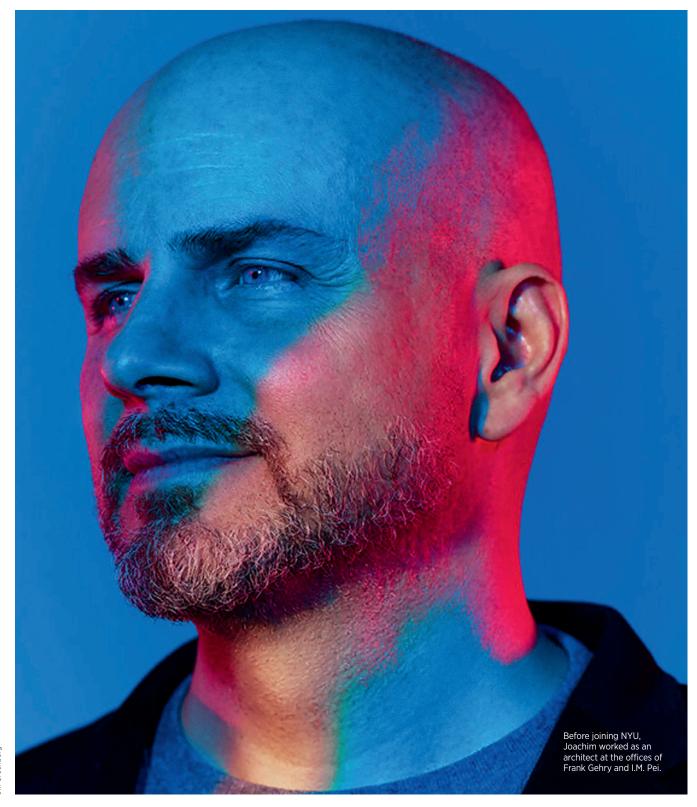
"This is for the first time recognizing the problem at its scale. This affects every single one of us, meaning plants, animals, humans. So this is the first time we're realizing we're one biology. And therefore, we've got to get our act together to work as a unified team. A planetary structure needs to be in place to handle planetary-scale problems, and we don't have that on any level. Globalization is there for materials and resources and trade, but not necessarily for a whole host of other problems that have massive externality costs. So this might be a way to create a bridge to some kind of physical network of how humans need to act together in a time of crisis."

-Lisa Armstrong

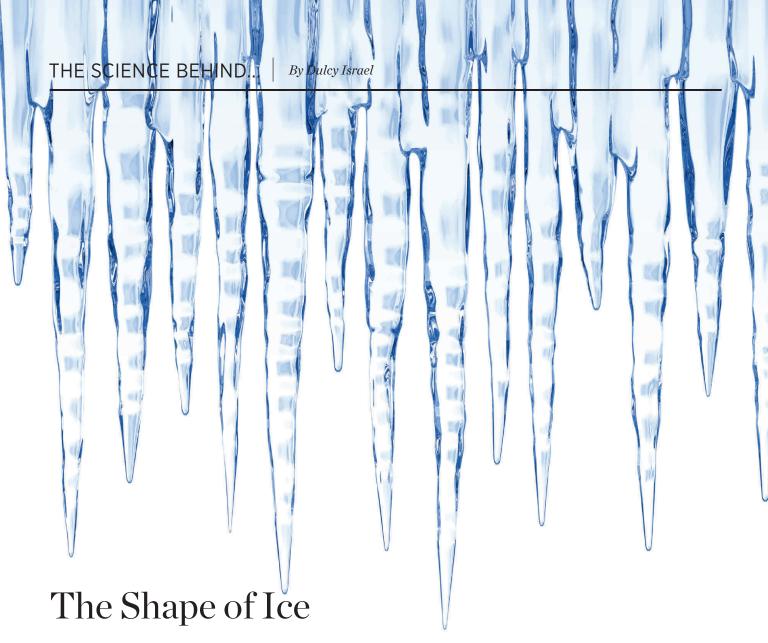
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For more on the COVID Memory Research Group, visit **covidmemoro.org**



Jill Greenberg



Trekking to the polar regions swaddled in Gore-Tex isn't the only way to make significant discoveries about the vanishing ice caps. A team of NYU mathematicians and physicists from Arts and Science's Center for Soft Matter Research and the Courant Institute's Applied Mathematics Lab has done just that in the university's own backyard. Braving the cold of a refrigerated room, the researchers conducted a series of experiments with a focus on temperatures between zero and 10 degrees Celsius and found that the shape and

pattern of melting ice submerged in water depends on the water's temperature. In the most frigid $\rm H_2O$ (below about five degrees Celsius) the ice took the shape of a downward-pointing pinnacle, like an icicle, but was completely smooth on its surface. Ice melting in warmer water (above around seven degrees Celsius) had a spiky form too, but pointed upward. And water at in-between temperatures (between five and seven degrees Celsius) caused the ice to melt with a scalloped pattern, similar to what's seen on icebergs. Observing how

variations in environmental conditions alter the shapes and patterns of melting ice in the lab and getting a handle on the physics and math behind it offers useful insights into the effects of ambient water temperature in the real world and how it relates to climate change. As associate professor of physics and study coauthor Alexandra Zidovska explains, "Our work helps to understand how melting induces unusual flow patterns that in turn affect melting, which is one of the many complexities affecting the ice on our planet."



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