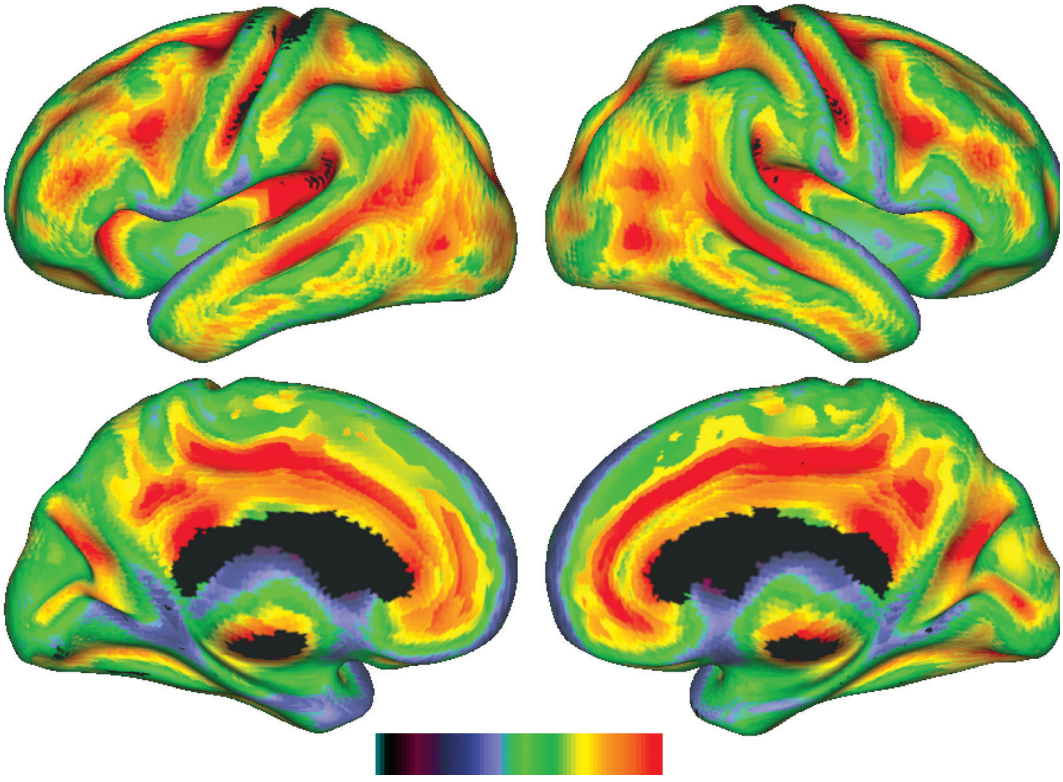
IMPACT

RESEARCH AT BROWN | 2023



DISCOVERIES IN AGING RESEARCH

From cell studies to therapeutics to elder care,
Brown researchers tackle the aging process

IMPACT
RESEARCH AT BROWN 2023

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ON THE COVER

Beta-amyloid plaques imaged using amyloid PET scans with florbetapir F18 tracer among cognitively normal older adults. Brain regions in warm colors show a greater amount of beta-amyloid plaque accumulation, an early indicator of Alzheimer's disease risk.

IMAGES BY HWAMEE OH, ASSOCIATE PROFESSOR OF PSYCHIATRY AND HUMAN BEHAVIOR

STARTING OFF

RESEARCHERS SHAPE OUR FUTURE, and Brown University trains them at every level. Everyone on campus, in every school, contributes to this collective enterprise by being an integral part of the research ecosystem.

This ecosystem will soon become even more critical. Last year, Brown announced an operational plan to grow and invest in research over the next five to seven years, magnifying our impact on the community, the nation, and the world.

The plan builds on the substantial growth of Brown's research enterprise in recent years and supports projects like the ones described in this issue, such as historian Linford Fisher's important work creating Stolen Relations, a centralized public database of Indigenous slavery throughout the Americas and a model for how Brown can engage with tribal communities.

The plan supports a culture of entrepreneurship that allows researchers to have the social impact they seek. Kareen Coulombe and her team are creating an in vitro testing model that will enhance the cardiac safety of therapeutic drugs. Ou Chen and Angus Kingon are reducing the risk and improving the accuracy of medical x-ray imaging. Anita Shukla and her graduate students are developing bacteria-triggered hydrogels that release antibiotics in carefully calibrated amounts, thus reducing the likelihood of antibiotic resistance. In our new section Brown Invents, you'll learn about these and other innovative technologies.

Brown's plan includes enhancing the research enterprise campus-wide to provide critical infrastructure and inspire collaborations within and across disciplines. Our cover story highlights how multiple projects and perspectives across the University can collectively become an area of research strength. "Discoveries in Aging Research" reports on the breadth of Brown's work on aging in biology, neuroscience, engineering, public health, gerontology studies, psychiatry, psychology, and biochemistry. Researchers are examining the basic science behind aging, conducting clinical research on age-related diseases and disorders, and developing nonpharmaceutical interventions in elder care to help people live longer, healthier lives. This story represents just a fraction of Brown's research in this area.

The commitment to growing research is integral to Brown's mission of preparing young people for lives driven by the need to ask and solve big questions. In "Why My Research Matters," you'll meet five doctoral students in search of answers who learned to communicate the essence of their research in five-minute TED-style talks.

Each year, *Impact* has curated research stories that have a unique perspective. In this sixth year of our magazine, I want to share a change coming in 2024. We are pausing *Impact* to build a new website that supports research at Brown, and to assess how best to deliver the stories of our researchers and their work. You'll find details on the inside back cover and an invitation to participate in a brief reader survey. Please take just a moment to share your insights.

Jill Pipher
Vice President for Research
Elisha Benjamin Andrews Professor of Mathematics

KINDRA CLINEFF

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A COMPENDIUM OF RECENT HIGHLIGHTS OF BROWN RESEARCH

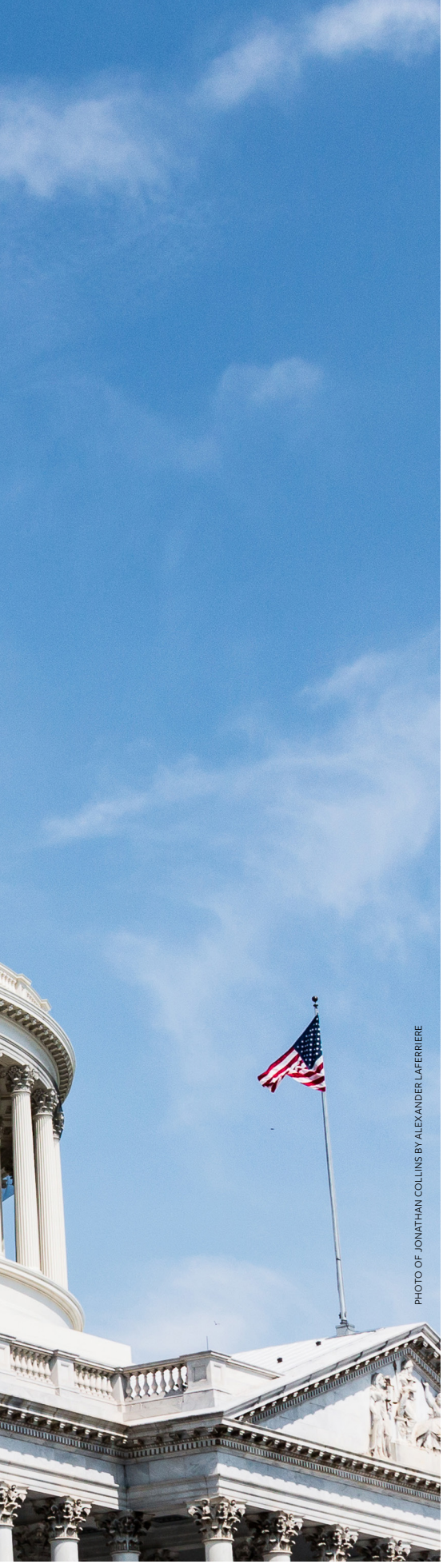


PHOTO OF JONATHAN COLLINS BY ALEXANDER LAFERRIERE

Students Engage the Issues, Deliberate the Future

Education expert joins $2 million grant project to transform high school civics.

Thanks to a $2 million federal grant from the Institute of Education Sciences, a Brown University researcher will spend the next four years bringing civics to life in high school classrooms across the United States.

Jonathan Collins, an assistant professor of education and international and public affairs at Brown, will work alongside seven scholars at the University of California Riverside and Ohio State University to develop and test a social studies curriculum that lets students discuss pressing social issues with sitting members of Congress.

Collins has long known that U.S. citizens feel more engaged when they directly interact with their elected representatives. One of his most recent research projects found that providing opportunities for deliberation at local school board meetings empowered parents from marginalized groups to advocate for themselves and their children, potentially leading school board officials to make decisions and craft policies that are more inclusive and universally beneficial. Similarly, Collins believes that giving students the chance to talk to their representatives could prove empowering for them and informative for federal leaders.

As part of the web-based curriculum Collins and his colleagues are developing, high school students will spend three weeks researching all sides of a policy issue, such as climate change or health care, and learning how to evaluate the credibility of information they find. Then they'll engage in "deliberative town halls" alongside one of their own congressional representatives. Finally, they'll have the chance to compare notes with students from other U.S. communities who have researched and debated the same issue.

Collins said the research team will conduct pilot tests of the curriculum in a diverse set of high schools in California, Illinois, and Florida, with the long-term goal of ensuring that all U.S. students become informed and engaged voters and citizens.

"For too long, Congress has felt like a distant myth for kids, and particularly kids who don't come from privileged backgrounds," Collins said. "We want to reverse this by not only connecting kids to sitting members of Congress but also giving them the opportunity to have real-time dialogues about pressing policy issues."—JILL KIMBALL

Left: The United States Capitol Building in Washington, DC

Above: Jonathan Collins, assistant professor of education and international and public affairs

Navigating a New Arctic

Melting Arctic ice could transform international shipping routes.

With climate change rapidly warming the world's oceans, parts of the Arctic that were once covered in ice year-round could be ice-free for months on end in as few as two decades.

Climate scientists from Brown and a scholar from the University of Maine School of Law collaborated on a study projecting that the melting of Arctic Ocean ice could create the potential for shorter, more eco-friendly maritime trade routes that bypass the Russia-controlled Northern Sea Route, reducing the shipping industry's carbon footprint and weakening Russia's hold over Arctic trade. The 2022 study was published in the *Proceedings of the National Academy of Sciences.*

"There's no scenario in which melting ice in the Arctic is good news," said Amanda Lynch, the study's lead author and a professor of earth, environmental, and planetary sciences at Brown. "But the unfortunate reality is that the ice is already retreating, these routes are opening up, and we need to start thinking critically about the legal, environmental, and geopolitical implications."

Lynch and Xueke Li, a postdoctoral research associate at the Institute at Brown for Environment and Society, modeled four navigation scenarios based on climate change outcomes. Projections showed new international trade routes emerging by midcentury, unless leaders halt warming to 1.5°C within 43 years.

If new pathways do open up, Lynch said, shipping companies could choose those northern routes over the much longer Suez and Panama Canal routes, reducing their greenhouse gas emissions by about 24 percent while also saving money and time.

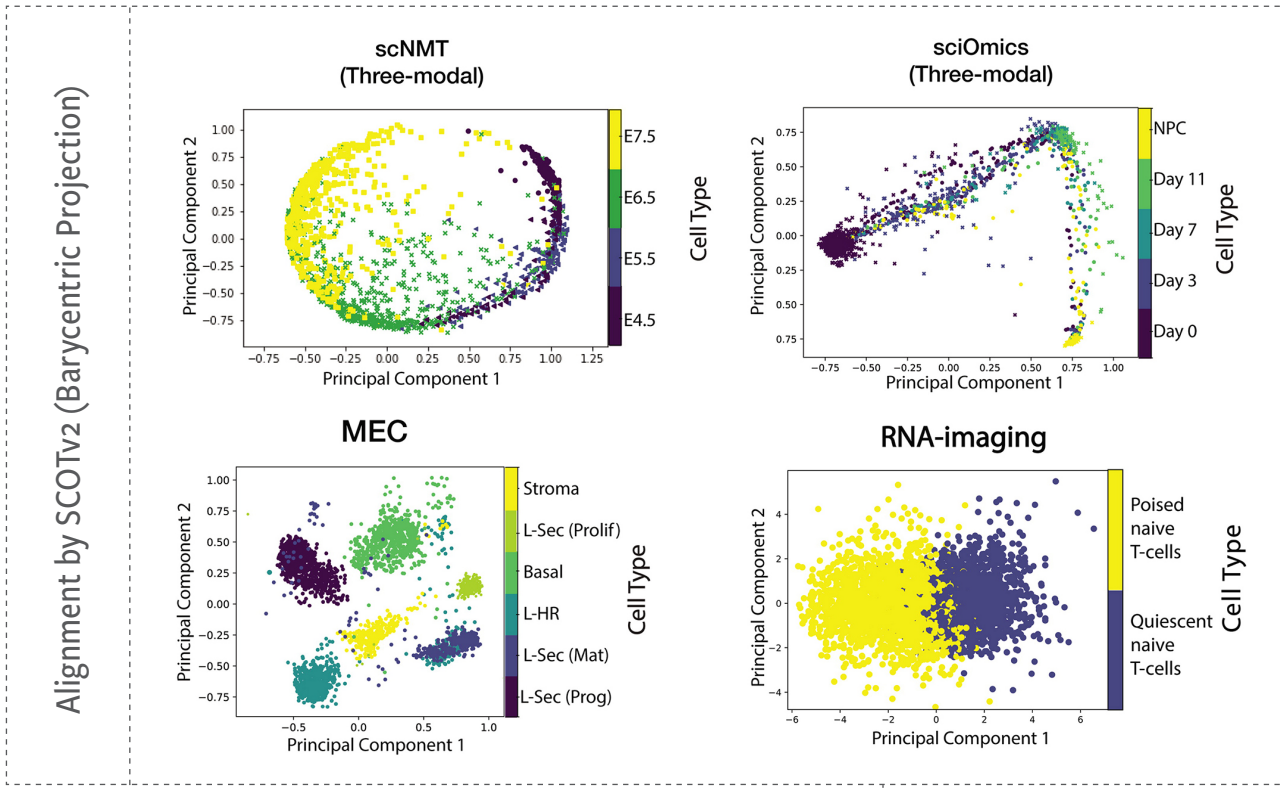
"These potential new Arctic routes are a useful thing to consider when you recall the moment when the Ever Given ship was stranded in the Suez Canal, blocking an important shipping route for several weeks," Lynch said. "Diversifying trade routes gives the global shipping infrastructure a lot more resilience."—JILL KIMBALL

ALUMNI IMPACT

MARCIA CHATELAIN, MA'03, PHD'08 is a professor of history and African American studies at Georgetown University, a scholar of African American life and culture, a speaker about pervasive social issues and activist movements, and an acclaimed author. Her book *Franchise: The Golden Arches in Black America* received the Pulitzer Prize for history in 2021. At Brown, she received her master's and doctoral degrees in American Civilization.

"My time at Brown University in the PhD program in American Civilization (now American Studies) revealed to me that disciplinary boundaries were made to be challenged and sometimes broken. Having received training and mentorship from historians, sociologists, and literary critics, and having access to lectures by cognitive scientists, and having been able to build friendships with emerging physicians and engineers, Brown taught me that research is always collaborative. My explorations into the various dynamics of African American history are informed by an array of thinkers, and I am ever grateful to Brown for giving me the skills and confidence to pursue my curiosities and to seek different ways of looking at the world."

COURTESY OF MARCIA CHATELAIN



Above: Ritambhara Singh graduated from COBRE support to become an independently funded researcher. She used the preliminary results from COBRE for this research.

Researchers Prepare for a Computational Revolution

NIH awards Brown $10.8 million to expand data-informed research to fight human disease.

Five years after an $11.5 million federal grant launched the COBRE Center for Computational Biology of Human Disease at Brown University, the National Institutes of Health (NIH) has awarded $10.8 million in new funds to Brown to build on the center's early success.

The center—a federal Center of Biomedical Research Excellence funded by the NIH's National Institute of General Medical Sciences—uses sophisticated computer analyses to advance human disease research.

Director David Rand, a professor of biology at Brown, said the renewal funds will enhance the center's research infrastructure, strengthen collaboration among scientists, and support four new research projects. Rand said a computational revolution is happening in the biomedical sciences, as researchers need computer analyses to help them make sense of massive amounts of available data.

"Everyone has large data sets and needs to convert these into useful information, and we aim to help people achieve that goal," said Rand. "Even those working in wet labs or clinics who don't use computers in their daily work will need assistance analyzing complex data sets. The center brings together researchers in the lab and clinic with exceptionally skilled and creative data scientists to turn data into information."

Providing that service is the center's Computational Biology Core (CBC)—a group of four scientists, data analysts, and software engineers who support data-intensive research. In the first year of the new five-year award, two researchers graduated from COBRE support after receiving major grants from the NIH and the National Science Foundation (NSF). George Lisi, assistant professor of molecular biology, cell biology, and biochemistry, received an NSF CAREER award and an NIH R01. Ritambhara Singh, assistant professor of computer science, received an NIH R35 Genomic Innovator Award. These awards were catalyzed by the initial COBRE support and will allow Lisi and Singh to pursue research on human disease for the next five years.

Funds from the renewal grant now support the research of two new junior faculty investigators who have replaced Lisi and Singh in the COBRE program: Roberta DeVito, assistant professor of biostatistics and data science, and Sanghyun Lee, assistant professor of molecular microbiology and immunology. This funding will help them earn additional, longer-term funding for their work.—CORRIE PIKUL, MICHAEL ANDAL

COURTESY OF RITAMBHARA SINGH. PUBLISHED IN *JOURNAL OF COMPUTATIONAL BIOLOGY* 2022 29:11, 1213–1228

A more equitable way to analyze DNA

New methods will improve understanding of how genetic conditions affect different populations.

By using new methods for analyzing DNA data and medical records, researchers from Brown University are helping improve the understanding of complex traits that will make more discoveries relevant to nonwhite, non-European ancestry groups.

Genome-wide association (GWA) datasets, which are commonly used by geneticists, are based on the assumption that individual genetic mutations underwrite the genetic basis of traits, explained Sohini Ramachandran, a professor of biology and computer science who directs both the Center for Computational Molecular Biology and the Data Science Initiative at Brown. The idea is that a discovery about those mutations will be relevant to all people across a range of diverse ancestry groups, so if the finding is used to develop treatments for genetic conditions, it will be applicable for all people with that condition.

However, recent studies have shown that GWA results estimated from self-identified European individuals are not transferable to non-European individuals. Consequently, the insights from GWA datasets are largely biased toward individuals with European ancestry.

Ramachandran teamed up with Brown assistant professor of biostatistics Lorin Crawford and former PhD student Samuel Pattillo Smith to analyze a ream of data across multiple biobanks using a new enrichment analysis. This more expansive methodology, which was previously developed in a collaboration between Ramachandran and Crawford to address bias and underrepresentation, moves beyond individual mutations to include genes and pathways.

In a study published in the *American Journal of Human Genetics*, the researchers illustrated examples of the robust associations of trait determinants, or patterns of similarity, while studying 25 traits in over 600,000 individuals from seven diverse human ancestries. A majority of these would not have been identified using GWA alone, the researchers said.

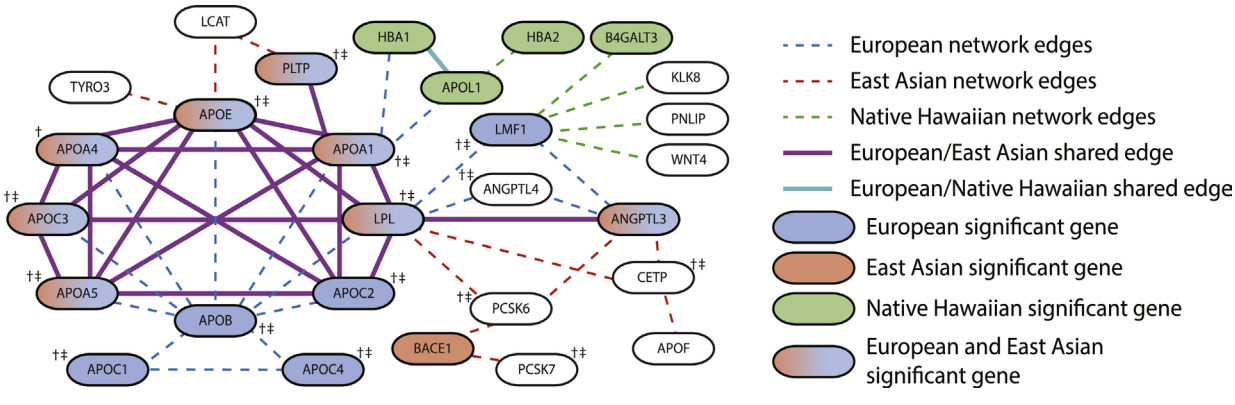
With these similarities, discoveries about the nature of diseases or illnesses and their responses to potential treatments have become more relevant to larger groups of people, including populations that have previously been ignored or understudied.

In a field like genomics, the stakes are high, Ramachandran said.

"It's really important to us that we understand trait architecture better so that we can make steps towards providing effective therapies for everyone, from every ancestry group," she said.

—CORRIE PIKUL

Below: Using network enrichment methods, which aggregate information from studies of mutations and gene analyses, researchers can find subtle and previously undetected commonalities among different ancestry groups.



COURTESY OF SAMUEL PATTILLO SMITH

Understanding the Moon's Two Faces

New research led by Brown scholars offers a credible explanation for one of the most enduring mysteries about the Moon: why its two sides are so different.

The face that the Moon shows to Earth looks far different from the one it hides on its far side. The nearside is dominated by the lunar mare—the vast, dark-colored remnants of ancient lava flows. The crater-pocked far side, on the other hand, is virtually devoid of large-scale mare features. Why the two sides are so different is one of the Moon's most enduring mysteries.

Now researchers have an explanation. A new study shows that the impact that formed the Moon's giant South Pole–Aitken (SPA) basin would have created a massive plume of heat that propagated throughout the lunar interior. That plume would have carried certain materials to the Moon's nearside, and that concentration of elements would have contributed to the volcanism that created the nearside volcanic plains.

"We know that big impacts like the one that formed SPA would create a lot of heat," said Matt Jones, a PhD candidate at Brown and the study's lead author. "The question is how that heat affects the Moon's interior dynamics. What we show is that under any plausible conditions at the time that SPA formed, it ends up concentrating these heat-producing elements on the nearside. We expect that this contributed to the mantle melting that produced the lava flows we see on the surface."

The study was a collaboration between Jones and Alexander Evans, assistant professor of earth, environmental, and planetary sciences at Brown, with researchers from Purdue University, Stanford University, University of Arizona, and NASA's Jet Propulsion Laboratory.

The nearside is home to a compositional anomaly known as the Procellarum KREEP Terrane (PKT)—a concentration of potassium (K), rare earth elements (REE), and phosphorus (P), along with heat-producing elements like thorium. KREEP seems to be concentrated in and around Oceanus Procellarum, the largest of the nearside volcanic plains, but is sparse elsewhere on the Moon.

"How the PKT formed is arguably the most significant open question in lunar science," Jones said. "And the South Pole–Aitken impact is one of the most significant events in lunar history. This work brings those two things together, and I think our results are really exciting."—KEVIN STACEY

Revising the Story of Mesoamerica

Were the ancient Maya an agricultural cautionary tale? Maybe not, new study suggests.

For years, experts in climate science and ecology have held up the agricultural practices of the ancient Maya as prime examples of what not to do.

"There's a narrative that depicts the Maya as people who engaged in unchecked agricultural development," said Andrew Scherer, an associate professor of anthropology at Brown University. "The narrative is that the population grew too large, the agriculture scaled up, and then everything fell apart."

But a new study, published in the journal *Remote Sensing* and co-authored by Scherer, suggests that that narrative doesn't tell the full story.

Using drones and lidar, a remote sensing technology, a team led by Scherer and Charles Golden of Brandeis University surveyed a small area in the Western Maya Lowlands situated at today's border between Mexico and Guatemala. They focused on a rectangle of land connecting three Maya kingdoms that existed between AD 350 and 900: Piedras Negras, La Mar, and Sak Tz'i'. Despite being roughly 15 miles away from one another as the crow flies, these three urban centers had very different population sizes and governance structures, Scherer said.

Scherer's lidar survey—and, later, boots-on-the-ground surveying—revealed extensive systems of sophisticated irrigation and terracing, but no huge population booms to match. The findings indicate that despite their differences, these three ancient kingdoms boasted one major similarity: agriculture that yielded a food surplus, allowing citizens to live comfortable lives free of food insecurity.

"In conversations about contemporary climate or ecological crises, the Maya are often brought up as a cautionary tale: 'they screwed up; we don't want to repeat their mistakes,'" Scherer said. "But maybe the Maya were more forward-thinking than we give them credit for. Our survey shows there's a good argument to be made that their agricultural practices were very much sustainable."

The research builds on decades of work by Scherer to uncover new insights on how the Maya lived, interacted with the land, and communicated with other peoples in the region. In 2018, Scherer and colleagues from Brown and Brandeis University worked with residents in rural Mexico to uncover remains of the long-lost capital of Sak Tz'i'—"white dog" in Mayan—in a cattle rancher's backyard. Scholars had been searching for physical evidence of Sak Tz'i' since 1994, when they first identified references to it in inscriptions found at other Maya excavation sites.

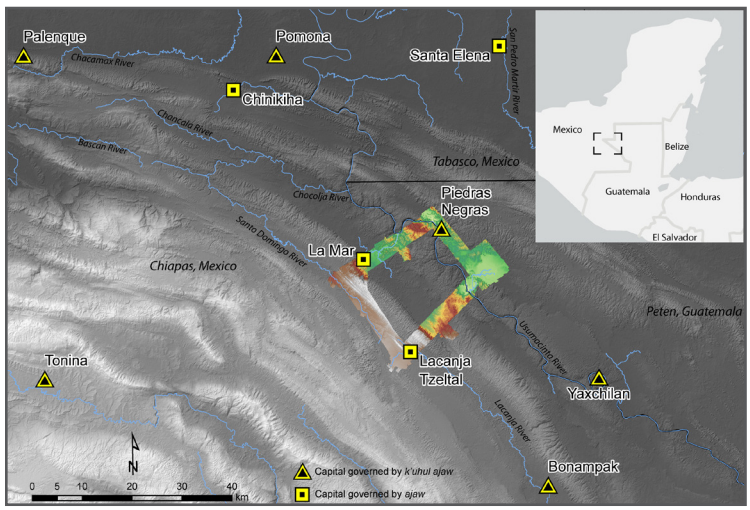
Following their discovery, the researchers shared initial findings in the *Journal of Field Archeology*. The research has since been widely covered in the international press, including a 2022 feature article in the *New York Times* and a TV program for *National Geographic* that will air on the Disney Channel.

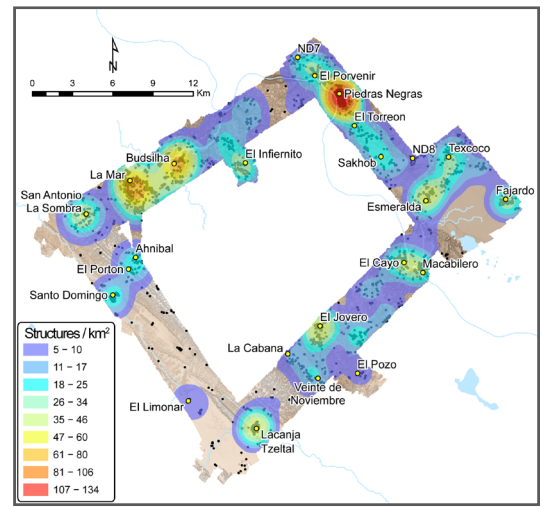
Scherer said he hopes his team's research helps shine a spotlight on a civilization whose society was just as sophisticated and influential as the ancient societies of the Mediterranean.

"Just as we celebrate the great feats of Rome or Greece, we should also acknowledge the many great accomplishments of the Maya and other indigenous peoples of the Americas," he said.—JILL KIMBALL

Below left: Regional map of Chiapas, Mexico, and Peten, Guatemala, showing the area surveyed by lidar (color transect) and the location of Classic-period Maya capitals.

Below: Lidar survey transect showing the density of settlement.

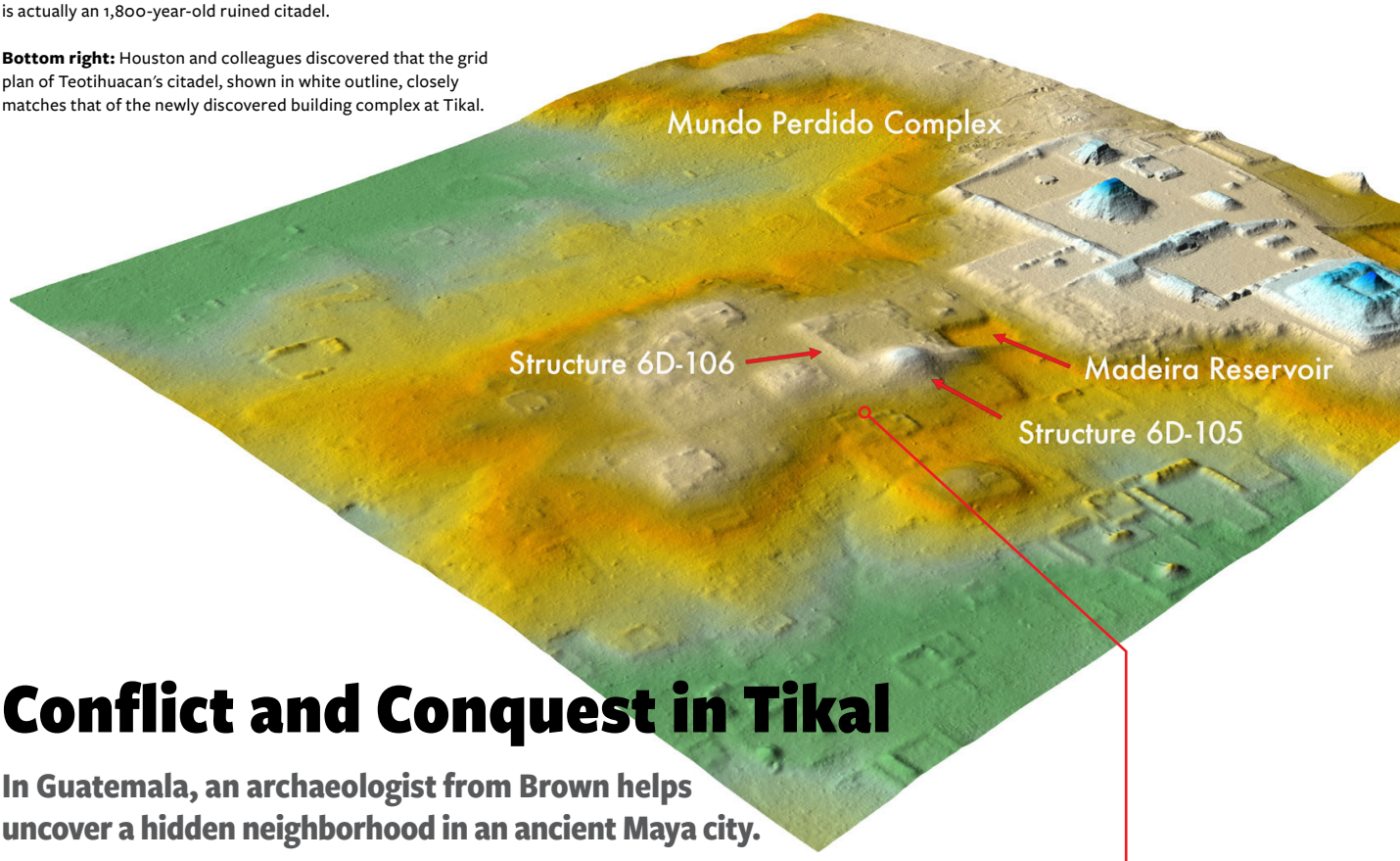




COURTESY OF ANDREW SCHERER

Below: A recent lidar analysis revealed that an area once assumed to be natural hills (center) near Tikal's Lost World complex (right) is actually an 1,800-year-old ruined citadel.

Bottom right: Houston and colleagues discovered that the grid plan of Teotihuacan's citadel, shown in white outline, closely matches that of the newly discovered building complex at Tikal.



Conflict and Conquest in Tikal

In Guatemala, an archaeologist from Brown helps uncover a hidden neighborhood in an ancient Maya city.

Since the 1950s, scientists have been excavating the ruins of Tikal, an ancient Maya city in modern-day Guatemala, unearthing countless revelations. But a startling recent discovery by the Pacunam Lidar Initiative, a research consortium involving Brown University anthropologist Stephen Houston, has scholars across the globe wondering whether they know Tikal's ruins as well as they think.

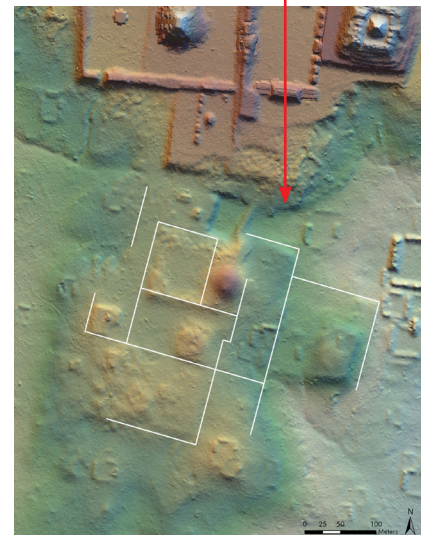
Using light detection and ranging software, or lidar, Houston and Thomas Garrison, an assistant professor of geography at the University of Texas at Austin, discovered that what was long assumed to be an area of natural hills a short walk away from Tikal's center was actually a neighborhood of ruined buildings that had been designed to look like those in Teotihuacan, the largest and most powerful city in the ancient Americas.

The lidar analysis and subsequent excavation has prompted new insights and questions about Teotihuacan's influence on Maya civilization. At the very least, Houston said, the findings prove that the imperial power in modern-day Mexico did more than just trade with and culturally influence the smaller city of Tikal before eventually conquering it.

"The architectural complex we found very much appears to have been built for people from Teotihuacan or those under their control," Houston said. "Perhaps it was something like an embassy complex, but when we combine previous research with our latest findings, it suggests something more heavy-handed, like occupation or surveillance."

At an adjacent, newly uncovered complex of residential buildings, archaeologists found projectile points crafted with flint, a mineral commonly used by the Maya, and green obsidian, a mineral used by residents of Teotihuacan, providing apparent evidence of conflict.

Houston and his international colleagues still have much more to uncover and analyze. But he hopes that the more the team discovers, the more scholars understand about Teotihuacan's presence in Tikal—and, more broadly, how its imperial power changed the cultural and political landscape in Mesoamerica.



"Before European colonization of the Americas, there were empires and kingdoms of disproportionate influence and strength interacting with smaller civilizations in a way that left a large impact," Houston said. "Exploring Teotihuacan's influence on Mesoamerica could be a way to explore the beginnings of colonialism and its oppressions and local collusions."

—JILL KIMBALL

COURTESY OF THOMAS GARRISON/PACUNAM

Teaching the Ukraine War

The Choices Program responds to world events with timely classroom resources.

When war broke out in Ukraine, teachers worldwide looked for resources that could help them explain the conflict to their high school students.

Many educators drew on the work of the Choices Program at Brown, which has developed secondary school teaching materials in collaboration with Brown researchers and other leading scholars since 1988. The program, housed in the Department of History, provides innovative curricula that explain contested international and historical issues for young audiences.

In response to the war, Choices released a free *Teaching with the News* lesson in February 2022 titled "The Ukraine Crisis" that examined the geographic and historical background of the conflict, political cartoons about the war, and coverage of Ukraine in the news.

Within a month, the lesson had received nearly 109,000 page views, according to Rebecca Nedostup, faculty director of the Choices Program. This was the most hits a single page on the Choices site had received in the previous two years. The lesson was highlighted by the *Boston Globe,* the *New York Times*, and scholarly and educational networks. Scholars, teachers, and administrators across the U.S. and beyond shared it hundreds of times on social media.

"Choices balances providing such timely, free lessons with strategically planned updates and additions to our core units, drawing on our educational expertise and Brown scholarship," said Nedostup.

Currently, the program offers 40 social studies curriculum units addressing such topics as immigration, international trade, colonialism, climate change, and genocide. Several units focus on individual countries, exploring their histories through the lens of critical issues. Choices also provides teachers professional development opportunities through workshops and webinars.—BRENDA SUBILHAGA '25

ALUMNI IMPACT

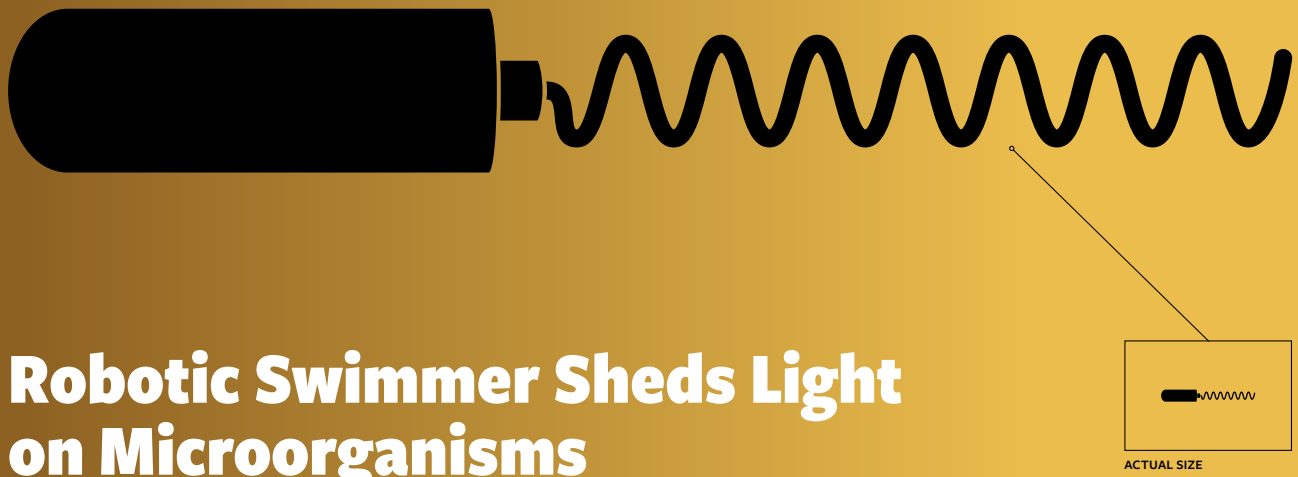
JAMES B. GARVIN '78, SCM'81, PHD'84, P'17 is the NASA Goddard chief scientist and principal investigator of the DAVINCI mission to Venus scheduled to launch in June 2029.

"Brown gave me the confidence to explore across academic boundaries—from paleontology and mathematical analysis of computer algorithms to art history and semiotics. The Brown experiences I had from freshman to PhD candidate helped me shape a career of space exploration. Thanks to Brown, my experiment flew in the Space Shuttle (Endeavour), and I was able to experience the joy of the first laser light hitting Mars as well as the Hubble Space Telescope searching the Moon for resources. These are all the stuff of dreams, yet Brown (and fellow Brown students and faculty) helped me pursue such ideas with a hopeful confidence and tenacity to see them fly.

My now 38-year career at NASA was more than catalyzed by my Brown education, and I will forever be grateful for all I learned. And I even got to appear on David Letterman!"

COURTESY OF THE CHOICES PROGRAM; COURTESY OF JAMES GARVIN

We have mathematical models that make approximations of how it works, but to improve those approximations we need to make detailed measurements of the velocity fields around these organisms. By making a device that can mimic that swimming as closely as possible, we hope to make some of those measurements." —Roberto Zenit



Robotic Swimmer Sheds Light on Microorganisms

A self-propelled robot is helping researchers better understand the complex swimming behaviors of bacteria and other microorganisms.

Microorganisms like bacteria are performing a remarkable feat simply by moving around. The effects of viscosity are amplified at small scale, which means a microorganism swimming in water is a bit like a person trying to do the backstroke in a tar pit.

A team of Brown students and faculty has developed a new tool to help researchers better understand how they do it: a robotic swimmer that mimics the action of a flagellum, the hair-like appendage that many microorganisms use for locomotion. By bringing that swimming action into the macroscopic world, the device makes it easier to study the fluid dynamics of flagellar movement. The team hopes that insights produced by the device could be useful in investigations of everything from fertility treatments to the spread of infectious disease.

"Microorganisms use an incredibly complex form of locomotion," said Roberto Zenit, a professor in Brown's School of Engineering. "We have mathematical models that make approximations of how it works, but to improve those approximations we need to make detailed measurements of the velocity fields around these organisms. By making a device that can mimic that swimming as closely as possible, we hope to make some of those measurements."

Zenit had previously developed a pill-sized device containing a magnet that could be made to "swim" using an oscillating magnetic field. The device was a reasonable approximation of bacterial swimming, but Zenit wanted to improve upon it, so he turned to Daniel Harris, an assistant professor of engineering whose lab specializes in building custom devices for fluid dynamics research. Under Harris's direction, a team of undergraduates worked to come up with a prototype.

The team performed a series of experiments with the device in a mixture of corn syrup and water, which approximates the viscosity of a microscale swimmer plowing through water alone. The results showed that the device's performance is in line with the predictions of a simple resistive force model, the same theory frequently applied to rationalize the motion of the device's microscopic counterpart. Having validated the device, the team now plans a variety of experiments to shed new light on helical swimming.—KEVIN STACEY

Daniel Harris, assistant professor of engineering

Roberto Zenit, professor of engineering

COURTESY OF DANIEL HARRIS; NICK DENTAMARO/BROWN UNIVERSITY

Eve Glenn is conducting independent research on self-administration and alcohol use disorders that involves studying the behavior and neural activity of fruit flies.

How Drinkers Think

A Brown student finds clues in the brains of fruit flies about the mechanisms of addiction in humans.

Although every person has their own reasons for drinking alcohol or using drugs, the neurobiological underpinnings of alcohol and substance abuse disorders remain a mystery. Eve Glenn's research on fruit flies advances the understanding of what's happening in the human brain that may contribute to addiction.

Glenn, who graduated from Brown in May 2022, studied neuroscience with a focus on neurobiological mechanisms of addiction and disease. Using the fruit fly as a model organism, she conducted independent research on self-administration and alcohol use disorders in the laboratory of Karla Kaun, an associate professor of neuroscience who is affiliated with Brown's Carney Institute for Brain Science.

Glenn's work delved into individual preference, allowing fruit flies to choose whether or not to self-administer ethanol. In collaboration with researchers in the Kaun Lab, Glenn identified a simple two-neuron circuit in the fruit fly's brain that contributes to increasing ethanol self-administration. By inactivating the two neurons, she found short- and long-term changes in the fruit fly's odor preference associated with alcohol intoxication.

"This is exciting as we now have an anatomical framework for investigating the structural and molecular changes associated with escalation of ethanol consumption," Glenn said.

Glenn also looked for differences in neuronal structure between fruit flies that escalate and de-escalate their ethanol consumption using trans-Tango, a tool developed by Brown professor of neuroscience Gilad Barnea and his team. By visualizing how the two-neuron circuit structurally changes in the presence of ethanol, researchers may be able to further understand how this circuit contributes to the escalation of ethanol self-administration, Glenn said.

This research served as the basis for Glenn's thesis. She is applying to medical school, where she hopes to focus on neurosurgery and neurology with the goal of working with marginalized and underserved patients.

In the meantime, Glenn is working as a research assistant studying amyotrophic lateral sclerosis (ALS) in fruit flies in the lab of Kristi Wharton, a Brown professor in the Department of Molecular Biology, Cellular Biology, and Biochemistry.

"In my undergraduate research I hypothesized applying any results to impulse control disorders that are seen in conditions like ALS," Glenn said. "While I am not currently researching this in the Wharton lab, understanding biologically why we see the onset of substance misuse or an ALS-like phenotype in fruit flies could theoretically inform mechanisms in the other condition."—SARA FEIJO & CORRIE PIKUL

TOP: NICK DENTAMARO/BROWN UNIVERSITY

Correcting Bias in Pulse Oximeters

Pulse oximeters often provide inaccurate readings for people with darker skin, a health disparity that one physics PhD student is working to eliminate.

Pulse oximeters provide a quick, noninvasive way to check someone's pulmonary health, using light shown through the skin to estimate the amount of oxygen in a person's blood. But research has shown that people with darker skin are at much greater risk for inaccurate readings than those with lighter skin.

Rutendo Jakachira, a third-year PhD student in physics, is working to change that. She is developing new optical techniques that return accurate oxygen saturation level results regardless of skin tone. The inaccuracy of pulse oximeters for people of color represents a significant concern in health care delivery, Jakachira said: "It has been found that there can be up to a 10 percent difference in oxygen saturation measurements among different pulse oximeters for individuals with darker skin tones. It has also been found that people of these tones are three times more likely to have hypoxemia, and it is likely to be missed by pulse oximetry."

That's because pulse oximeters tend to overestimate blood oxygen for people with dark skin. In other words, someone with dangerously low blood oxygen levels could receive a pulse ox reading that appears perfectly normal. The problem became particularly acute during the COVID-19 pandemic, when doctors relied on pulse oximeter readings taken in clinics and homes to gauge the severity of a patient's illness.

Rutendo Jakachira is working to make pulse oximeters that return accurate readings regardless of skin color.

The incorrect readings arise because melanin, the dark pigment found in skin and hair, tends to absorb light traveling through the skin. In people with dark skin, that high level of melanin can interfere with oxygen readings. Jakachira, working with Professor of Engineering Kimani Toussaint, is looking to reduce the interference by using radially polarized vector beams. They've demonstrated in experiments what they believe to be the first LED-based source that can emit such light. Testing of the device's ability to detect blood oxygen levels looks good so far, she said.

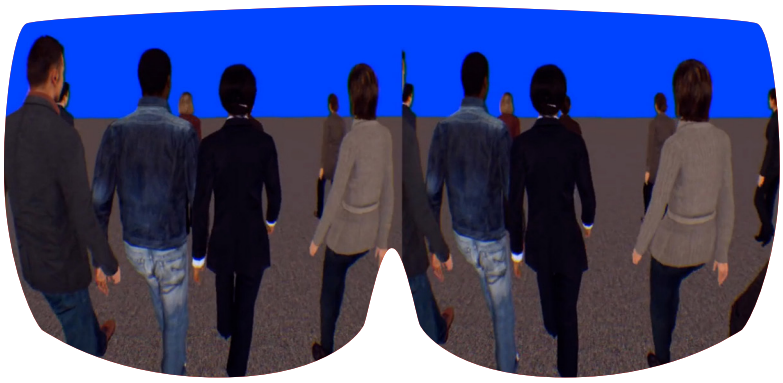
"Rutendo has approached this project with a combination of ingenuity, dedication, and strong interest," Toussaint said. "This has allowed us to gain a better understanding of the problem in terms of the underlying optical physics, and to creatively think outside of the box in developing a solution."—KEVIN STACEY

ALUMNI IMPACT

GUIDO IMBENS MA'89, PHD'91, LHD'22 HON. is an economics professor at Stanford University. He was awarded Brown's Horace Mann Medal in 2017 for his contributions to the economics field, shared the 2021 Nobel Prize in Economic Sciences, and received an honorary degree from Brown in 2022.

"Coming to Brown University opened up a whole new world for me. It was the first time I came to the United States, and the friendliness of the [economics] department and the University community made me feel very welcome. It was not just the rigor of the academic program that prepared me well for my subsequent work, it was also the humanity of the department. I vividly remember getting invited by one of the professors for a family Thanksgiving dinner. As a faculty, we now often invite graduate students to our house to make them feel welcome and seen."

TOP: COURTESY OF JOSHUA BURROW; NICK DENTAMARO/BROWN UNIVERSITY



Seen and Herd

Cognitive scientists bring a fresh new perspective to predicting crowd behavior.

Like flocks of birds or schools of fish, crowds of humans also tend to move en masse—almost as if they're thinking as one. Scientists have proposed different theories to explain this type of collective pedestrian behavior.

A new model from researchers at Brown that takes the point of view of an individual crowd member is remarkably accurate at predicting actual crowd flow, its developers say.

The model, described in a *Proceedings of the Royal Society B: Biological Sciences* paper, illustrates the role of visual perception in crowd movement. It shows how crowd members who are visible from a participant's viewpoint determine how that participant follows the crowd and what path they take. The paper is based on an idea developed by the paper's co-author Gregory Dachner, who earned his PhD at Brown in 2020.

The new approach is a departure from previous models, which operate from the point of view of an omniscient observer, said study author William H. Warren, a professor of cognitive, linguistic, and psychological sciences at Brown.

In a series of experiments that involved tracking the movements of people wearing virtual reality headsets, researchers in Warren's lab could predict an individual's movement based on their view of a virtual crowd.

When the researchers used the experiment results to create a new theory of collective motion, it successfully predicted individual trajectories in both virtual crowd experiments and real crowd data.

Warren said that models on crowd movement can be used to inform the design of public spaces, transportation infrastructure, and emergency response plans.

"We are the first group to provide a sensory basis for this type of coordinated movement," Warren said. "The model provides a better understanding of what individuals in a crowd are experiencing visually, so we can make better predictions about how an entire group of people will behave."—CORRIE PIKUL

Top: In a study of collective behavior, participants wore virtual reality headsets and walked with animated three-dimensional virtual humans as researchers tracked their movements and paths.

ALUMNI IMPACT

STEFANIE TOMPKINS MSC'93, PHD'97 is the director of the Defense Advanced Research Projects Agency (DARPA), a research and development agency of the U.S. Department of Defense.

"I lead a high-risk, high-payoff research and development agency within the Department of Defense, charged with making pivotal investments in breakthrough technologies for national security. Past successes include the Saturn V rocket, stealth aircraft, the ARPANET (which became the internet), self-driving cars, and mRNA vaccines—we are working on what comes next! In my job, I see hundreds of new ideas across many technology domains and have to make critical judgments about which ones we are going to take risks on. Brown prepared me for this in three ways: first, by training me as a geologist, an incredibly diverse field that requires you to use many different STEM disciplines (math, chemistry, physics, engineering); second, by honing my capacity for critical thinking; and third, by providing amazing role models."

TOP: WILLIAM WARREN; COURTESY OF STEFANIE TOMPKINS

SHORT TAKES

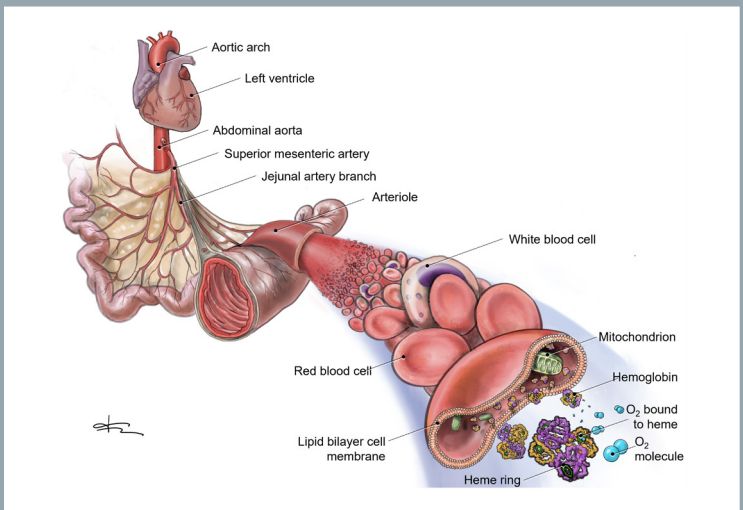
—KAILEE TANAKA '26

While serving the Biden administration as assistant director for science and justice in the White House Office of Science and Technology Policy, **Suresh Venkatasubramanian**, professor of computer science and data science, proposed the Blueprint for an AI Bill of Rights, a framework of principles and practices essential to protecting citizens during the rise of artificial intelligence.

Emily Oster, professor of economics and author of three bestselling books analyzing the data behind pregnancy and parenting choices, was named one of *Time*'s 100 Most Influential People of 2022.

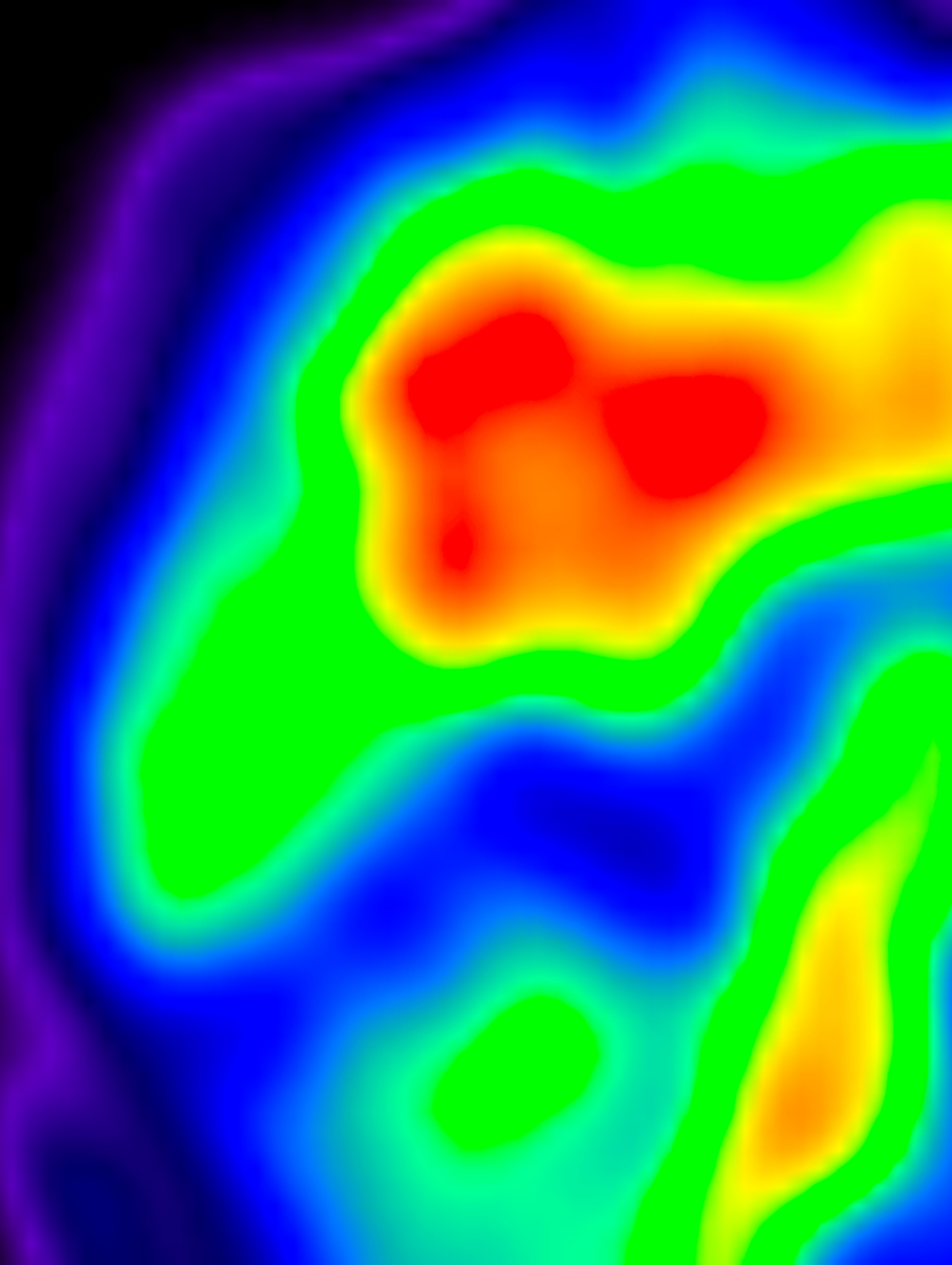
Amanda Lynch, professor of environment and society and earth, environmental, and planetary sciences, has been named chair of the World Meteorological Organization's research board, which oversees research focused on ensuring safety in the face of climate change, weather phenomena, and water shocks.

Appointed by President Biden in March 2022, Ashish K. Jha, MD led the nation's pandemic response and recovery efforts as White House COVID-19 response coordinator. Jha returns from this temporary leave and resumes his post as dean of the School of Public Health on July 1.

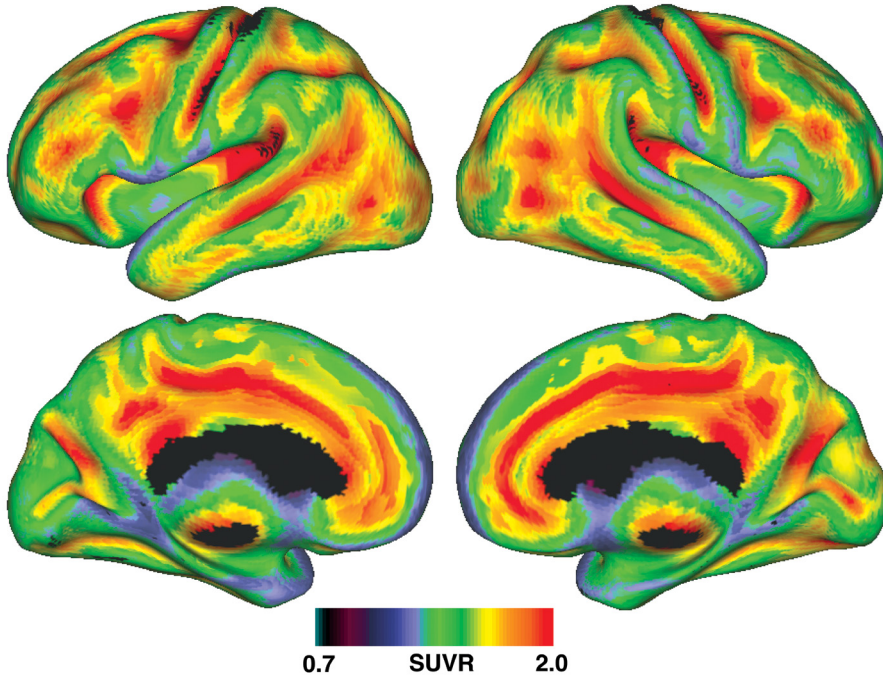


FRANÇOIS LUKS/*MEDSPEAK ILLUMINATED*

François Luks, MD, professor of surgery, pediatrics, obstetrics, and gynecology, published a book on medical illustration, ***MedSpeak Illuminated***, to facilitate better communication between physicians and patients. The book evolved from his course Introduction to Medical Illustration, which is offered to Brown and RISD students.



Facing page: Images from florbetapir F18 PET scans of the posterior and medial sides of the brains of cognitively normal older adults, showing a high level of beta-amyloid plaque accumulation (in red and orange).



DISCOVERIES IN AGING RESEARCH

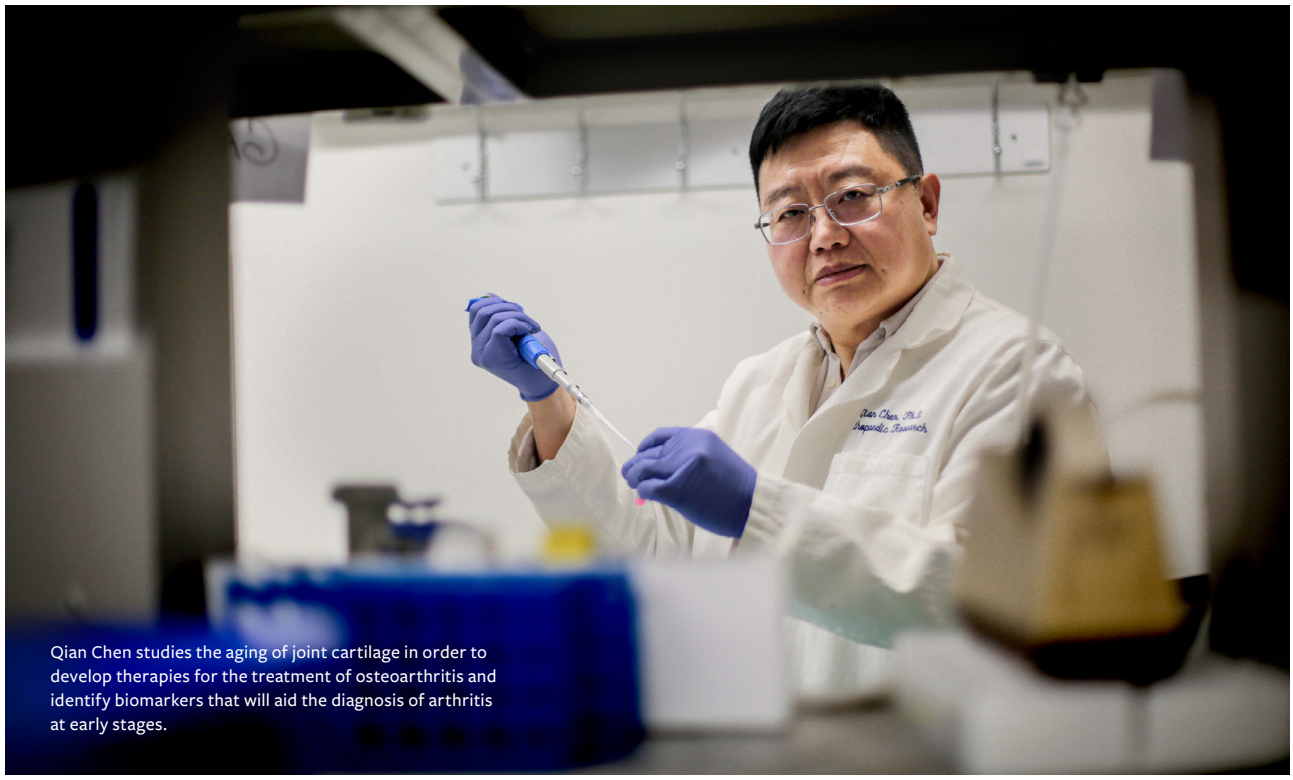
From cell studies to therapeutics to elder care, Brown researchers tackle the aging process.

By David Levin

The indignities of aging creep in slowly. A bit of wrinkled skin, a nagging pain in your joints, a blurry tinge to formerly perfect vision. Age-related quirks like these are a normal part of living—but, strangely, they don't affect us all the same way. For some, ailments may be just an annoyance; for others, they're significant enough to require full-time care.

Why is this? If all factors are equal, how can a 70-year-old man be bedridden while the 95-year-old woman next door is still alert and active? A small army of researchers at Brown is working on answers. On lab benches, in clinical trials, and in programs aimed directly at older adults, these scientists reveal how our bodies age and what we can do to prevent the worst effects of that aging process. With each new finding, they make painstaking, incremental progress, laying the foundation for our old age to become healthier and happier.

IMAGES COURTESY OF HWAMEE OH



Qian Chen studies the aging of joint cartilage in order to develop therapies for the treatment of osteoarthritis and identify biomarkers that will aid the diagnosis of arthritis at early stages.

BASIC SCIENCE

THE AGING CELL

The work many Brown scientists are doing on aging falls squarely into the category of basic science, research that may not have an immediate application but that reveals the fundamental principles and phenomena that make our cells tick. It lays the groundwork for applied science by providing knowledge other researchers can build upon down the road. Bit by bit, these scientists are discovering how aging occurs on a cellular and molecular level and are creating the foundation for new drugs and other treatments in the future.

PART OF THE PACKAGE

Erica Larschan, associate professor of molecular biology, cell biology, and biochemistry, studies chromatin, the molecular "packaging" that holds our DNA. Under normal circumstances, she said, chromatin molecules wind specific stretches of DNA tightly around themselves, which prevents certain genes from being read. In doing so, chromatin is a critical part of regulating gene expression in a cell—but when it falters, the whole finely-tuned system can come crashing down.

"The packaging of the genome just starts to fall apart with age," Larschan said. "That could be one of the first triggers or signals that drive the aging process, because once you dysregulate gene expression, it affects lots of other things in the body."

Exactly why that happens is a central question of her research. Larschan wants to understand how chromatin changes in later life and how that change differs by sex. This trait could explain why women have higher rates of diseases like Alzheimer's while men have higher rates of other diseases like amyotrophic lateral sclerosis (ALS).

She is just starting to investigate the root cause of these differences, but thanks to a new $12.5 million grant from the National Science Foundation to a project on which she is a co-principal investigator, she hopes to make significant progress in the next five years.

CELLS IN STASIS

Qian Chen, professor of orthopedic research and medical science, is also trying to figure out how aging affects individual cells. He focuses on osteoarthritis, a common ailment associated with aging and injury. Like Larschan, he thinks a breakdown in gene expression within cartilage cells—which may also be caused by damaged chromatin—could be a root cause of osteoarthritis.

Normally, Chen said, cartilage cells can divide a finite number of times. If joint tissue is damaged by injury or worn out by age, some cells hit their division limit before the wound is fully healed. Instead of just dying off like they usually would during development, a few of those cells settle into senescence, a lingering

TOP: BILL MURPHY/LIFESPAN; DEIRDRE CONFAR

Bottom left: Ana Saade, laboratory assistant in Marc Tatar's lab, prepares *Drosophila* (fruit flies) for an experiment to understand the effects on aging of metformin, a medication for the treatment of Type 2 diabetes.

Below: The nucleus of a nonsenescent cell shows chromosomes 4 (red) and 18 (green), which appear significantly larger than in the nucleus of a senescent (aging) cell.

Right: Neurogenesis, or the generation of new neurons (green dots), is weakened in the hippocampus of mouse brains affected by aging and Alzheimer's disease. The Huang laboratory is developing a treatment that may restore neurogenesis and improve cognitive function.

state of malaise where they can no longer divide yet refuse to go gently into that good night. These zombified cells hang out in joint tissue for years, causing long-term inflammation that could trigger arthritis.

"Once a few cells go senescent, you basically have a time bomb in your body. Even if you're able to restore perfect mechanical function to an injured joint through surgery, those cells that are buried deep in cartilage will lead to osteoarthritis down the road," said Chen.

To solve this problem, he is developing a delivery system for RNA therapies that could travel through cartilage, a notoriously dense and impenetrable substance. By creating a nanoparticle small enough to squeeze through its thicket of fibers, Chen's work could lead to methods that treat osteoarthritis at the source and prevent inflammation from occurring.

MIXED SIGNALS

Outside factors, like hormones and signaling molecules, also contribute to cellular aging. Professor of Biology Marc Tatar thinks that one of the body's most ubiquitous hormones, insulin (which generally helps regulate blood sugars) could play a significant role.

For the past 20 years, Tatar has been studying how changes in insulin levels are linked to aging. Back in 2001, he found some tantalizing clues: by limiting insulin in fruit flies, he could prolong their lives by 30 to 40 percent. The longevity came at a cost, however—while the flies survived longer than their peers, they also had diabetes, stunted growth, and poor reproduction.

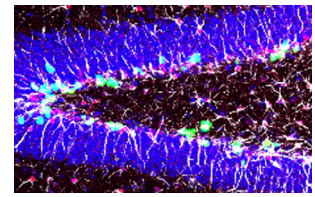
In 2022, Tatar and his team at Brown made a new and equally exciting discovery: a mutation in a tiny and understudied part of fruit flies' insulin receptors that seemed to give them unusually long lives. Their lifespans stretched phenomenally, yet they could still grow, thrive, and reproduce like flies half their age with no adverse side effects.

The cause, Tatar believes, is the unique placement of the mutation. The slight tweak it created in the flies' genetic code altered the structure of their insulin receptors in tiny ways that led to massive results. Some forms of insulin and its close cousins, insulin-like growth factors, could still bind normally to these mutated insulin receptors, preventing harmful side effects like diabetes, while other forms of the molecules were left out in the cold. Tatar suspects their absence is somehow responsible for the insects' long lives.

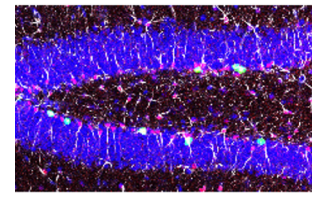
Humans and fruit flies share many of the same genes that control insulin processes, so what's good for these insects might also be good for people. If Tatar can show similar results in mammals, it could lead to a drug that combats the effects of old age.

"It's hard to see the translation from fruit fly to human, but when you get down to the level of the cell, we're all the same," he said.

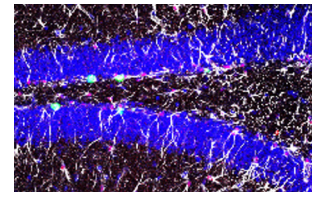
Without the incremental progress these scientists and their peers bring to the field, there would be no new medical insights, no drugs to combat diseases of aging, and no forward momentum in the field. Through their work with cells, genes, and molecules, these researchers are paving the way for the treatments of the future.



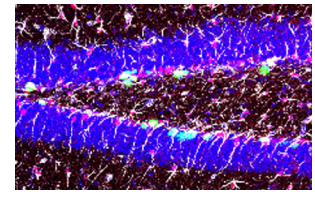
Young mouse brain (hippocampus)



Old mouse brain



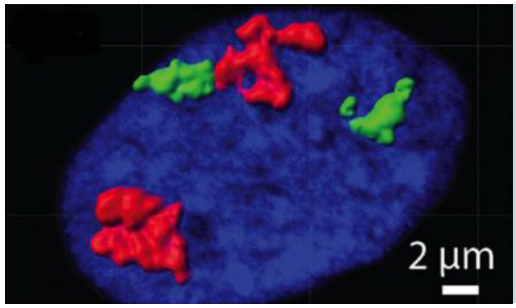
Mouse brain with Alzheimer's disease



Alzheimer's disease mouse brain after treatment

Yu-Wen Alvin Huang

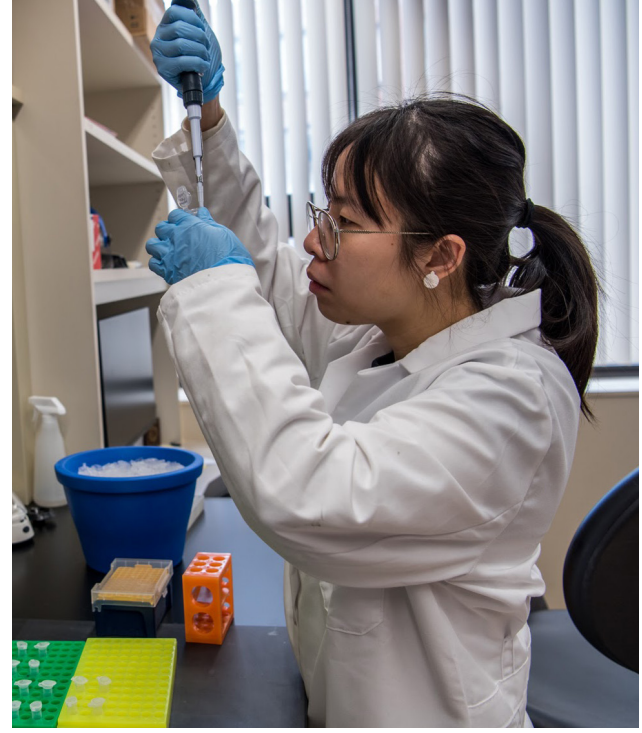
Huang, assistant professor of molecular biology, cell biology, and biochemistry, studies the molecular basis of Alzheimer's disease and examines how it differs from normal aging. He is currently focused on a protein called CHI3L1, which causes inflammation, stops immune cells in the brain from functioning normally, and prevents neuronal stem cells from producing more neurons. The protein may help trigger diseases like Alzheimer's and other forms of dementia.



Nicola Neretti

Neretti, associate professor of molecular biology, cell biology, and biochemistry, is working to understand cellular senescence—a semidormant state that triggers widespread inflammation in the surrounding tissue—and is exploring its role in aging. His latest work examines how senescent cells accumulate in the body and contribute to age-related conditions such as cancer, heart disease, and Alzheimer's.

COURTESY OF YU-WEN ALVIN HUANG/BROWN UNIVERSITY; COURTESY OF NICOLA NERETTI/BROWN UNIVERSITY



CLINICAL AND APPLIED RESEARCH

NEW TREATMENTS AND THERAPIES

Many researchers at Brown are already building on the work of their peers and are actively creating treatments for diseases of aging. These scientists are partnering with older patients to conduct observational studies or are entering clinical trials for new drugs. Their innovative work could lead directly to therapies and diagnostic tools that will help us thrive well into our sunset years.

EARLY ACTION

William Heindel, professor of cognitive, linguistic, and psychological sciences, is one of those researchers. With his colleague, Senior Lecturer Elena Festa, he's working on ways to spot neurological diseases like Alzheimer's and other forms of dementia early in their course before patients show any symptoms. To do so, he's using a series of deceptively simple computerized tests that can reveal if cognitive damage is happening in the brain even a decade or two before symptoms appear.

The tests challenge two components of our visual system that process what we see through two distinct neural pathways or "streams." The first, called the dorsal stream, processes motion, luminance, contrast, and black-and-white elements of our vision; the second, called the ventral stream, handles object recognition and processes color. Both streams must work together seamlessly to coherently assess what we see.

Heindel's tests probe this connection. In the lab, a video screen shows many green dots moving left to right and red dots moving up and down, while a single green dot moves only up and down. Participants are asked to track this green dot with their eyes, and since doing so requires processing both motion (the dorsal stream) and color (the ventral stream), slight delays in their reaction, even just a by few milliseconds, can show that the link between both streams is breaking down.

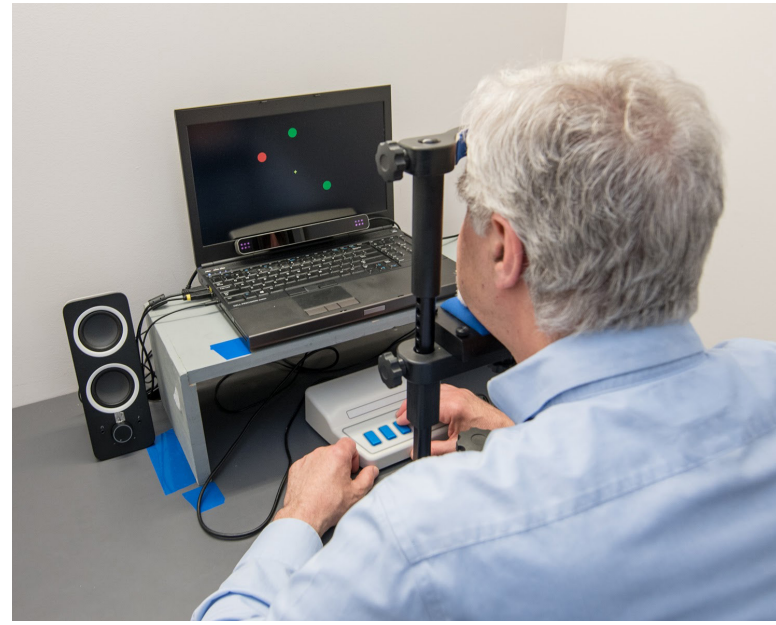
TOP: BOTH IMAGES: DEIRDRE CONFAR

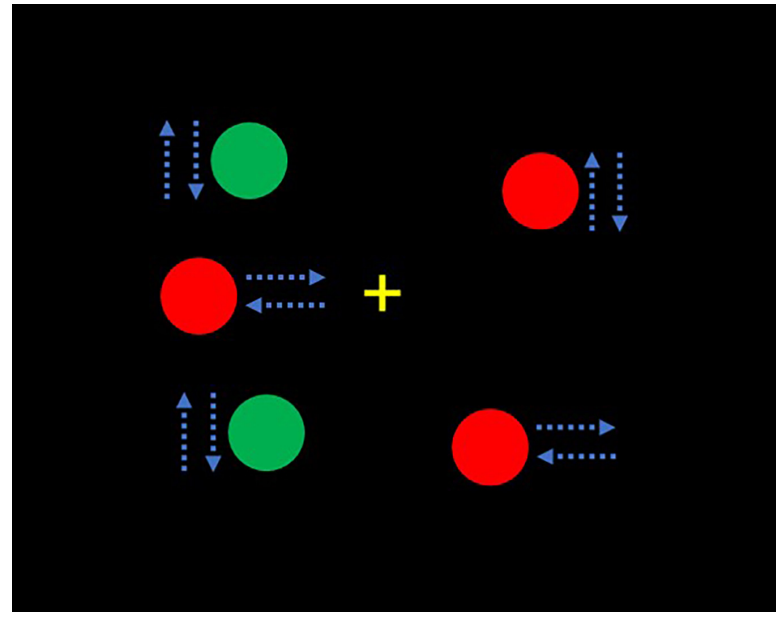
Top left: Yufei Lin, graduate student, conducts aging research in John Sedivy's lab at the Center on the Biology of Aging.

Bottom left: Justin Fallon, Ashley Webb, and Johnny Page are co-founders of the biotechnology company Bolden Therapeutics, which received Brown's 2022 Start-Up of the Year award.

Top right & middle: William Heindel demonstrates a cognitive test he developed with colleague Elena Festa, senior lecturer in cognitive, linguistic, and psychological studies, that can reveal whether cognitive damage is happening in the brain long before symptoms of neurological disease appear.

Below: With their new imaging technique, the Lee lab generated an image of a brain microvasculature network in which different levels of betweenness, a key network property, were represented by a range of colors.





"That's the beauty of certain cognitive tests like this. You don't necessarily need medical imaging to see what's going on in the brain," said Heindel.

REPLACING NEURONS

Spotting age-related disease is only half the battle; treating it is just as important. Justin Fallon, professor of neuroscience, and Ashley Webb, assistant professor of molecular biology, cell biology, and biochemistry, are working towards that goal along with Johnny Page, a former student of Fallon's. Together they've created Bolden Therapeutics, a new biotech company based on their collaborative research.

Bolden aims to find treatments for various neurodegenerative diseases, from Alzheimer's to ALS. These diseases kill off neurons in the brain through multiple means, leaving gaps in its complex circuitry. The team wants to replace missing neurons entirely to fix those broken connections, which could restore patients' original brain function.

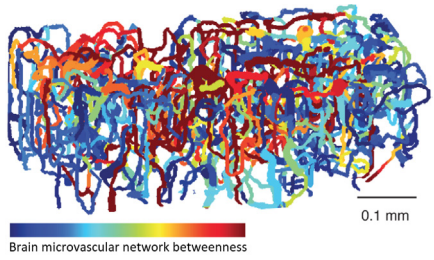
This may be possible by targeting stem cells in the hippocampus, a region of the brain that plays a central role in learning and memory, Webb said. Early in life, those cells crank out neurons regularly, but the older we get, the fewer they produce. A new therapy they are developing may offer a way to boost the activity of those cells on demand, creating new neurons whenever needed.

"That might be useful for normal cognitive decline as well as in situations like Alzheimer's disease, which destroys cells in the hippocampus early on," Webb said. "If we can figure out ways to replace the neurons that are lost in Alzheimer's, that would be a game changer."

Currently the researchers are testing their RNA therapy in mice and on human cells in the lab. If successful, the drug will move into clinical trials in the next few years, bringing the world closer to a treatment for millions of patients worldwide.

AN OUNCE OF PREVENTION

Professor of Biology John Sedivy is also working on ways to treat age-related diseases in the brain. Instead of rebuilding damaged neurons, he's focusing on a method to stop or slow that damage.



Jonghwan Lee

Lee, assistant professor of engineering and brain science, is developing new methods for diagnosing Alzheimer's disease using advanced vascular imaging techniques. He is currently exploring how the degeneration of small blood vessels in the brain may contribute to cognitive decline and dementia. By better understanding this process, his work may lead to new strategies for preventing the disease, such as regular checkups for early detection through simple eye scans.

TOP: DEIRDRE CONFAR; COURTESY OF WILLIAM HEINDEL; COURTESY OF JONGHWAN LEE

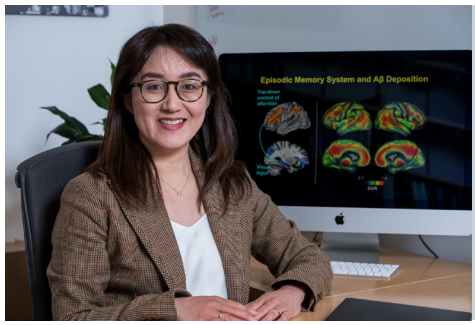
Postdoctoral research associate Alberto Caligiana (right) shows John Sedivy western blot data with results of ORF1 and ORF2 protein expression in senescent compared to young cells.

Sedivy, director of Brown's Center on the Biology of Aging, studies cells that have entered senescence, a semidormant state that causes inflammation in surrounding tissue. If too many cells in the brain become senescent, he said, the resulting inflammation can damage or destroy neurons, causing diseases like ALS and dementia.

One cause of cell senescence in the brain may be retrotransposons, virus-like stretches of genetic code in our DNA. If activated, these bits of code can replicate themselves and damage cells. Sedivy's lab discovered that cells also mistake retrotransposons for real viruses and mount antiviral defenses that fuel chronic inflammation. Through his biotech startup, Transposon Therapeutics, Sedivy is working towards a treatment that can stop that scenario from unfolding. He's currently in early clinical trials for a new drug that can block retrotransposons in human brain cells and ultimately may prevent neurons from dying off in patients with ALS or Alzheimer's.

"We're discovering new things all the time," he said. "Retrotransposons have been known for decades, but they haven't attracted a lot of attention in the medical world. We're really firmly connecting them with disease."

Each of these researchers has a tangible sense that the process of aging is, essentially, the process of living. It's an inextricable part of who we are; from the day we're born, it's a steady presence wherever we go. Just because our bodies are perpetually aging doesn't mean we're destined to end our days in illness, though: thanks to the clinical research Brown scientists are doing today, we may be able to stay healthy and mentally sharp late in life.



Hwamee Oh

Oh, associate professor of psychiatry and human behavior, is studying the early effects of Alzheimer's disease pathologies, such as beta-amyloid plaques and tau-protein neurofibrillary tangles, on cognition and brain structure and function using advanced brain imaging techniques like MRI and PET. She is developing new cognitive tasks and methods for analyzing these scans to detect early cognitive and brain imaging signs of the disease and track its progression—work that could lead to earlier diagnosis and more effective treatments.

BOTH IMAGES: DEIRDRE CONFAR

Below: Meals on Wheels recipient Lena Belton, a former army base supervisor and Sunday school teacher, says her favorite part of the meal delivery program is the volunteers who stop by to check on her.

GERONTOLOGY AND ELDER CARE

IMPROVED QUALITY OF LIFE

Most of us hope to live long lives, preferably in the comfort of our own homes. However, what that takes in practice isn't so obvious, since assisted living facilities and nursing homes are full of older adults who require full-time professional care to meet their basic needs.

A growing number of researchers at Brown are studying these care settings and finding that the key to healthy aging isn't just medical intervention; it's also the social and emotional framework surrounding those patients. Issues like isolation, limited transportation, and poor access to nutritious food, they say, can be just as much of a problem as a chronic disease. So how can we know what kinds of care will give people the best possible outcomes?

SIZING UP CARE

These kinds of questions drive the work of Vincent Mor and Kali Thomas, professor and associate professor of health services, policy, and practice. Both are researchers at Brown's Center of Gerontology and Healthcare Research (which Mor directed for 10 years), specializing in improving care for older adults.

"Nonmedical services, like meal prep, shopping, groceries, and laundry, are social determinants of healthy aging," said Mor. "They are not historically the realm of medicine or healthcare. Yet they're a critical part of making care more holistic so we can stop just treating one disease at a time."

Mor and Thomas are combing through massive nationwide datasets, including Medicare electronic health records, to identify the best policies and practices for older adults. They're searching for patterns that show which techniques and programs have genuinely effective results, and by quantifying those outcomes, they're creating scientific evidence that could lead to more standardized and equitable care.

Thomas, for instance, is currently working with the nonprofit Meals on Wheels America to study how in-person meal deliveries impact recipients. She found that the meals themselves are only part of the benefit: social interaction with the person delivering them is also incredibly valuable for health outcomes. Thomas is testing that idea through a "pragmatic clinical trial"—one that takes place in the real world rather than in a clinic—and her results may help expand Medicare and private insurance coverage to include these services.

COURTESY OF MEALS ON WHEELS AMERICA, USED WITH PERMISSION

Top: Kali Thomas specializes in improving care for older adults needing long-term services and supports, such as Meals on Wheels. **Middle:** Rosa Baier tests music and other nondrug health interventions to protect the autonomy of dementia patients. **Bottom:** Erick Loucks researches the benefits of mindfulness practice on healthy aging, which include better cardiovascular health and cognition in older adults.

Pragmatic clinical trials are at the core of a nationwide effort to transform dementia care, led by Mor and Susan Mitchell, MD, professor of medicine at Harvard Medical School. Mor and Mitchell co-lead the NIA IMPACT Collaboratory, a research incubator evaluating nondrug, care-based interventions for dementia patients and their caregivers. The incubator is funded by a five-year $53.4 million grant from the National Institute on Aging awarded to Brown and Boston-based Hebrew SeniorLife in 2019, the largest federal award in Brown University history.

FINDING WHAT WORKS

Rosa Baier, professor of the practice of health services, policy, and practice, is also working to improve health interventions for older adults. Baier directs the Center for Long-Term Care Quality and Innovation at Brown. She partners with vast networks of caregivers representing more than 12,000 assisted living and long-term care facilities nationwide.

Through these partnerships, she and her colleagues have identified significant problems these facilities struggle with daily. Quality care for dementia patients, for instance, is an ongoing issue—in many cases, facilities manage those patients' confusion and erratic behavior with unnecessary antipsychotic drugs.

Baier and her colleagues at the center are testing nondrug interventions that can both protect patients' autonomy and aid in softening their outbursts. For example, one of the group's current studies involves musical intervention, which involves working with caregivers to make personalized playlists that might help calm agitated dementia patients. The principal researcher on that work, Ellen McCreedy of Brown's School of Public Health, has already helped more than 50 nursing homes develop a music-based regimen.

"These are exactly the kinds of studies where collaboration with the provider community is valuable," Baier said. "There's a synergy between the things that researchers are interested in and the things that address healthcare providers' needs."

MIND OVER BODY

Other innovations in elder care, like mindfulness practice, can also benefit healthy aging. Eric Loucks and Elena Salmoirago-Blotcher, MD, researchers at Brown's Mindfulness Center and the Lifespan Cardiovascular Institute respectively, find that extended practice of those techniques can benefit cardiovascular health and improve cognition in older adults.

In a 2020 study, Loucks, associate professor of behavioral and social sciences, gathered a cohort of more than 200 older adults with elevated blood pressure and conducted an eight-week intensive mindfulness training program with them all. Under his guidance, the cohort learned to focus on how they felt when eating certain foods, exercising, taking medications, or consuming alcohol.

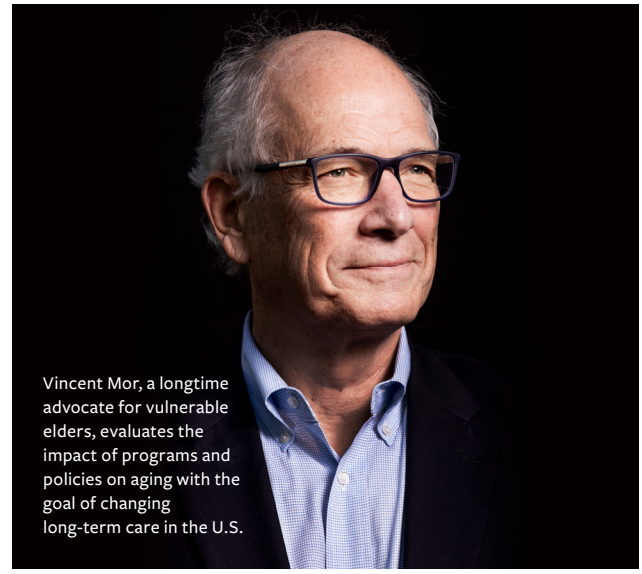
After six months, he saw a marked improvement in the group. Participants were more likely to eat heart-healthy foods, reported lower levels of stress overall, and, most importantly, had a notable five-millimeter drop in average blood pressure.

TOP: KENNETH C. ZIRKEL/BROWN SCHOOL OF PUBLIC HEALTH; DEIRDRE CONFAR; NICK DENTAMARO/BROWN UNIVERSITY

Salmoirago-Blotcher, associate professor of psychiatry and human behavior, is studying other ways mindfulness practices may improve health and well-being in aging adults. She's found that it can improve cognitive function in older people with heart failure or at risk for dementia. She is now conducting a more extensive study to see how mindfulness training can affect cognition. The study will also examine its effects on interoception, or awareness of what's happening inside one's body.

"For patients with heart failure, this self-awareness is really important. Being able to notice if your legs are getting swollen, or if you are feeling more tired than usual, or if you are suddenly short of breath when you climb the stairs could help people seek medical attention and receive adequate treatment sooner rather than later," she said.

No matter where we're living in our old age, the work of these scientists is ensuring that we'll be better cared for, more comfortable, and more aware of our health—all elements that will vastly improve our quality of life. ■



Vincent Mor, a longtime advocate for vulnerable elders, evaluates the impact of programs and policies on aging with the goal of changing long-term care in the U.S.

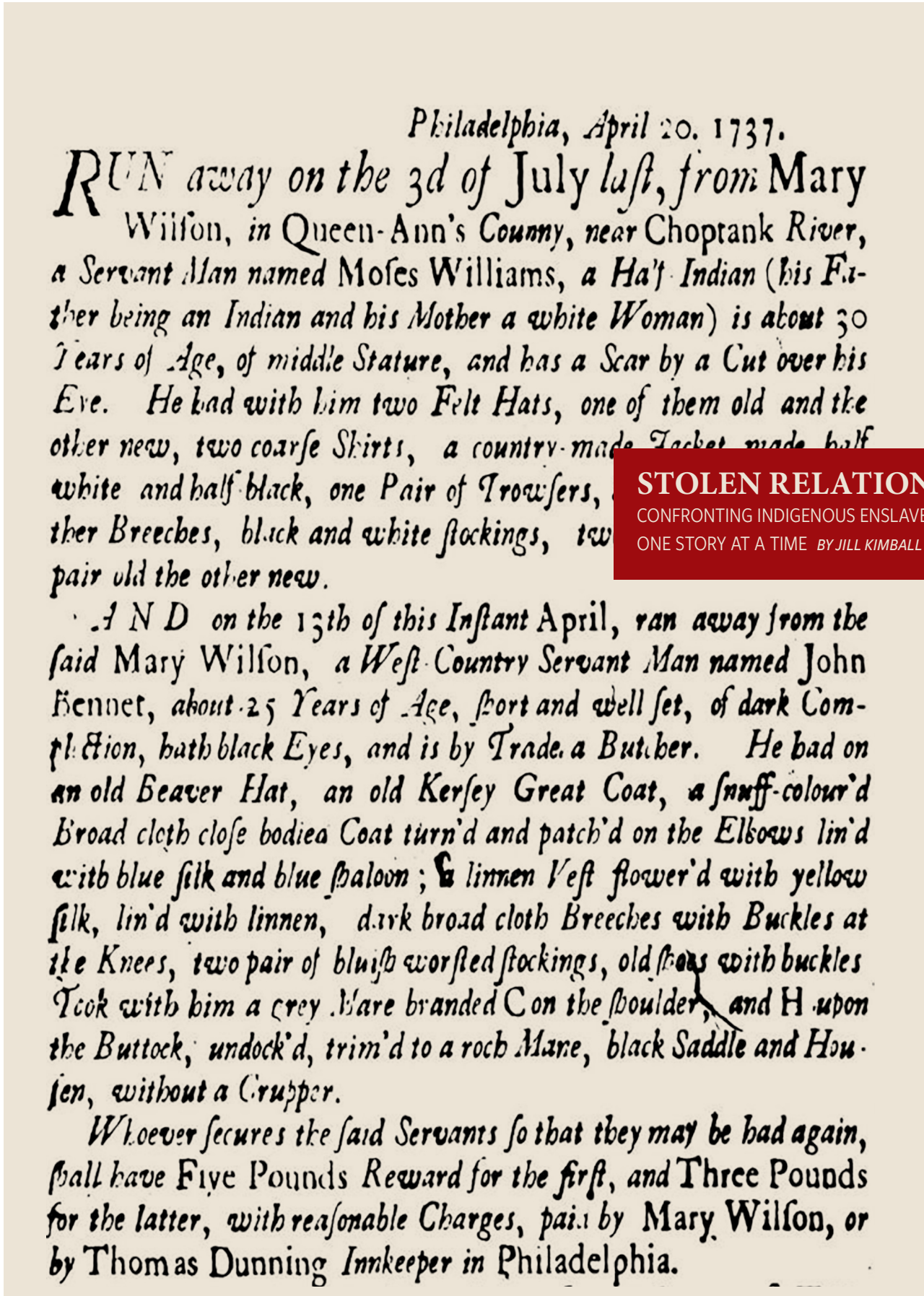
Rich Jones
Jones, professor of neurology, studies "cognitive reserve" in older adults, or how well their brains compensate for declining cognitive function in Alzheimer's disease, other forms of dementia, and clinical aging. He is also exploring potential interventions for cognitive loss, such as exercise and mental training, that may help slow down or prevent these age-related changes.

Stephen Salloway, MD
Salloway, professor of psychiatry and human behavior, is currently co-leading the New England division of the U.S. POINTER study, research that aims to better represent patients impacted by Alzheimer's (a disease that disproportionately affects older Black and Hispanic Americans). He is working with community leaders to build a trusted network to increase participation in clinical trials among people of color in Rhode Island and southern New England.

BOTTOM: ALEX GAGNE

"We want to not only uncover and recover those stories of enslavement but also understand how our people adapted to the difficulties they faced and persisted into the 21st century." —Lorén Spears, Tomaquag Museum director and Narragansett Tribe member

COURTESY OF THE TOMAQUAG MUSEUM



Philadelphia, April 20. 1737.

RUN *away on the 3d of* July *last, from* Mary Wilſon, *in* Queen-Ann's *County, near* Choptank *River, a Servant Man named* Moſes Williams, *a Half-Indian (his Father being an Indian and his Mother a white Woman) is about* 30 *Years of Age, of middle Stature, and has a Scar by a Cut over his Eye. He had with him two Felt Hats, one of them old and the other new, two coarſe Shirts, a country-made Jacket made half white and half black, one Pair of Trowſers, [illegible] ther Breeches, black and white ſtockings, two pair old the other new.*

AND *on the* 13th *of this Inſtant* April, *ran away from the ſaid* Mary Wilſon, *a Weſt-Country Servant Man named* John Bennet, *about* 25 *Years of Age, ſhort and well ſet, of dark Complexion, hath black Eyes, and is by Trade a Butcher. He had on an old Beaver Hat, an old Kerſey Great Coat, a ſnuff-colour'd Broad cloth cloſe bodied Coat turn'd and patch'd on the Elbows lin'd with blue ſilk and blue ſhaloon; a linnen Veſt flower'd with yellow ſilk, lin'd with linnen, dark broad cloth Breeches with Buckles at the Knees, two pair of bluiſh worſted ſtockings, old ſhoes with buckles Took with him a grey Mare branded C on the ſhoulder, and H upon the Buttock, undock'd, trim'd to a roch Mane, black Saddle and Houſen, without a Crupper.*

Whoever ſecures the ſaid Servants ſo that they may be had again, ſhall have Five Pounds *Reward for the firſt, and* Three Pounds *for the latter, with reaſonable Charges, paid by* Mary Wilſon, *or by* Thomas Dunning *Innkeeper in* Philadelphia.

STOLEN RELATIONS

CONFRONTING INDIGENOUS ENSLAVEMENT, ONE STORY AT A TIME *BY JILL KIMBALL*

COURTESY OF LINFORD FISHER

An ever-expanding initiative of Brown scholars, young volunteers, and Native American leaders, the online repository Stolen Relations has recovered thousands of records of Indigenous enslavement in the Americas, drawing increased attention to a topic rarely broached in school history lessons.

About 350 years ago, amid a conflict known as King Philip's War, the English captured and enslaved a group of Wampanoag Native Americans.

The Wampanoags were shipped by boat to Tangier, once an English colony and now a major Moroccan city. When they arrived, they wrote in a panic to Massachusetts colony pastor and missionary John Eliot, whom they considered an ally.

According to Linford Fisher, associate professor of history, "They essentially wrote, 'We were enslaved during the war, we're serving in Tangier, and our simple request is just to be returned to our homeland.' As far as I can tell, they were never able to leave. They never saw their families again, and nothing was ever done."

Their story, Fisher said, is one of the countless heartbreaking tales of Indigenous enslavement that historians have only just begun to unearth in the past few decades. In 2015, to advance collaboration in the nascent effort, Fisher created Stolen Relations: Recovering Stories of Indigenous Enslavement in the Americas, an online repository that contains more than 5,500—and counting—records of Indigenous enslavement.

Created with his scholarly peers in mind, the project aims to become an empowering tool for Indigenous communities and descendants of European colonizers who wish to confront their full, painful ancestral histories. It also intends to raise widespread awareness of Indigenous enslavement, which has long been omitted, glossed over, or mentioned only obliquely in U.S. classrooms.

"As the field kept on growing, and as I talked more and more with colleagues who were researching the same thing, I kept thinking that there should be some sort of centralized resource where we can all benefit from each other's work," Fisher said. "I hope the project will ultimately become a resource that is not only beneficial to researchers and educators but also to public historians, genealogists, and tribal nations."

BROADENING THE MISSION

Eight years after its start, Stolen Relations is set to continue expanding thanks to a $350,000 grant from the National Endowment for the Humanities. The majority of the grant will fund a redesigned, publicly accessible site for the online repository, which is currently available only to registered users, most of them scholars and community partners. According to Ashley Champagne, director of Brown's Center for Digital Scholarship and the longtime project manager of the Stolen Relations repository, the website's records will not only continue to grow but also be enriched by the important cultural context provided by regional Indigenous leaders.

"Most people know so little about Indigenous enslavement, but creating a public portal to more than 5,500 records could change that," Champagne said. "Over time, we hope to offer maps, timelines, and multimedia that help people understand how Indigenous enslavement shaped economies and people in the Americas and scattered Indigenous communities around the world."

13 Tribal Nation Partners

- ASSONET BAND OF WAMPANOAGS
- CHAPPAQUIDDICK TRIBE OF WAMPANOAG NATION
- CHAUBUNAGUNGAMAUG NIPMUCK INDIAN COUNCIL
- EASTERN PEQUOT RESERVATION
- MASHANTUCKET PEQUOT TRIBE
- MASHPEE WAMPANOAG TRIBE

The funds will also allow Fisher to hire graduate fellows, who over three years will help sort through and organize archives at Rhode Island's Tomaquag Museum. The museum's archives contain critically important records of Indigenous life in southern New England, and many could shed light on yet more instances of Indigenous enslavement. Drawing from the archives, the fellows and the museum will ultimately collaborate on an exhibition about settler colonialism and Indigenous enslavement in the region. The exhibition will be on view at the museum and later travel to Brown.

Lorén Spears, director of the Tomaquag Museum, said the partnership would expand public access to the museum's estimated 100,000 records, offering broader insights on local Indigenous life. It will also add a needed dimension to Stolen Relations, humanizing its enslaved subjects and emphasizing Indigenous peoples' resilience.

"We want to not only uncover and recover those stories of enslavement but also understand how our people adapted to the difficulties they faced and persisted into the 21st century," Spears said. "Some Native people in this area were sent to Bermuda to work on sugar cane plantations. Their descendants are now reconnecting with relatives in New England and sharing how they kept and adapted cultural traditions. It's important to know that their ancestors were enslaved, yes, but it's equally important to celebrate their resilience and the reconnection that is happening."

The grant funds will also allow Stolen Relations to deepen its already-close partnerships with tribal communities in Rhode Island, Massachusetts, Connecticut, and beyond, Fisher said. Three years of funds for a summer tribal internship will allow Fisher to work with and learn from young tribal members as he and his team continue to build and expand the online repository. The grant will also support regular meetings with local tribal leaders, who have provided crucial insights that have transformed Stolen Relations.

"I think one of the biggest positive outcomes of this project is that it not only directs people to the past to learn about this important history, but it also increases their awareness of Indigenous peoples today," Fisher said. "Tribal leaders have left their stamp all over this project, which I think leads people to come away saying, 'Wow, these people are still here; even after all they've suffered, they've persisted with incredible resilience.'"

LONG-FORGOTTEN HISTORY

Across the Americas, between 1492 and 1900, an estimated 2 million to 5.5 million Indigenous people were summarily taken from their ancestral homelands and forced into slavery. Some were made to work on farms and estates on the lands they once used freely, while others were sent to European cities and colonial outposts in Africa and Asia.

Fisher said that despite the phenomenon's huge scale, most students in the U.S. never learned about Indigenous enslavement in school. That's partly because European colonists didn't keep meticulous records of the Indigenous people they enslaved.

"It's not like the transatlantic slave trade, where we have very clear shipping records and plantation records where slaves were tabulated," Fisher said. "Indigenous slavery operated in this semilegal realm and wasn't always called slavery. As a result, the documentation is much sparser, and it takes more work to turn up these stories."

Fisher believes the subject didn't enter the national consciousness until 2003 when two books on Indigenous enslavement won the Bancroft Prize, which is considered one of the highest honors for American historians. Those books inspired a proliferation of scholarship on the topic, and in the last 20 years, facts about European colonists' past enslavement

DEIRDRE CONFAR

Ashley Champagne, director of Brown's Center for Digital Scholarship, and Linford Fisher created the Stolen Relations website, a repository of more than 5,500 records of Indigenous slavery found in historical documents.

MASSACHUSETT PONKAPOAG TRIBE

MONTAUKETT INDIAN NATION

NARRAGANSETT INDIAN TRIBE

NIPMUC NATION

POCASSET WAMPANOAG TRIBE

TOMAQUAG MUSEUM

WAMPANOAG TRIBE OF GAY HEAD (AQUINNAH)

Above: As part of a Spring 2022 course Fisher taught titled Captive Voices: Atlantic Slavery in the Digital Age, Brown students visited the John Hay Library to consult historical records of Indigenous enslavement. The students in the course contributed to Stolen Relations, digitizing some records for the repository.

of Indigenous people in Brazil, the Dominican Republic, and other parts of the Caribbean and Spanish Americas have emerged.

The topic gained even more momentum after 2016 when the book *The Other Slavery: The Uncovered Story of Indian Enslavement in America* was shortlisted for the Booker Prize. By the time the Black Lives Matter movement renewed public focus on widespread systemic racism in 2020, some K–12 teachers had already begun introducing the subject of Indigenous slavery to their students, alongside lessons on the transatlantic slave trade.

"I've had a few opportunities to participate in workshops for local high school teachers, and whenever I present, teachers always say, 'This is crazy; I had no idea that it was happening here and it wasn't just the Spanish [enslaving Native Americans],'" Fisher said. "They'll say, 'How can I incorporate this into my classroom lessons?'"

Fisher's research on Indigenous enslavement began in 2011; he traveled to the United Kingdom, the Caribbean, and other sites where Indigenous peoples had been enslaved. After several years in the field, he wished to collaborate with scholars exploring the subject in Latin America, Brazil, and other parts of the world.

So, in 2015, he worked with the Center for Digital Scholarship to create the Stolen Relations website. This repository now contains historical records of Indigenous slavery found in journals, property documents, newspapers, books, and manuscripts. Stolen Relations shares decades of research, fieldwork, and ancestral knowledge from approximately 60 contributors at Brown and across the globe. Some are records of the enslaved, others of enslavers. Some contain extremely detailed personal accounts, while others are brief: a name, maybe an age.

Each record offers but one anecdote—but together, Fisher said, they are an unsettling reminder of the systemic violence and subjugation Europeans employed to build their empires.

"This is not just an add-on to the story of colonization," Fisher said. "This is fundamental to how the English succeeded in colonizing the continent. You don't have vast areas of New England, the Mid-Atlantic, or the South 'available' for settlements if you haven't destabilized the existing Indigenous communities and tribes over time through kidnapping and enslavement."

A COMMUNITY-WIDE PROJECT

This isn't the first time Stolen Relations has shifted direction in a beneficial way. Fisher said that a few years after the repository's original launch, he and his colleagues realized it was missing something: a perspective from Indigenous peoples.

"We became convinced that this should be a collaborative project with tribes and Indigenous communities," Fisher said. "That was a big pivot for us. It ceased to be simply an academic project serving the academic community."

In the fall of 2019, Fisher reached out to 15 regional tribes and communities to propose forming a Tribal Community Collaborators board for the project. Joining in this effort were

COURTESY OF LINFORD FISHER

> **"I think this younger generation sees historical injustices very clearly, and they feel so compelled to set things right that they make time to do that work outside of school."**
>
> *Linford Fisher, Associate Professor of History*

Rae Gould, executive director of Brown's Native American and Indigenous Studies Initiative, and former Brown librarian Lydia Curliss, both members of the Nipmuc Nation. Since then, Indigenous leaders across southern New England, including Spears, have met with Fisher, Gould, and others at Brown twice a year to discuss the ongoing research and its online home.

Their meetings transformed the project, starting with its name. Originally called the Database of Indigenous Slavery in the Americas, the team renamed the website Stolen Relations after seeing firsthand how personal and painful its stories were to tribal leaders. Fisher recalled a moment when a Shinnecock leader, after learning that some of her ancestors had been enslaved, paused the meeting to offer a verbal apology to her forebears for the trials they'd endured.

"To academic researchers, slavery is largely about labor and economics," Fisher said. "We make these nitpicky distinctions between slavery and servitude based on how people ended up in the position they were in. But watching Mohegan, Narragansett, and Nipmuc leaders look at these documents for the first time and process the information they found really chastened me. Their attitude is, who cares whether it's slavery or servitude? Who cares whether someone was kidnapped or whether they surrendered to the English to protect their family from harm? The result is the same: people were stolen from our communities."

The tribal board also counseled Fisher to focus on collecting records of the enslavers and the enslaved; doing so could bolster the work of Native genealogists since many Indigenous people were assigned their enslavers' surnames. The board also inspired Fisher and Champagne to add important contextual notes to the historical records. The website's new notices about the documents' harmful terminology and possible inaccuracies, Champagne said, help humanize Indigenous people and allow the archive to balance compassion and historical accuracy.

Fisher received the 2023 Howard R. Swearer Engaged Faculty Award for Research for his work on Stolen Relations and its partnership with the Tomaquag Museum.

Since the start of this project in 2015, he has developed an increasingly collaborative approach that Gould deems "a model for how Brown can do important engaged scholarship with tribal communities." Tribal representatives—appointed by tribal leadership—are involved in critical aspects of the project and paid for their time and expertise. Tribal interns have been engaged as research assistants, and Indigenous elders and youth from Native nations in the region have participated in summer institutes. Gould appreciates how these activities "help to build bridges and connections with local tribal peoples in positive and powerful ways."

The project's collaborators extend beyond Indigenous tribes and nations. Fisher hopes to work with Brown's Choices Program to develop a nationwide K–12 curriculum on Indigenous enslavement for teachers. And for several years now, Fisher has maintained a roster of 12 to 15 high school interns, in addition to Brown student research assistants, who help digitize, organize, and update records in the ever-growing repository. Each of those students reached out to Fisher unprompted, a testament to Stolen Relations' broad and ever-growing impact.

"They are so smart and so hardworking; it's astonishing," Fisher said. "I think this younger generation sees historical injustices very clearly, and they feel so compelled to set things right that they make time to do that work outside of school. That's so encouraging to me because I'm the same way. I teach,

Above: Linford Fisher, an associate professor of history at Brown, created Stolen Relations in an effort to advance collaboration among scholars who unearth stories of Indigenous enslavement across the Americas.

and I write books, and I hope those make an impact. But this collaborative project has been incredibly meaningful to me, and I hope that it is part of creating a public good that will far outlast those of us who were fortunate enough to participate in its development."

Spears considers the project "extremely important, as it recovers a hidden history that, if properly interpreted, can go a long way to help a wider public understand the important role Indigenous enslavement played in settler colonialism as well as the ongoing historical trauma it imposed on our communities." ■

DEIRDRE CONFAR


ROWN


Gradua
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BRATING IDEAS
COVERIES

Facing page (clockwise from top left): Aarit Ahuja, Baoli Yang, Ethan Kyzivat, Vanessa Ryan, Sarah Christensen, and Cooro Harris.

WHY MY RESEARCH MATTERS

Students learn to communicate their research in five-minute TED-style talks.

By Kathleen Meininger '23

The lights dim, and a hush falls over the crowd. **Sarah Christensen**, a PhD candidate in the history department, takes her spot center stage on the red carpet. "Once upon a time, there was a princess named Melkorka," she begins. "She lived in Ireland at the time after St. Patrick had driven away all the snakes but before the English came to conquer."

Christensen is presenting at the 2022 Research Matters, an annual event hosted by the Brown University Graduate School during which students from a wide range of disciplines address the prompt "Why My Research Matters." Melkorka, a character from a 13th-century Icelandic saga, is one of the few documented examples of the countless women sold into slavery in medieval Europe between the 6th and 12th centuries, and hers is just one of the stories Christensen seeks to illuminate in her research.

Although the legal and economic effects of medieval slavery have been widely studied, there has been comparatively little research devoted to the lives of enslaved people, Christensen explained. This is largely due to a lack of sources—the diaries, correspondence, and literature medieval historians often use to study people's lives rarely include information about the lives of enslaved people. Even fewer sources detail the experiences of enslaved women.

For this reason, most of the documents Christensen has to work with are saints' lives and fictional narratives. Although these stories

ALL PHOTOGRAPHY: PETER GOLDBERG

Speakers in the group shot (left to right): Sarah Christensen, Danielle Blum, Jorge Ledesma, Cooro Harris, Alison Veintimilla, Joe Colleyshaw, Baoli Yang, Ethan Kyzivat, Donnell Williamson, Joseph Heffner, Kristin Kimble, Aarit Ahuja.

often lie at the intersection of reality and religious lore, Christensen argues that they offer valuable insight into the lives of enslaved women.

"I push the boundaries of our approach to medieval emotion by finding meaning in a sparse array of scattered textual and material fragments that offer glimpses into these women's lives," Christensen said in her talk. "By reimagining stories like Melkorka's, I hope to show that enslaved women in early medieval Europe survived and subverted their circumstances and altered their newfound worlds."

A HISTORY OF COMMUNICATION

Christensen originally learned about Research Matters from her advisor. She applied to be a speaker at the event for the opportunity to practice her presentation skills while also learning about the research conducted by graduate students from other departments.

"In humanities departments, there isn't always much focus on preparing grad students for public speaking, even

though lecturing and speaking at conferences are a big part of our job," she said. "I was interested in challenging myself to quickly prepare a talk and perform in front of people without expertise in my field, to prove that I can communicate my work effectively to a broad audience."

This desire to communicate research effectively lies at the heart of the event, according to Senior Associate Dean of Student Development Vanessa Ryan, who has organized and overseen the event since its start. "We have multiple goals in Research Matters," she said. "One is that we want to give visibility to graduate students and celebrate their research. And that's why it's a live event—it's fun, and it's engaging." Another goal is to give graduate students opportunities for professional development.

The first Research Matters event was held in 2014 as part of Brown's 250th anniversary celebrations, Ryan said. By featuring five-minute TED-style talks, the planners hoped to differentiate the event from standard research symposia by engaging specialists and nonspecialists alike. "We ask students to present a talk that will make their advisor say, 'Yes, you nailed it, you really captured your dissertation!' but also so that their roommate, sibling, cousin, or someone of the general public can understand," Ryan said.

Each year, about 20 to 25 Research Matters semifinalists are selected from a competitive pool of nominations. Students can either nominate themselves or be nominated by someone else. Finalists are then chosen on the basis of semifinalist presentations.

"We have a selection committee that includes some past Research Matters presenters, and we're really looking for great stories with potential," Ryan said. "We're also looking for diamonds in the rough—we're not necessarily looking for the person who's already ready to go on stage. Sometimes we see a great story, a wonderful research topic, and we think that with mentorship, this person is going to give an exceptional talk."

"I was interested in challenging myself to quickly prepare a talk and perform in front of people without expertise in my field, to prove that I can communicate my work effectively to a broad audience."

—SARAH CHRISTENSEN

FROM SCRIPT TO PRESENTATION

After being selected, the finalists go through four weeks of practice presentations and workshops, where they revise their original talk with mentor and peer suggestions.

According to Byrd McDaniel, who presented at the 2019 Research Matters as a graduate student and now works at Brown as assistant director of student development, these workshops are "one of the most meaningful aspects of the process."

"Having those conversations with peers and giving them advice and feedback about how they can hone their presentation skills definitely allows you to attend to your own delivery as well," Byrd said. It also fosters a supportive community and encourages students to make interdisciplinary connections and to learn about the pursuit of knowledge in other fields, he added.

Baoli Yang, a PhD candidate in comparative literature, was drawn to Research Matters as a way to convey her research to a broader audience, but "was not sure if my presentation skills, being a nonnative speaker, or my understanding of my research topic was sophisticated enough to participate," she said. Still, after passing her doctoral qualification exam, she decided to take a chance.

Once accepted, she worked closely with her advisor and Ryan to prepare a script. "Vanessa Ryan provided me with a lot of advice on how to make my presentation better during rehearsals, and the other participants also offered me encouragement and constructive suggestions," Yang said. "On the event day, I was so nervous that I forgot to pick up the remote control for my slides when mounting the stage. But with all the practice from the rehearsals, I soon collected myself, retrieved the remote, and finished my presentation."

Her talk described her research on Sinoscript, a medieval Chinese writing system that spread throughout medieval East Asia as a result of Chinese imperialism. "In institutional literature and historiography, there is a consistent narrative about how China became this cultural superiority, especially in Chinese documents in Korea and Japan, where China installed Chinese political and cultural systems. However, in manuscripts and other newly excavated texts, there are different stories to be told," Yang said.

By highlighting the ways surrounding cultures engaged with and appropriated Sinoscript, Yang hopes to "revise mainstream history by bringing to light underappreciated voices," she said.

"Graduate students are the engine behind a lot of our research. They're the hands in the labs doing calculations. They're in the archives. They're in the field. They're all becoming the world's biggest experts in their fields—that's what a PhD is." —VANESSA RYAN

Participating in Research Matters gave her confidence in her ability to share her work and bring awareness of this topic to a wider audience.

"Preparing for the event definitely changed how I communicate my research," said **Aarit Ahuja**, a PhD candidate in neuroscience. "One of the hardest things to do as a researcher is to know what to edit out, be it while speaking, writing a paper—whatever the format may be. Because you're so entangled in the work, all of it feels equally important, and it can be a struggle to keep things concise," he said.

In his talk, Ahuja discussed his research on mental simulation, or "the ability to form a mental model of the world and play that model forward," he said.

To do this, he uses functional magnetic resonance imaging, a technique that allows scientists to visualize what parts of the brain are active. "What we have found so far is that when you are tasked with solving a problem that involves predicting how something is gonna move…your brain responds as if it were actually seeing something move," Ahuja said. Basically, "this simulation strategy does actually recruit visual circuits."

Now Ahuja and his lab want to delve deeper to understand how the visual circuitry informs these simulations on the neural level, which requires experimental techniques that cannot safely be conducted on human subjects. They have been able to replicate their human test trials with primates, and this "opens the door for researchers to dissect this neural phenomenon at a much more granular level," he said.

"But at the end of the day, why does any of this really matter?" he asked in his talk. To answer this question, he highlighted its direct relevance to our understanding of disorders like posttraumatic stress disorder and schizophrenia, where people experience unwanted, vivid hallucinations.

VOICING IMPACT

Ethan Kyzivat, a PhD candidate in the Department of Earth, Environmental, and Planetary Sciences, emphasized the way his research will contribute to combating global climate change. Kyzivat and his team are part of a decade-long NASA project dedicated to measuring environmental and human changes in the Arctic, which contains nearly half of the world's lakes.

"We know that wetlands and lakes are the biggest persistent emitters of methane in the landscape. If we can better quantify how much of the area of the landscape they take up, we can have a better, more nuanced estimate of emissions," Kyzivat said.

Typically, the amount of methane emitted from each lake is calculated based on the lake's size. However, "not all water bodies are created equal," Kyzivat said. "There's deep ones, shallow ones, vegetated, and non-vegetated, and all those factors influence the amount of methane" each lake emits.

By separating lakes into two bins—ones with vegetation, which only grows in shallow lakes, and ones without—Kyzivat and his team calculated a 21 percent increase in methane emissions compared to nonbinned estimates.

"Modern climate models can not only resolve the projected human emissions of greenhouse gasses, but also natural emissions," he said to conclude his talk. "I hope my research is important in informing the wetland maps to build models that are our best estimate of how climate change will play out in the coming decades."

Cooro Harris, a PhD student in chemistry, illustrated the relevance of their research on polybenzoxazole, or PBO. They began with posing potential uses for PBO, highlighting the

fact that it is twice as strong as Kevlar—a material commonly utilized for its strength in car tires and bulletproof vests—at the same weight. "Why is PBO not everywhere?" Harris asked the audience. "Why aren't we using this to line our police officers' bulletproof vests? Or our firefighters' protective coats?"

Because PBO is so strong, it lacks flexibility, they explained, and cannot be formed into fibers without the use of harsh acids to soften it. In order to "access the strength of PBO without dealing with the strength of PBO," Harris manipulated PBO precursors using a series of chemical reactions to create pre-PBO, which can mix well in organic solvents without the need for harsh chemicals.

Now Harris is moving forward with a new NASA-funded project to take this new, soluble pre-PBO and make it into a thin sheet that can be used to coat the uniforms of astronauts and firefighters as well as for other protective purposes.

"Preparing for Research Matters helped me realize that a number of good speaking skills I see in other areas of my life, like stand-up comedies and improv storytelling from Dungeons & Dragons, can be directly transferable skills to scientific presentations," Harris said. "This kind of cross-lateral thinking with regards to the different aspects of my life helps me be a better researcher because I can apply the lessons I learned elsewhere to my work."

MORE THAN JUST A PRESENTATION: TAKEAWAYS

For audience members, this event is an opportunity to learn about the wide range and far-reaching implications of Brown University research and to celebrate the graduate students behind it. "Graduate students are the engine behind a lot of our research," Ryan said. "They're the hands in the labs doing calculations. They're in the archives. They're in the field. They're all becoming the world's biggest experts in their fields—that's what a PhD is."

Ultimately, Research Matters is about sharing and communicating research in a way that is exciting. "If you do great research, but it's hidden, if it's not communicated, then there's a loss," Ryan said. "We want to make sure that students feel empowered and gain the skills needed to take their research and make an impact." ■

Vanessa Ryan gives the speakers a motivational chat at the end of dress rehearsal, the last words before they come for the event the next day.

IMMERSIVE **RESEARCH** *BY KATHLEEN MEININGER '23*

Undergraduates develop skills through summer internship and fellowship programs

BROWN-LIFESPAN CENTER FOR DIGITAL HEALTH UTRA AWARD

Devon Newman '25

Devon Newman '25 received a Brown Undergraduate Teaching and Research Award (UTRA) to work with Megan Ranney, MD, former deputy dean of Brown's School of Public Health and founding director of the Brown-Lifespan Center for Digital Health, on two projects. The first tested a digital intervention to reduce intentional firearm injury among teens, and the second evaluated a text-based intervention to reduce depressive symptoms and peer conflict in at-risk adolescents. A public health major planning to pursue a career in medicine, Newman said that the research "fits in really well with my major and my interests, especially the gun violence study, because a lot of the sites where we're doing the study are rural areas, and I'm very interested in rural public health as I come from a town of about 5,000." He continued this research project for an independent study credit.

NATIONAL CENTER FOR HEALTH STATISTICS FELLOWSHIP

John Lin '23

John Lin '23 completed a research fellowship at the Centers for Disease Control and Prevention's National Center for Health Statistics, where he conducted epidemiologic research—analyzing national data on food insecurity and adult allergies as well as leading a preliminary analysis of the new National Health Interview Survey for teenagers—to inform CDC policies. "My fellowship was such an important learning experience because I got to see a more public role for research. In the future, I hope to continue working with the government and academic institutions like Brown." Lin has continued his research with long-time mentor Paul Greenberg, MD, Brown professor of surgery, at the Providence VA Medical Center on medical education, health policy, and ophthalmology.

CALTECH WAVE FELLOWSHIP

Sultan Daniels ’23

Sultan Daniels ’23 participated in a WAVE Fellowship at the California Institute of Technology, where he worked with a postdoctoral researcher to conduct information theory research in the electrical engineering department. His project involved developing the proof for a scheme that achieves the fastest theoretical rate at which data could be reliably transmitted by a Gaussian network channel. “The biggest thing that this research project gave me was the chance to put faces to the names in the field. I enjoyed speaking with the other students interested in information theory to brainstorm together or hear about their aspirations. I also enjoyed talking with the professor and the postdoc, as they were always able to point me to interesting papers or other insights,” Sultan said. He is applying to PhD programs with the goal of continuing to pursue research in information theory.

DUKE UNIVERSITY AMGEN SCHOLARS PROGRAM

Yannie Lam ’23

Yannie Lam ’23 conducted pharmacology research as part of the Amgen Scholars Program, administered through the Office of Biomedical Graduate Education in the School of Medicine at Duke University. In addition to working in a lab, she attended weekly lectures given by researchers, spoke with current PhD students, and presented her research to other students and faculty at the Amgen Scholars North America Symposium at the University of California, Los Angeles. “The program made me want to pursue a PhD. I’d never done biochemical research before, so this was a really good lab environment where I got to try something new. I realized that I’m really interested in translational research where you figure out how to solve problems related to human disease.”

PHOTOS COURTESY OF DEVON NEWMAN, JOHN LIN SULTAN DANIELS, AND YANNIE LAM

FOCUS

A CLOSER LOOK AT RESEARCHERS AND PROJECTS GAINING WIDER INFLUENCE

Spot, an agile robot by Boston Dynamics, performs dance moves choreographed by students in Choreorobotics 0101.

"We get so excited about what we can build that we don't think about whether we should."
—MADELINE MORNINGSTAR

Responsible Robotics

Choreographers and roboticists translate human movements into robotic code, and question the implications.

BY EMILIJA SAGAITYTE '22 MD'26

THE QUICK TAPPING OF TOES, a passé, the moonwalk—classic movements performed by human dancers are being emulated by robots, whose performances are showcased virtually to a global audience. Yet the same robots that jam to pop hits may be deployed for surveillance, police work, and war.

Robots' evolving roles raise their profile and advertise their versatility to the mass public, but they also present questions involving ethics and the meaning of performance. Expert performers and engineers at Brown are sharing the stage to examine and teach this intersection of dance and robotics, known as choreorobotics, and explore its implications for the future.

Sydney Skybetter, deputy dean of the College, senior lecturer in theatre arts and performance studies (TAPS), and founder of the Conference for Research on Choreographic Interfaces (CRCI), and Stefanie Tellex, associate professor of computer science and engineering, have been in communication for years based on the overlap in their studies of motion, both human and robotic. They decided to teach these concepts together and worked with students to create the first course collaboration between the departments of TAPS and computer science: Choreorobotics 0101: Robotics and Choreography.

In the course, students studied robotics software, human choreography, and the history and implications of choreorobotics. "The interdisciplinary work we did showed me that it's possible to combine these two fields," said Navaiya Williams '25.

The classroom training prepared students to work with Spot, a four-legged robot from Boston Dynamics. Williams and other students in the course programmed Spot to dance.

Spot's simple robotic movements were synchronized to music as a series of flowing motions: the extension of the legs forward as if in a crawl, elegant swoops of the robot's long neck like a ballerina's arms, and little steps on its rounded feet.

Researchers in this area investigate the optimal ways of translating the fluid transitions between human movements into robotic code. Choreographers bring an integral perspective on how best to interpret motion through technology, and computer scientists enable the technology to produce those movements.

Students are further exploring this research space beyond the choreorobotics course; for example, they worked with choreographer and CRCI artist-in-residence Yanira Castro to build and instruct a robot to perform with a *güícharo*, a traditional Puerto Rican musical instrument.

"As robotics gets applied to different fields, new subproblems appear that have never really been considered and act as a test bed or a research bed for developing new technologies that can be applied to other areas," said Choreorobotics 0101 co-instructor Eric Rosen '18, PhD'23, who also helped design the course.

Researchers are investigating how robots can communicate with people without words. Other questions involve how robots can be programmed to understand and respond to their surroundings more independently rather than being limited to concrete scripts of code.

The field also presents an ethical dilemma. Given the emotional, communicative essence of choreography and the historically utilitarian, function-first nature of robotics, "the logic applied to this field becomes very one-sided, either purely qualitative or purely quantitative" if choreographers and roboticists aren't both involved, said Madeline Morningstar '21, a consultant in emerging technologies and experience management and CRCI's former director of curriculum. "We get so excited about what we can build that we don't think about whether we should."

Skybetter noted that artistic pursuits in choreorobotics can serve multiple purposes, sometimes in opposition to the creators' intentions. Morningstar offered an example: programming robots to dance can serve as a test of their physical capability for police work, while the resulting entertainment helps robots appeal to the public.

"Robots' proliferation into personal, social, and civic spheres will generate new ways of meaning-making and relationality," said Skybetter. "Robots will increasingly be members of society on some emergent level."

"To engage in this work without an expanded timescale is dangerous, though," he continued. "This technology is cool, but there are people's actual bodies on the line when robots are deployed in civic, domestic, policing, and martial contexts. I want our students to understand the dynamics between robots and people's bodies as being real and tangible and with corporeal consequences."

NICK DENTAMARO/BROWN UNIVERSITY

Slavery and Justice Report, Revisited

Fifteen years after its initial publication, Brown's watershed Slavery and Justice Report has been reinvigorated, and the Simmons Center is changing how the world learns about the legacies of slavery.

BY ADRIENNE N. WARTTS (ADDITIONAL REPORTING FROM JILL KIMBALL)

HOW DOES AN ACADEMIC INSTITUTION tell the story of its ties to the transatlantic slave trade and inspire global conversations that grapple with the residual effects of slavery in the present day?

Brown University first responded to this challenge in 2003, digging deeply into its complicated past and sharing the findings in its watershed 2006 Report of the Brown University Steering Committee on Slavery and Justice. Commissioned by then-president Ruth J. Simmons, the report publicly confronted and documented the University's complex history with the transatlantic slave trade. It prompted Brown to address issues of inequity in everything from its teaching and research to its admissions and hiring practices, and it sparked a national discussion on higher education's entanglements with slavery, inspiring similar reckonings at more than 100 other colleges and universities.

One of the report's core recommendations was the founding of a center for research, teaching, and public programs on slavery and other forms of injustice. The result was the 2012 launch of Brown's Center for the Study of Slavery and Justice (CSSJ), recently renamed the Ruth J. Simmons Center for the Study of Slavery and Justice.

"As a center for research and public humanities, we have an objective to tell histories in ways which might transform the

Anthony Bogues (left) moderated a panel of history professors from Brown, Georgetown, and Stanford who discussed the Slavery and Justice Report's origins, its impact, and the question of reparations.

present," said center director Anthony Bogues, professor of humanities and Africana studies.

In 2020 and 2021, Brown took up that challenge a second time. As millions watched in horror as police violence and the COVID-19 pandemic claimed a disproportionate percentage of Black lives—and as those realities shed light on the indelible connections between historical slavery, anti-Black racism, and systemic inequality—Brown responded with an expanded second edition of the groundbreaking Slavery and Justice Report.

The new edition offered an unflinching assessment of both how far Brown has come in implementing the report's original recommendations and what remains to be accomplished. It also includes commentary from President Christina H. Paxson, President Emerita Simmons, and numerous University scholars and alumni.

"Based upon the current state of our country's—and the world's—confrontation of systemic racism, we know that the commitment to equity is a perpetual march—one that will perhaps never be complete," Paxson wrote in the foreword. "Meanwhile, Black people continue to be harmed by persistent disparities in access to medical care, wealth, employment, housing, education, wages, and food security. It is through the lens of these complex issues, inextricably intertwined with the legacies of slavery, that we revisit the Slavery and Justice Report."

The updated report is available as an immersive, interactive digital experience created by the Brown Library's Digital Publications Initiative, as a digital teaching edition used in Brown's First Readings program for incoming students, and in print.

As readers engage with the new text, the Simmons Center continues to carry out its mission, with hundreds of public programs offered to date. Currently, the center is engaged in an archival storytelling initiative, delving into historical, personal accounts of people enslaved as well as their ancestors, to unearth new insights about the realities of slavery. Students, scholars, historians, and contributors will have access to these oral narratives, which will be housed at Brown's John Hay Library and exhibited in museums across the globe.

In support of the endeavor, the University received a $1.25 million grant from the Abrams Foundation to fund the project, titled Unfinished Conversations. The project is connected to the Global Curatorial Project, co-convened by the Simmons Center and the Smithsonian's National Museum of African American History and Culture (NMAAHC).

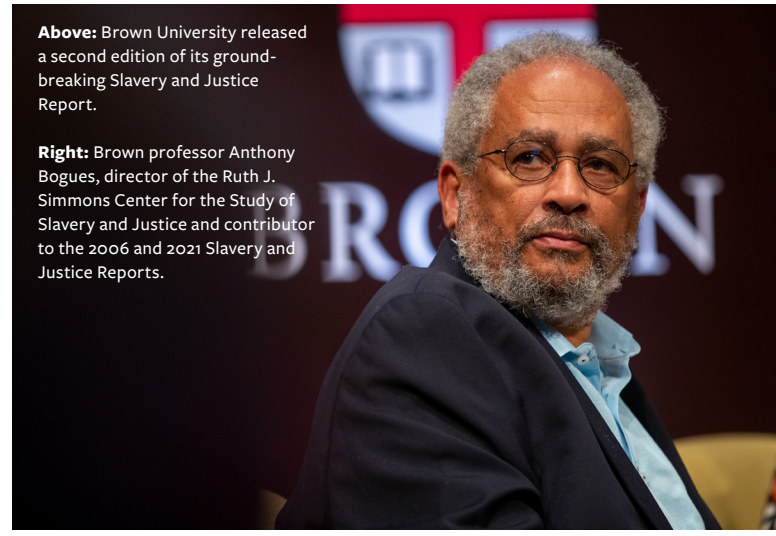
Select narratives and materials collected by the Unfinished Conversations initiative will be incorporated into a major exhibition, tentatively named *In Slavery's Wake: Slavery, Freedom, and the Making of Our World*, which is expected to open at the NMAAHC in Washington, DC, in December 2024 and will travel to Brussels, Cape Town, Dakar, Liverpool, and Rio de Janeiro.

Amanda Strauss, associate university librarian for special collections, said a central repository is being built to ensure that each individual and every partnering institution retains the intellectual property rights of the oral interviews.

"Although these oral histories will be preserved at Brown's John Hay Library, which serves a global audience of scholars, the work to preserve these precious stories is being undertaken on behalf of the individuals and communities who are sharing them," Strauss said. "Our primary goal is respectful and informed consent–driven stewardship. We will not replicate the systems that extracted labor and knowledge from the ancestors and descendants whose stories we will care for."

Bogues says that while all histories are complex, the history of racial slavery and colonialism is one that continues to reverberate today in the shaping of societies across the globe.

"Part of what we try to do at the center is advance historical narratives that can make a difference," Bogues said. "People learn their histories not just from books but also within museums, films, and other modalities. We operate on the legs of scholarship and public humanities so we can confront this particular aspect of the American experience."

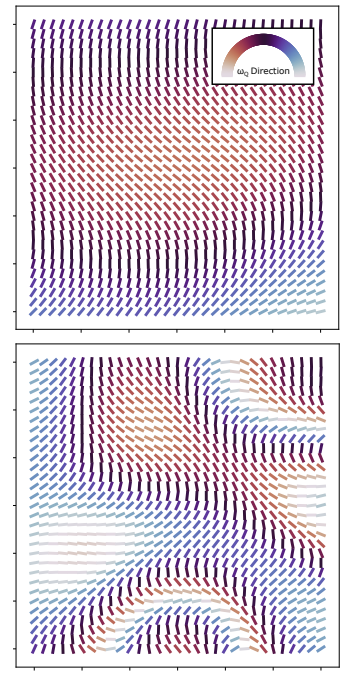


Above: Brown University released a second edition of its groundbreaking Slavery and Justice Report.

Right: Brown professor Anthony Bogues, director of the Ruth J. Simmons Center for the Study of Slavery and Justice and contributor to the 2006 and 2021 Slavery and Justice Reports.

ALL PHOTOGRAPHY: NICK DENTAMARO/BROWN UNIVERSITY

Below left: Vesna Mitrovic, professor of physics and engineering



Below: Illustration of the complexity of the quantum phases of matter characterized by some very complex quantity (so-called order parameter vector) whose magnitude (intensity) and position varies in space in a very intricate pattern.

The Next Quantum Leap

Brown researchers prepare for breakthroughs in quantum science.

BY DAVID LEVIN

ZOOM FAR ENOUGH IN TO ANY OBJECT—past cells, molecules, and even atoms—and you'll eventually enter the strange world of quantum physics. At this minute scale, the universe is governed by truly bizarre rules, where particles and waves of energy are one and the same, and seemingly impossible feats like teleportation are the norm. It's a weird and enigmatic place, yet it may be the key to creating new materials and devices that could utterly change our world—from ultra-thin superconductors to tiny computers that mimic the human brain—if, that is, we can unravel its secrets.

New research at Brown is leading the way toward that future, with dozens of scientists working on the quantum puzzle from multiple angles. Together, they're developing new ways to both understand and harness the quantum world's strange traits, starting with its most fundamental properties.

"Right now, we're at the basics of how we prove this stuff. Can we actually figure out what quantum interactions really are, and can we control them to make a useful device?" said Vesna Mitrovic, a condensed matter physicist at Brown. Her lab is starting to answer those questions by focusing on one of the biggest conundrums of quantum science: measuring the basic states of particles like electrons, which act as the quantum glue that binds together every molecule.

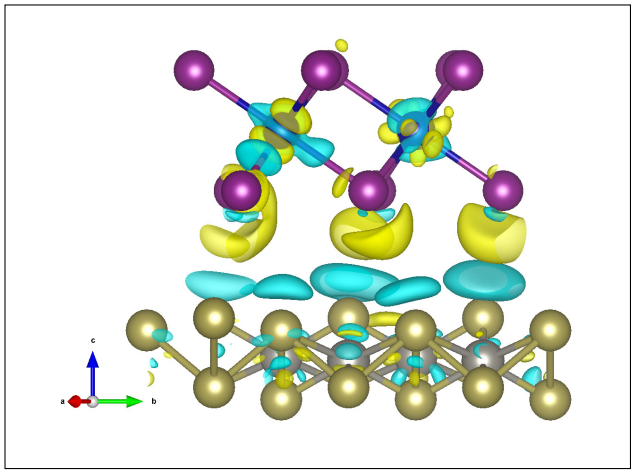
It's a tall order. Recording the energy level of a particle at any given moment ultimately changes that energy, so by necessity Mitrovic takes an oblique approach. She's developed techniques that instead look at the spin of the atom's nucleus, which is influenced by the movement of electrons around it. Using this method, she's starting to probe the behavior of electrons on a quantum level, providing data that can inform her colleagues' work.

Other Brown researchers, like chemistry and physics professor Brenda Rubenstein, take a different approach to a similar problem. Instead of measuring quantum behavior directly, Rubenstein's computer models predict how subatomic particles will behave in new materials, making it possible to test their properties before they're created. Her work could eventually provide a way to engineer quantum materials from the ground up, leading to new batteries, solar panels, and other electronic components that are more efficient than anything currently available.

"I'm really motivated by finding and developing these materials so we can make those kinds of devices in the future," she said. "It's incredibly exciting to me that we can use quantum phenomena and quantum theories to solve problems nobody has been able to solve before."

Some of Rubenstein's colleagues at Brown are already moving towards that future on a practical level, applying their

COURTESY OF VESNA MITROVIC, CONDENSED MATTER NMR GROUP/BROWN UNIVERSITY



Top: Gang Xiao, professor of physics and engineering

Center: Brenda Rubenstein, associate professor of chemistry and physics, points to a simulation of methane absorbing to a gold electrode in a quantum computer.

Diagram above: Electrons with a particular spin move closer to a nearby atomically thin magnet (CrI_3) in the quantum spin filter material, bilayer WTe_2/CrI_3.

TOP: NICK DENTAMARO/BROWN UNIVERSITY; DEIRDRE CONFAR; COURTESY OF THE RUBENSTEIN GROUP/BROWN UNIVERSITY

"If you built a silicon computer that mimics the human brain, you'd need a nuclear power plant to run it. But humans only need about ten watts of energy to power our brains."

—GANG XIAO

quantum knowledge to create and test new materials.

Physics department interim chair Gang Xiao, professor of physics and engineering, is building devices that generate skyrmions—disk-like magnetic swirls in two-dimensional metallic films—that can change their polarity, motion, and size when exposed to a magnetic field or an electric current. Xiao is already using skyrmions to generate truly random numbers, which might be useful in cybersecurity and encryption, yet he has his sights set higher. Arrays and networks of skyrmions, he said, could form the basis for tiny yet incredibly efficient computers.

Like traditional silicon computer processors, these devices would still be based on ones and zeros (or, in the case of skyrmions, a larger or smaller size), but the way information flows through the processor would be vastly different. When a skyrmion oscillates its size, it changes the state of its neighbors, creating a cascading effect that is eerily similar to the way neural circuits in the brain function—meaning that this sort of device could make huge strides in computing power while requiring only a small fraction of the energy required by existing computers.

"If you built a silicon computer that mimics the human brain, you'd need a nuclear power plant to run it. But humans only need about ten watts of energy to power our brains. Skyrmions could bring us a lot closer to that sort of fast, low-power computation," said Xiao.

On the surface, the work of scientists like these may seem abstract and disconnected, but Brown's community of quantum scientists are all moving towards a common goal. When taken together, said Rubenstein, each baby step that she and her colleagues make toward understanding the quantum world brings them closer to developing revolutionary new technologies. Eventually, she's confident that this research will lead to machines that process vast amounts of data quickly and efficiently, enabling breakthroughs in medicine, chemistry, communications, and many other fields.

"We're still in the early stages," said Rubenstein. "We've got a lot of the individual pieces figured out, but the next step is, how do we put all those things together? If we can do that, quantum science has the potential to transform people's lives."

Composing as Cultural Research

Wang Lu connects sounds, surroundings, and listeners through musical composition.

BY ADRIENNE N. WARTTS

"COMPOSING MUSIC PROVIDES THE FREEDOM to say what you want to say using music in an abstract way," said Wang Lu, associate professor of music at Brown. "It is about having the courage to build community and accept one another's uniqueness."

Wang Lu's music showcases the beauty of environmentalism and highlights social justice issues, a passion that began in China. "I grew up in Xi'an, the ancient capital of China, in the 1990s, surrounded by construction noise, bulldozed homes, street vendors, traditional opera singers in the park, propaganda and pop music on radios, TVs, bicycles, and motorcycles—all sounds that found their way into the music I create."

Wang Lu's practice of recreating the pulse of daily life through her art began during her studies at the Central Conservatory of Music in Beijing. There she defined her own way of using the variety of techniques she learned during her foundational training, which allowed for "a way of liberating and finding your unique voice down the road," she said. While attending Columbia University in New York for a doctoral degree in composition, she immersed herself in her surroundings and studied different music and cultures within their settings. Fusing it all together, her compositions are an eclectic mix of recorded and electronically processed environmental sounds and instruments from solo and chamber ensembles to the full orchestra, artfully blended to harmoniously express stories in an emotional, whimsical, and entrancing fashion.

Wang Lu's periods of residence in international metropolises such as New York and Rome have produced a profusion of research comprising her firsthand experiences as a conscious observer of sound, movement, and space. "The sonic insights I have developed become my own musical vocabulary," she said. As part of her artistry, she analyzes the physics of sound: how a chord or sound is constructed, what are its layers of frequencies, and how to manipulate sounds to construct new acoustic space. She transcribes language intonations and uses linguistic contours of dialect to inspire new tonalities.

In composing *Urban Inventory* (2015), Wang Lu offers a glimpse of life in the rapidly transforming modern China of her youth. As she describes in the program notes, the track "City Park" incorporates "scenes of leisurely and nonchalant chatting, strolling, dancing, tai-chi, dog- and kid-walking. Sounds of broken instruments mix with songs of praise to Western and Eastern gods and fantasies of early propagandist dance troupe goddesses. Other sounds meld the beguiling voice of a 1990s pop icon, a peasant rap sensation who briefly went viral, and the monotone voice of a rural poet."

"It is the music alone that provides the freedom to say what you want to say by incorporating the sounds in an abstract way," she said. "You start to develop an emotional connection with the sounds you hear around you."

DEIRDRE CONFAR

Wang Lu, composer and pianist and associate professor of music, says each piece begins like a cultural research project.

In contrast, *Surge* (2022), commissioned by the Toulmin Foundation and the League of American Orchestras for the New York Philharmonic for a January 2023 premiere, is a more abstract response to emerging environmental and political challenges. Her program notes for the premiere performance expand on the title concept: "There is an overwhelming sense of unforeseen surges that permeate our lives. Yet there is also an irresistible sense of collective urgency to build on more complex perspectives that would tolerate bold and unique innovations. *Surge* frequently features full orchestral tutti moments, transforming them into colossal textures and mixing tone colors while amplifying a single theme throughout."

"Each piece of mine arises from an idea that is not only about music, so it begins almost like a cultural research project," she said. This is a model Wang Lu also applies in the classroom, where she teaches Music in China since 1900, an introductory course for undergrads, and Issues of Time and Space in New Music, a graduate seminar. Students analyze scores and historical recordings and learn about cultural and political contexts.

Wang Lu said her goal is to live and teach her passion with the hope of encouraging others to focus on accepting one another and their cultural differences. "Being an artist is about deeply dealing with oneself, allowing yourself space, and finding pleasure in exploring the passion of creation," she said. "If you can live honestly with yourself as a composer, then you have more empathy towards others' experiences. I hope my music connects listeners and brings us into new cultural and artistic perspectives."

"The sonic insights I have developed become my own musical vocabulary." —WANG LU

Wang Lu is a recipient of the 2014 Guggenheim Award, the 2019 Berlin Prize in Music Composition, and the 2021 Wladimir and Rhoda Lakond Award from the American Academy of Arts and Letters. ■

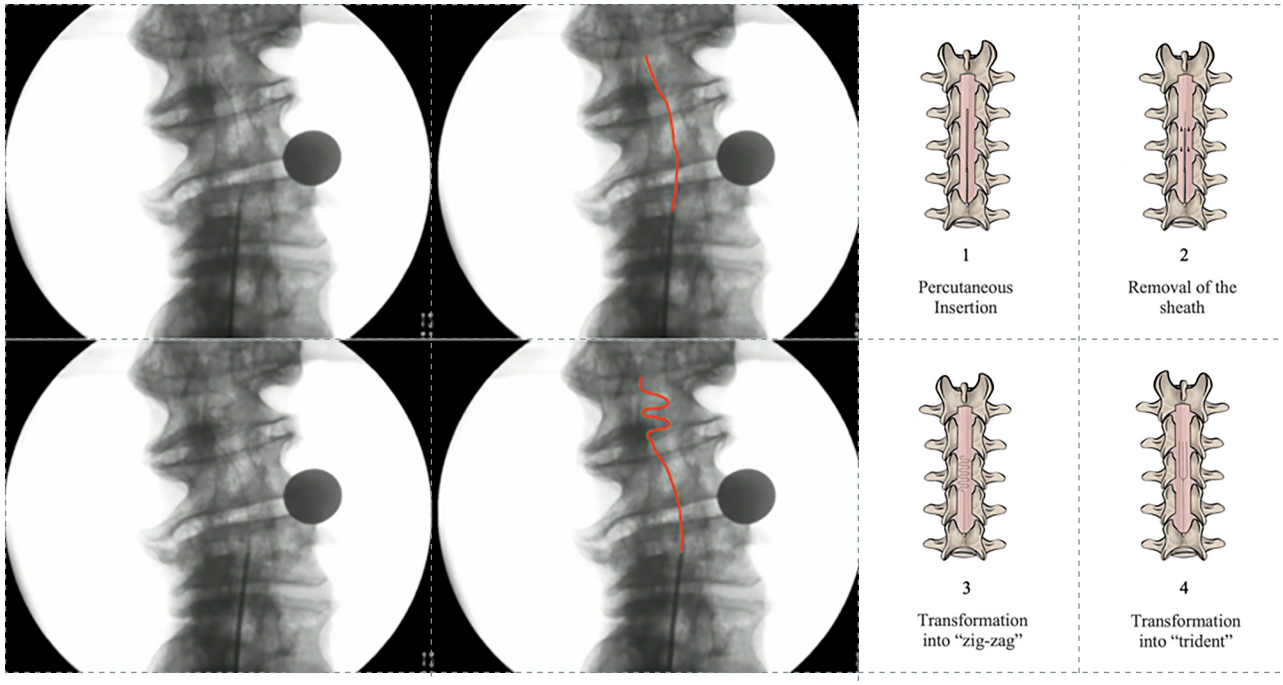
BY ANN RAE JONAS & SHERRI MILES

BIOMEDICAL BREAKTHROUGHS

BBII AWARDEES CREATE TECHNOLOGY, LAUNCH START-UPS

Launched in 2018 with $8 million in philanthropic gifts from Brown donors, Brown Biomedical Innovations to Impact (BBII) is run by the University's Division of Biology and Medicine in collaboration with Brown Technology Innovations. BBII manages an accelerator fund that supports academic biomedical technologies with potential for high impact in the commercial sector. Since 2018, BBII has made 17 awards supporting 15 faculty inventors and their technologies for a total of $1.8 million in funding.

2022 BBII Awardees: Improving Patient Safety and Care




Vikas Srivastava

Managing chronic neuropathic pain through spinal cord stimulation

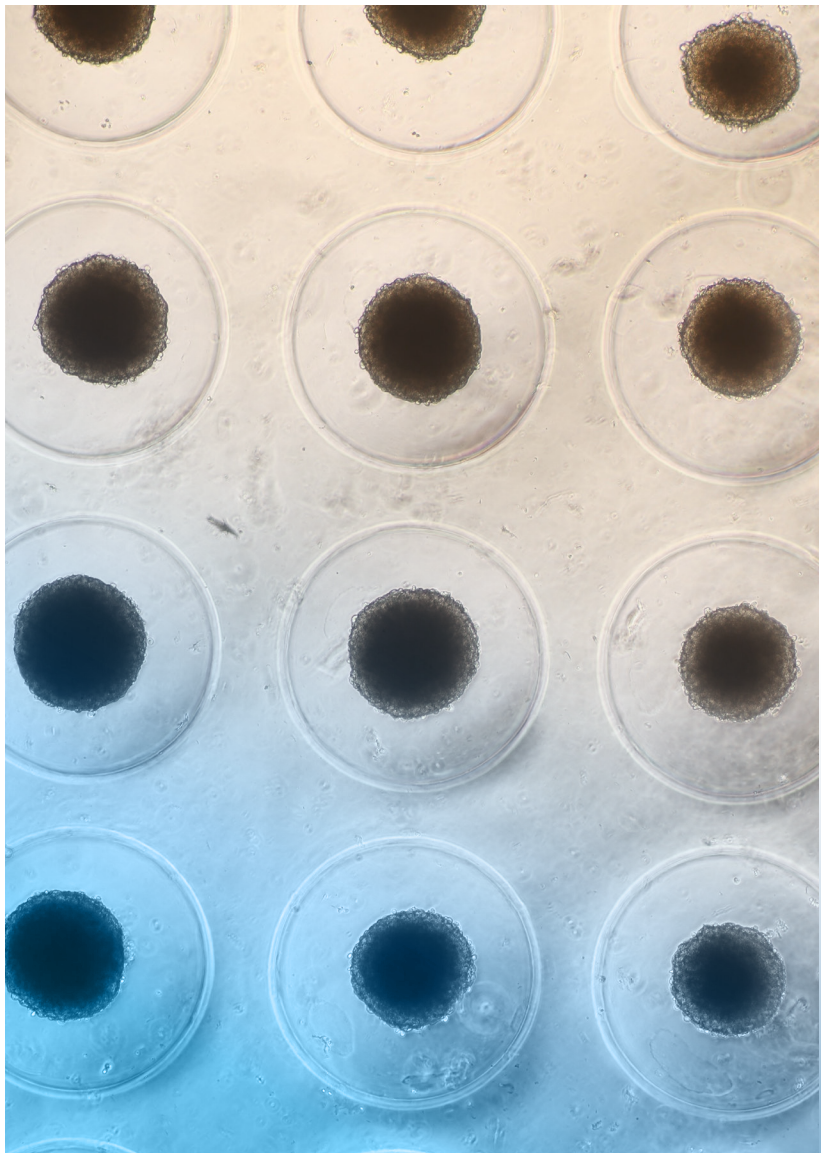
Vikas Srivastava, assistant professor of engineering, and team member **Albert Telfeian, MD**, professor of neurosurgery, will develop a novel implantable lead for a spinal cord electrical stimulation device to manage chronic neuropathic pain. The lead will be made of nitinol, a material capable of shape memory that can be inserted with a needle. Once placed in the epidural space, it will expand to the correct shape. The advantage would be to achieve better contacts than can be achieved with a cylindrical lead while avoiding the surgery required for a larger paddle lead.

Above left: Fluoroscopic images from the cadaver trial (lead is highlighted in red in the images on the right). The images on the top show percutaneous minimally invasive lead insertion through a 2 mm-diameter hole. The images at the bottom show the shape memory alloy-based lead taking a desired zig-zag shape in the epidural space under body temperature actuation.

Above: In steps 1 and 2, a percutaneous insertion into the epidural space takes place. In steps 3 and 4, the shape memory alloy lead reverts to new shapes that optimize electrode coverage.

COURTESY OF VIKAS SRIVASTAVA; COURTESY OF THE SRIVASTAVA LAB

An invention has to make sense in the world it finishes in, not in the world it started. – TIM O'REILLY

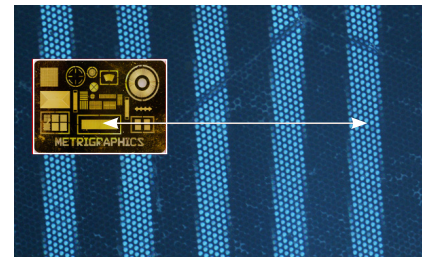


Kareen Coulombe

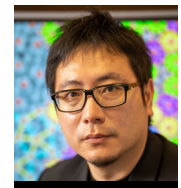
Testing the cardiac side effects of oncology drugs

Kareen Coulombe, associate professor of engineering, and team members **Bum-Rak Choi**, associate professor of medicine (research), and **Ulrike Mende, MD**, professor of medicine, received a BBII award in 2020 for research to make therapeutic drugs safer for the heart. With an additional round of BBII funding in 2022, the team continued to develop an in vitro cardiac tissue model platform for drug discovery and cardiotoxicology testing. The team is further expanding the model to be able to test for cardiac side effects of oncology drugs as well as to identify drugs that can be used to mitigate or treat these side effects.

Top: The electrical activity of up to 35 three-dimensional human heart microtissues generated from stem cells can be recorded simultaneously using a high-speed fluorescence microscope, enabling high-throughput cardiotoxicity testing.



Developing a high-sensitivity, low-dose x-ray detector



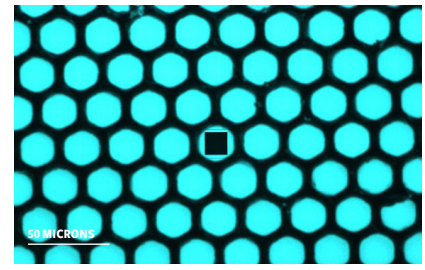
Ou Chen

Angus Kingon

Angus Kingon, professor of entrepreneurship and engineering, and team member **Ou Chen**, associate professor of chemistry, will build upon research by Emeritus Professor Ted Morse that led to the development and patenting of a proof-of-concept novel x-ray scintillation detector, which has demonstrated both vastly improved resolution and a means of reducing the radiation dose rate. Their research will have implications for medical x-ray imaging, such as mammography, by lowering the x-ray dose and increasing the ability to detect abnormal features at an early stage.

Top: Image of an x-ray scintillator detector showing the definition of a 100-micron test pattern. The standard optical test pattern is shown in the inset.

Below: Image of a prototype x-ray detector showing the structuring of the sensor elements to achieve improved detector resolution. The scintillator material that responds to the x-rays is nanoparticle perovskite, $CsPbBr_3$, produced in the Ou Chen laboratory.



TOP LEFT: MARK DALEY; COURTESY OF KAREEN COULOMBE TOP RIGHT: CHEN LAB/BROWN UNIVERSITY; OU CHEN PHOTO BY KINDRA CLINEFF; ANGUS KINGON PHOTO BY DEIRDRE CONFAR

Previous BBII Awardees: Launching Start-ups

Several new faculty start-ups supported by BBII accelerator funding demonstrate the success of the BBII awards program in helping bridge the gap between when federal funding for research ends and when private investors are ready to invest. PedialyDx and XM Therapeutics are two such success stories.

pedialydx

In 2020, the team of **Barry Lester**, a professor of psychiatry, human behavior, and pediatrics, and **Stephen Sheinkopf**, executive director of the Thompson Center for Autism and Neurodevelopmental Disorders at the University of Missouri and an adjunct associate professor of psychiatry, human behavior, and pediatrics, received a BBII award to develop diagnostic tools based on acoustic signatures from infants' cries that are not discernible to the human ear. Recently, a new start-up, PedialyDx, was formed to further develop and commercialize this technology. The first product will be a handheld device that uses a cloud-based algorithm to determine whether the cries of an infant with prenatal opioid exposure meet the criteria for neonatal opioid withdrawal syndrome. The company is also exploring use of the device in autism research.

XM THERAPEUTICS

In most chronic diseases, including heart failure, kidney failure, and pulmonary fibrosis, the extracellular matrix becomes abnormal, leading to inflammation, fibrosis, and hypoxia, or reduced oxygen supply. In 2019, with the support of BBII funds, **Jeffrey Morgan**, a professor of pathology and laboratory medicine, developed a process for producing uniform injectable particles that potentially could be used to treat damaged tissue in various organs. The company XM Therapeutics was formed to further develop the treatment and bring it to clinical trials. XM Therapeutics is initially focusing on two of the most serious disorders, heart failure and pulmonary fibrosis, for which the clinical need and market size are enormous and continue to grow.

Jeffrey Morgan (left), Frank Ahmann (right)

DEIRDRE CONFAR

ENTREPRENEUR CONNECT INITIATIVE:

XM Therapeutics

The Entrepreneur Connect Initiative, a project of Brown Technology Innovations (BTI), pairs seasoned entrepreneurs with faculty inventors to work on specific university intellectual properties with the goal of creating fundable start-ups. The entrepreneurs conduct customer discovery and bring a market perspective to the academic research, and the faculty inventors observe how the entrepreneurs approach their findings.

Once the entrepreneur and inventor have brought a project to maturity, the Entrepreneur Connect Initiative markets the opportunity to interested investors, drawing on angel investors and venture capitalists from both groups' networks. In cases in which BBII has provided financial and project management support for a research project, the BTI team offers guidance on how to achieve both scientific and business goals.

The start-up XM Therapeutics is a good example of the initiative's successful matchmaking. Members of the Entrepreneur Connect Initiative introduced entrepreneur **Frank Ahmann** to **Jeffrey Morgan**, a professor of pathology and laboratory medicine at Brown who had developed a technology for making extracellular matrix particles for use in treating damaged tissue in various organs. Together they formed the Rhode Island-based XM Therapeutics; Ahmann became president and CEO.

FACULTY DISTINCTIONS

BROWN FACULTY ARE RECOGNIZED FOR OUTSTANDING CONTRIBUTIONS TO THEIR FIELDS WITH HIGHLY SELECTIVE, PRESTIGIOUS NATIONAL AWARDS.

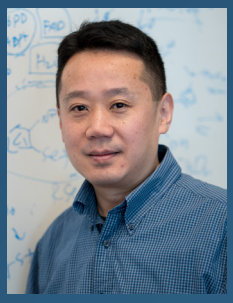
American Association for the Advancement of Science *(Elected Members)*

Dan Abramovich
Professor of Mathematics

Walter Atwood
Professor of Medical Science, Professor of Neurology

Anne C. Hart
Professor of Neuroscience

Jill Pipher
Professor of Mathematics

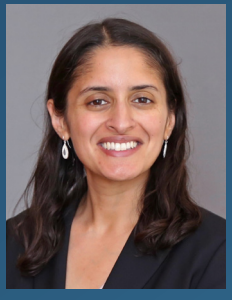


Ming Xian
Professor of Chemistry

Andrew Carnegie Fellowship

Françoise Hamlin
Associate Professor of Africana Studies and History

Dr. Ralph & Marian Falk Medical Research Trust Transformational Award



Anita Shukla
Associate Professor of Engineering

Goddard Lieberson Fellowship, American Academy of Arts and Letters

Eric Nathan
Associate Professor of Music

Mellon Emerging Leaders Fellowship

Elena Shih
Assistant Professor of American Studies

Mellon New Directions Fellowship

Lukas Rieppel
Associate Professor of History

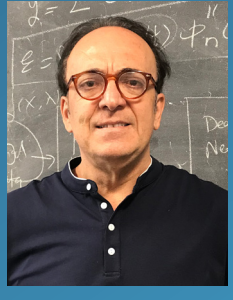
Elected Fellow of the National Academy of Public Administration Fellowship

Kenneth Wong
Professor of Education Policy, Professor of Political Science, Urban Studies, and International and Public Affairs

Searle Scholar

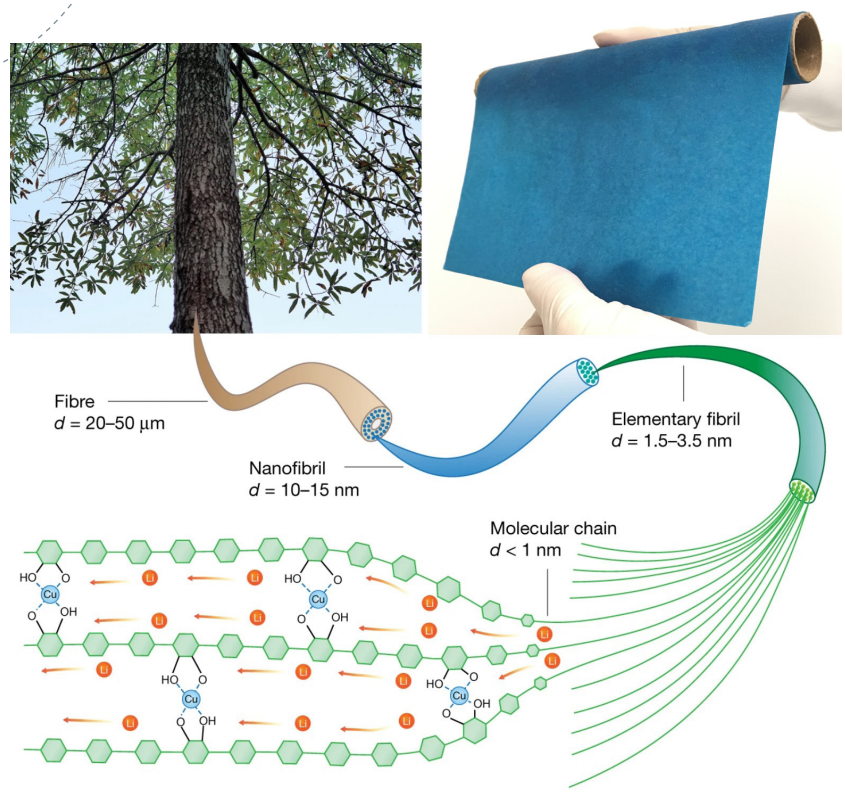
Ahmed Abdelfattah
Assistant Professor of Brain Science

U.S. Department of Defense Vannevar Bush Faculty Fellowship



George Karniadakis
Professor of Applied Mathematics and Engineering

BY ANN RAE JONAS



A new solid ion conductor that combines copper with cellulose nanofibrils—polymer tubes derived from wood—has 10 to 100 times higher lithium-ion conductivity than other polymer ion conductors.

Cellulose from Trees Could Make Safer, Better Batteries

The pursuit of more stable and powerful lithium-ion batteries hinges in part on the development of improved electrolytes. Current lithium-ion batteries contain electrolytes made from lithium salt dissolved in a liquid organic solvent. Liquid electrolytes can short circuit and are made with chemicals that are toxic and flammable. Solid electrolytes are made of ceramic, and while excellent at conducting ions, they are thick, rigid, and brittle.

Now there's a better option—a thin and flexible material derived from trees for use in solid-state batteries. The new material was developed by a team of researchers co-led by the laboratory of **Yue Qi**, a professor in Brown's School of Engineering, and a materials science laboratory at the University of Maryland. In a paper published in *Nature* in October 2021, the team describes a solid ion conductor that combines copper with cellulose nanofibrils—polymer tubes derived from wood. The paper-thin material, which has an ion conductivity of 10 to 100 times that of other polymer ion conductors, could be used as either a solid battery electrolyte or as an ion-conducting binder for the cathode of a solid-state battery. Eventually, the new material could be a step toward bringing solid-state battery technology to mass production.

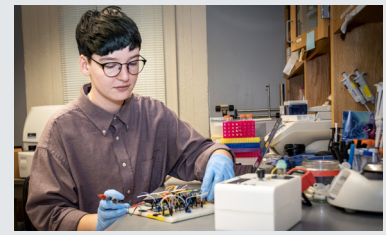
Electric Fields Shown to Isolate Single Cancer Cells

Cancer researchers know that individual tumor cells can reveal important information about how an individual's cancer develops and spreads and how it might be best treated. Yet conventional methods of tumor analysis rely on the extraction of nucleic acids from bulk tissue samples and result in low-resolution genetic readouts. The poor quality of these results can even lead to misdiagnosis.

Cel Welch, a PhD candidate in the lab of engineering professor Anubhav Tripathi, has developed a way to isolate high-quality, intact single cells from biopsied cancer tissue within minutes. The individual cells can be used for single-cell RNA sequencing, which is especially useful in detecting rare mutations.

The process uses electric field fluctuations rather than enzymes to separate cells from one another. The biopsied tissue is placed in a liquid-filled receptacle between two parallel plate electrodes. Electric field fluctuations applied to the liquid create opposing forces, which cause the tissue cells to move first in one direction and then in the opposite direction until they separate from one another.

The new electric field method is superior to standard isolation methods in terms of labor, cost, and efficiency and was described in June 2022 in *Scientific Reports*. Welch has been named to *Forbes*'s 2023 30 Under 30 list in science.



Cel Welch in the lab with different prototypes of the electrical tissue-dissociation device.

TOP: HU GROUP, UMD / LIANGBING HU LABORATORY; COURTESY OF CEL WELCH

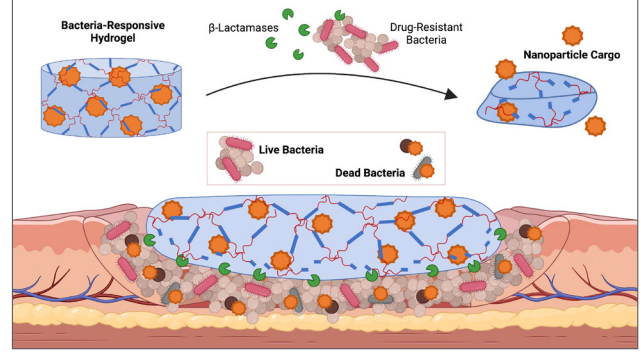
Responsive Drug-Delivery System Releases Antibiotics in Presence of Bacteria

The rapid spread of antibiotic-resistant bacteria is causing serious global public health and environmental issues. Beta-lactamases, common enzymes released by a variety of harmful bacteria, destroy antibiotics and are a major cause of drug resistance.

Anita Shukla, an associate professor in Brown's School of Engineering, and her graduate students developed a responsive bacteria-triggered drug-delivery system that could be used to make wound dressings and deliver medication on demand. The system consists of antibiotic-loaded hydrogels that respond to the presence of beta-lactamases by degrading to release encapsulated therapeutic nanoparticles.

Such smart hydrogels could be used in diagnostics to reduce the amount of drug needed for treatment, in turn limiting side effects and the development of antibiotic resistance and increasing the lifetime of newly introduced antibiotics. The new material was described in a 2022 issue of the journal *ACS Applied Materials & Interfaces*.

For the new material, Shukla and her team developed a hydrogel that is sensitive to beta-lactamases, a class of enzymes released by a variety of harmful bacteria. The presence of beta-lactamases causes the material's crosslinked polymer network to degrade, releasing the encapsulated therapeutic nanoparticles.



Strange Metal Behavior Never Seen Before

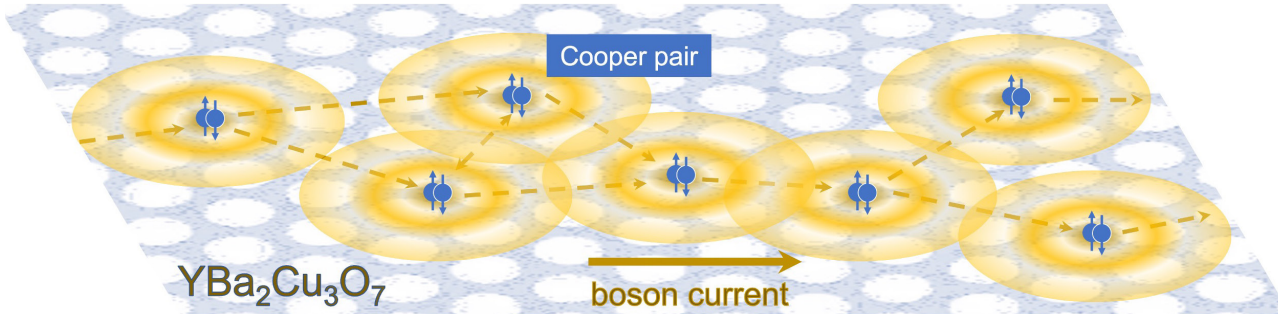
Strange metals, discovered around 30 years ago, are materials related to high-temperature superconductors and share fundamental quantum attributes with black holes. High-temperature superconductors conduct electricity with zero resistance at temperatures far above normal superconductors.

The two fundamental classes of subatomic particles are fermions and bosons, which usually behave very differently. However, a research team co-led by Brown physics professor **James Valles** has found strange metal behavior in a material in which electrical charge is carried not by electrons, which are fermions, but by more wavelike entities called Cooper pairs. Although they consist of two electrons, Cooper pairs are bosons.

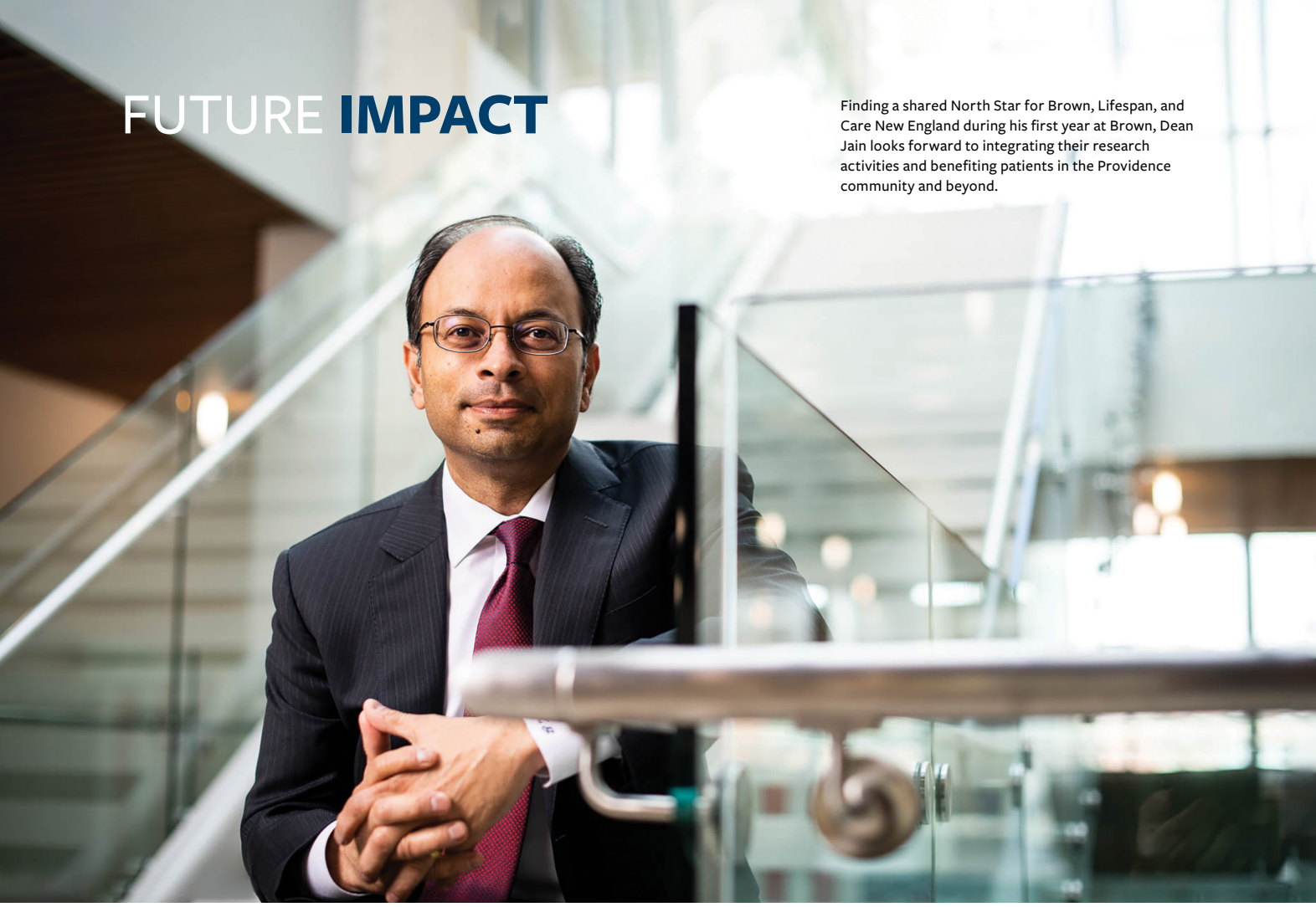
Using a material called yttrium barium copper oxide, Valles and his team discovered strange metal behavior in a Cooper-pair metallic state—the first time strange metal behavior had been seen in a bosonic system.

The findings, reported in *Nature* in January 2022, could help scientists understand strange metal behavior, such as high-temperature superconductivity, and potentially provide fundamental insights into the quantum world.

Cooper-pair bosons meld as waves while flowing through perforated landscape of yttrium barium copper oxide.



TOP: COURTESY SHUKLA LABORATORY FOR DESIGNER BIOMATERIALS/BROWN UNIVERSITY; COURTESY JAMES VALLES



Finding a shared North Star for Brown, Lifespan, and Care New England during his first year at Brown, Dean Jain looks forward to integrating their research activities and benefiting patients in the Providence community and beyond.

JARED LEEDS

Petri Dish, Patient, Population

Dean Jain leads Brown to a future of integrated biomedical research

A conversation with Mukesh K. Jain, MD, Brown's senior vice president for health affairs, dean of medicine and biological sciences, and professor of medicine, molecular biology, cell biology, and biochemistry.

BY SHERRI MILES

Since Mukesh K. Jain, MD became dean of the Division of Biology and Medicine in March 2022, he has been partnering with everyone within Brown and its affiliated health systems to define the future of biomedical research.

At Brown, Dean Jain is identifying areas of research strength; building an integrated biomedical ecosystem with Brown's Warren Alpert Medical School, School of Public Health, and School of Engineering; and expanding opportunities for trainees to seek dual careers as physician-scientists. He's recruiting faculty in the areas of RNA, aging, cancer, brain science, and immunity and working to attract biotech and biopharma companies to the state.

In the community, his leadership brought what had long been a hazy, ambitious hope at Brown into clear and connected focus: a signed agreement between Brown, Lifespan, and Care New England to align their research operations, a goal that had been elusive for more than 25 years. The agreement will allow physicians, scientists, and physician-scientists within Brown and the two health systems to collaborate more effectively to advance science and medicine.

In Rhode Island, along with colleagues at the medical school, he is working with congressional and academic leaders to develop programs for teachers and students from K–12 through postsecondary schools to ensure the long-term future of the state's STEM workforce, focusing on students from backgrounds underrepresented in medicine and science.

Nationally, Dean Jain is spearheading a movement to sequence RNA, positioning Brown to become a leader in this next big wave of biomedical research.

In a conversation with *Impact*, Dean Jain talks about the value of an integrated academic health system, the vital role of physician-scientists, and Brown's areas of research strength.

Q: You are a physician-scientist who specializes in cardiovascular medicine, a doctor who both treats patients clinically and engages in biomedical research. What impact do physician-scientists have on advances in modern medicine?

MKJ: Physician-scientists are individuals who see patients, identify unmet challenges in medicine, and then come back to the research setting to try to gain fundamental insights. Then, on the basis of those discoveries, physician-scientists seek to develop new interventions, new diagnostics, and new therapeutics to improve human health. We commonly refer to this virtuous cycle as "bedside-to-bench-and-back" research to advance human health.

Q: You were trained as a physician-scientist during your postgraduate studies. Did you immediately begin to utilize this training in your work?

MKJ: Yes. When I was going through my medical training, I became interested in cardiology. At that time, there was a lot of excitement in the field derived from clinical observations that there was a link between obesity and cardiovascular disease. The main question at the time was whether this was all about lipids, or was there something else going on? Clinical evidence was emerging that vascular disease states such as atherosclerosis, which leads to heart attacks, gangrene of the extremities, and strokes, were not just caused by bad cholesterol. The missing link was identified to be inflammation. Today we talk about inflammation as being important in many, many diseases, particularly those associated with aging.

Our efforts led to the discovery of a family of genetic factors termed Krüppel-like factors (KLFs). We would go on to show that these factors coordinate the function of blood vessels, the immune system that regulates inflammation, and the metabolic system that regulates obesity. The clinical observations I mentioned were instrumental in our work, which is quite basic and fundamental but led to a new field. Today there are hundreds of labs across the nation and globe studying novel functions of KLFs for their roles in diverse disease states.

Q: Will you continue this research at Brown?

MKJ: That is the plan, but I will acknowledge that it will not be easy, given my other responsibilities. Once upon a time, I had a lab of two dozen people. My lab today is three people, but we're continuing our work. It was about 20 years ago when we discovered that family of genetic factors. A lot of our focus today, interestingly, is on how these factors control the very process of aging itself. We're hoping to apply the knowledge we gain to impact cancer, cardiovascular disease, and dementia as age-associated disorders through collaborations with colleagues at Brown.

Q: The number of physicians engaged in research has been in decline nationally for many reasons—medical school debt, insufficient time for research, pressure to write grants, and stiff competition for research dollars, to name a few. Despite these challenges, one of your goals is to revive the physician-scientist. Why do we need more doctors who are scientists?

MKJ: Physician-scientists constitute about 1.5 percent of all physicians in the United States, and the numbers are declining. Think about a world without a Tony Fauci, the quintessential physician-scientist. He was an immunologist of great capability and rose to the highest levels to head the NIH's Institute of Allergy and Infectious Diseases. Not only did he do great science and develop therapies, but he has served for decades as a pillar for public health advocacy.

Physician-scientists have developed therapies, devices, and technologies, and their discoveries have led to the creation of hundreds of the medications we use today. Seventy percent of the chief research leaders of Big Pharma are physician-scientists. More than one-third of Nobel laureates in medicine and physiology are physician-scientists. Yet they're dwindling and becoming rare. So there's a real challenge, and issues such as debt, low funding rates, and long training periods, among others, exacerbate the problem.

We've been very focused on trying to figure out ways to increase the numbers of physician-scientists. Along with four other colleagues (including two Nobel laureates), I started the Physician-Scientist Support Foundation to address some of those issues at the individual, institutional, and national levels and to increase the number of physician-scientists.

Q: You have suggested that medical schools and health systems work with other partners to address the challenge. What does such a collaboration look like, and how does it help solve the problem?

MKJ: Medical schools and health systems need to work together because we both share the view that physician-scientists are critical to our efforts to impact human health. I do not believe that everybody needs to be a physician-scientist. But we do need a critical mass, and that is being threatened today.

Also, people who identify as Hispanic, Black, or Native American make up just 5 percent of physician-scientists receiving NIH funding, so at the same time, we must ensure that we are preparing a diverse cadre of students for these careers. Health systems and medical schools working together can encourage

FUTURE **IMPACT**

Bottom: Dean Jain advocates increasing the number of physician-scientists through integrated research opportunities for medical students, residents, and fellows.

and support trainees at multiple levels—students, residents, and fellows—to pursue this rewarding dual-career path.

Q: Describe your vision for a research collaboration with Lifespan and Care New England. Why would such a collaboration benefit the institutions, the broader biomedical ecosystem, and the Providence community?

MKJ: After more than 25 years and multiple failed efforts, we signed an agreement last year between the Warren Alpert Medical School, the School of Public Health, Lifespan, and Care New England to integrate our research activities. The name of this new structure is the Brown Innovation and Research Collaborative for Health, or BIRCH.

This integration across the entire research continuum—from petri dish studies in the laboratory to patients in clinical trials in the hospitals to population research that occurs in the School of Public Health—is very unusual nationally. We're able to do it because of the collaborative culture and trust that's been built in the last year. The School of Engineering is also part of this ecosystem, with areas such as biomedical engineering that are joint efforts between the medical and engineering schools.

This milestone moment for the Rhode Island community will have many benefits. First and foremost, we will be able to bring cutting-edge care to impact the lives of our community. This integration will also allow us to recruit the best and brightest, attract the biotech and biopharma industries, and enhance the community's economic vibrancy and workforce opportunities.

Q: What are your plans for supporting the expansion of research activity across the Division of Biology and Medicine?

MKJ: We identified five areas where we have real strengths and capabilities. Aging and age-associated disorders, cancer, and brain health are three areas. The fourth is neglected tropical diseases—health challenges that aren't important in our backyard but affect millions of the most marginalized citizens across the globe. One of the most wonderful aspects of Brown, the ethos of Brown, which is different from any institution I've been at, is the deep commitment to be a global citizen and do things for societal impact.

And fifth is an area of science that touches all diseases: RNA science and therapeutics, which is viewed as the next big wave to benefit human health. That wave is just starting, and we are investing very heavily in that space because we want to be leaders on the top of that wave. We're establishing a new center and have recruited an international authority in this space who will be starting at Brown on July 1, 2023. We're aggressively recruiting new faculty and engaging with biotech and biopharma companies that have an interest in RNA diagnostics and therapeutics.

We're also deeply involved with the National Academies of Sciences, Engineering, and Medicine, helping to catalyze a movement to sequence RNA—the human RNome. This project is akin to the Human Genome Project but in size and scale many times larger. The efforts of the three academies are being funded by the NIH and the Warren Alpert Foundation, which has been very supportive of innovative research and education. They named the medical school with a $100 million gift in 2007 and, in a subsequent gift in 2016, established the Warren Alpert Physician-Scientist MD/PhD and Advanced Training Program.

Q: Why is the expansion of research so important to Brown's undergraduate college students?

MKJ: Brown is one of the nation's oldest universities and is best known for providing an exceptional collegiate education. Every year, roughly 300 students graduate from an undergraduate biology program, and more than 400 students pursue a thesis, fellowship, independent study, and/or paid research with faculty in the Division.

We are increasing opportunities for undergraduate research not at the expense of education but to amplify the educational experience and better position our students for success. It is something they clearly desire, and the University's commitment to expanding research for impact is aligned with the aspirations of our students. What's more, through our efforts in undergraduate biology education, we are exposing a much more diverse group of students to research with the goal of encouraging them to pursue related careers. That, in turn, will further diversify the research workforce. ■

NICK DENTAMARO/BROWN UNIVERSITY

IMPACT

RESEARCH AT BROWN | 2023

Your insights can help shape the future of *Impact* magazine.

One of the priorities of Brown University is to support research by telling the compelling stories of the faculty, students, and staff who work to advance knowledge, innovation, and discovery.

In the coming year, we will pause *Impact: Research at Brown* magazine as we build online resources that will support plans to increase the scope and influence of Brown's research enterprise. This pause allows us to reflect on how to strengthen the ways we bring our readers narratives about exceptional research across the academic disciplines.

Please scan the QR code or use the link below to participate in a five-minute survey and help inform how we deliver stories of research to our many audiences.

And please continue to follow news about the latest Brown research on brown.edu, Twitter, Instagram, and Facebook.

BROWN

Dear *Impact* reader,

We are inviting you to play a role in shaping the future of *Impact: Research at Brown* magazine, now in its sixth year. Your feedback will help inform editorial and publishing decisions as the magazine takes a pause in 2024 to assess the best strategies for reaching readers with news of Brown University's high-impact research.

Please take just five minutes to respond to this brief survey about your reading preferences and satisfaction with the content provided in *Impact* magazine.

Thank you for your time!
Impact: Research at Brown
Office of the Vice President for Research

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BROWN

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Providence, RI 02912

AGING CELLS

Shown below is an immunohistology of aging articular cartilage from an osteoarthritic patient. The image shows that the aging cells in a human cartilage joint make pro-inflammatory cytokine protein (green signal), which causes joint degeneration and pain in osteoarthritis patients.

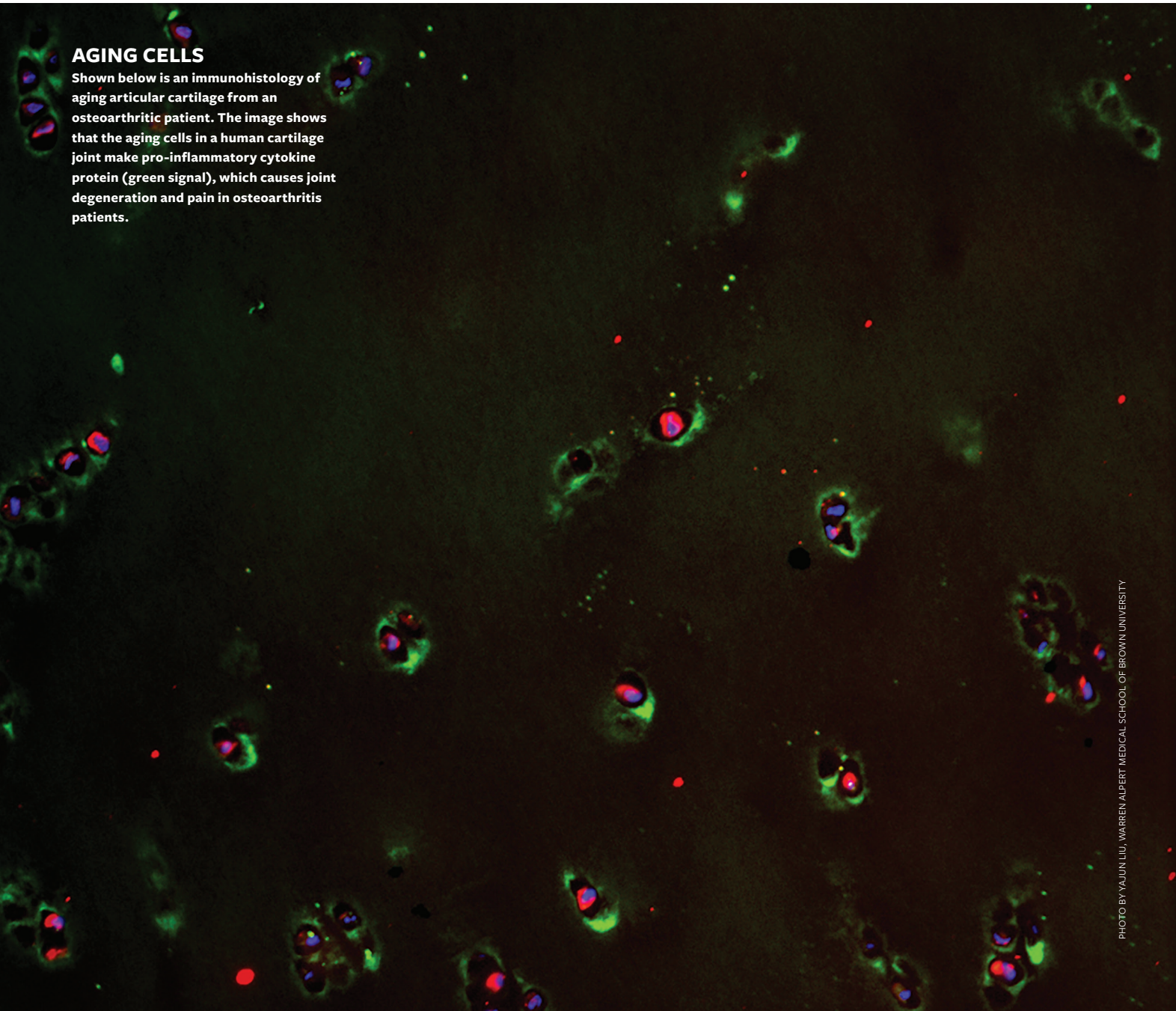

PHOTO BY YAJUN LIU, WARREN ALPERT MEDICAL SCHOOL OF BROWN UNIVERSITY