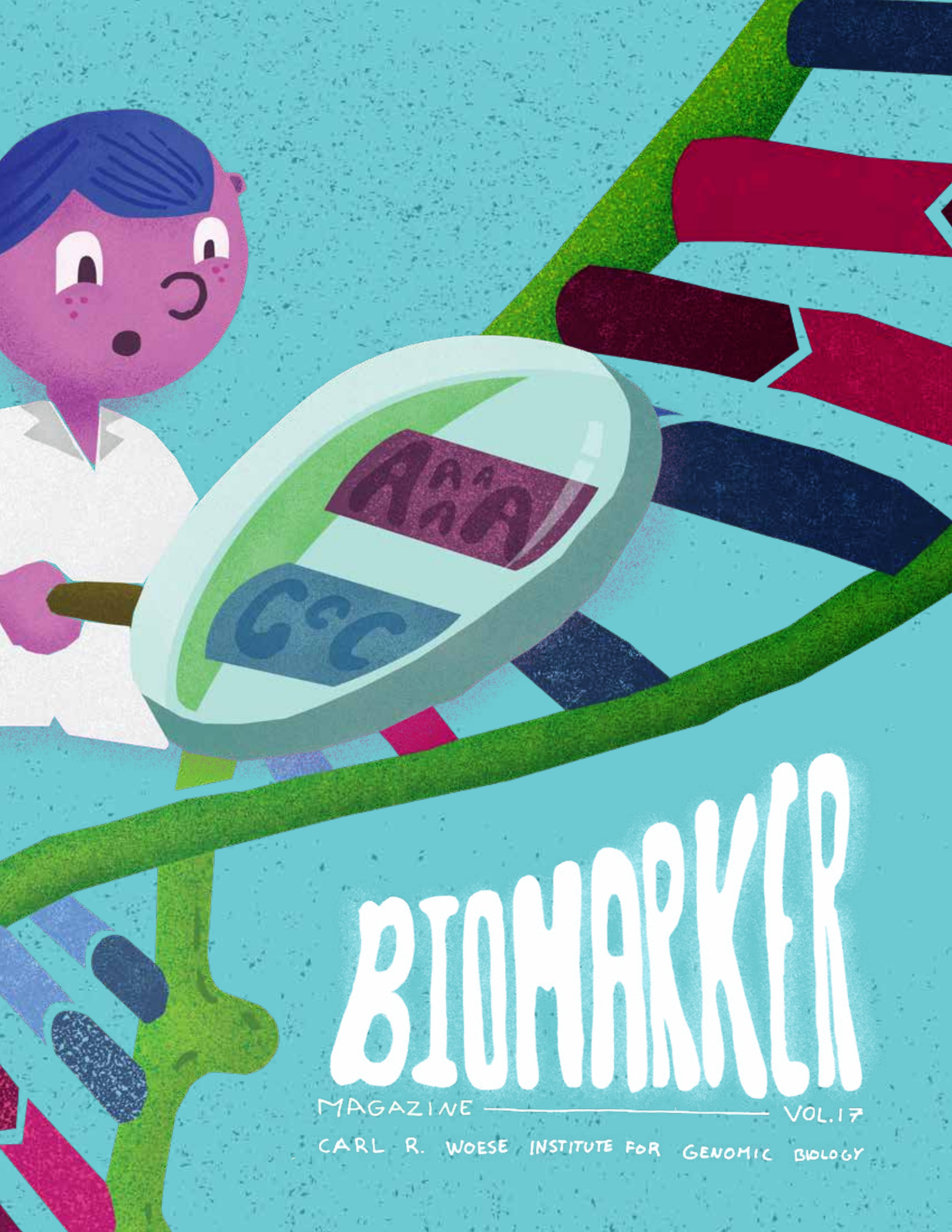
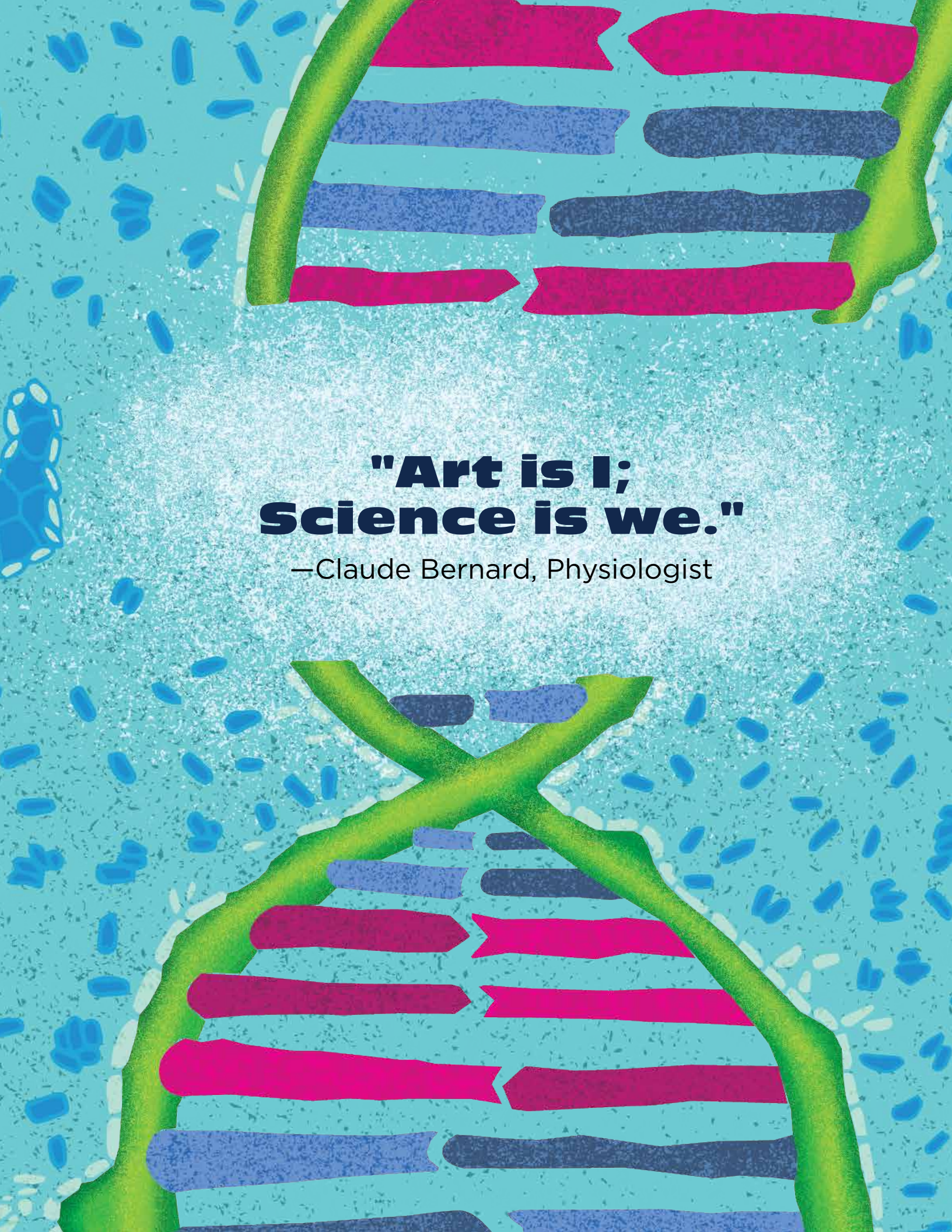


BIOMARKER

MAGAZINE — VOL.17

CARL R. WOESE INSTITUTE FOR GENOMIC BIOLOGY


"Art is I;
Science is we."
—Claude Bernard, Physiologist


AT
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BIOMARKER

IGB THEMES

ACPP *Anticancer Discovery from Pets to People*
BSD *Biosystems Design*
CABBI *Center for Advanced Bioenergy and Bioproducts Innovation*
CAIM *Center for Artificial Intelligence and Modeling*
CGD *Center for Genomic Diagnostics*
CIS *Center for Indigenous Science*
EIRH *Environmental Impact on Reproductive Health*
GEGC *Genomic Ecology of Global Change*
GNDP *Gene Networks in Neural & Developmental Plasticity*
GSP *Genomic Security and Privacy*
IGOH *Infection Genomics for One Health*
M-CELS *Multi-Cellular Engineered Living Systems*
MME *Microbiome Metabolic Engineering*
MMG *Mining Microbial Genomes*
RBTE *Regenerative Biology & Tissue Engineering*

IGB STRATEGIC PARTNERSHIPS

HPCBIO *High-performance Biological Computing*
GEMS *Genomic and Eco-evolution of Multi-scale symbioses*
MSI *Microbial Systems Initiative*
MMLI *Molecule Maker Lab Institute*
PNI *Personalized Nutrition Initiative*

IGB FUNDING AGENCIES

DOE *United States Department of Energy*
HHMI *Howard Hughes Medical Institute*
NIH *National Institutes of Health*
NSF *National Science Foundation*
USDA *United States Department of Agriculture*
NIAID *National Institute of Allergy and Infectious Diseases*
NIGMS *National Institute of General Medical Sciences*

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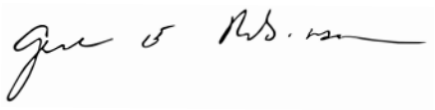
HONORS

Director's Message

> "We believe in the power of people coming together to shape the future we want to see, and as such, the IGB has continuously embraced new collaborators and partners that assist us in bringing about this change."



Gene Robinson

DIRECTOR,

CARL R. WOESE
INSTITUTE FOR GENOMIC BIOLOGY

COLLABORATIVE AND DIVERSE COMMUNITIES ARE THE CORNERSTONE of progress and innovation, both within science and society at large. At the Carl R. Woese Institute for Genomic Biology, we hold a deep appreciation for the transformative power of community. "Where Science Meets Society" is not just our motto, it's the driving force behind our mission.

It's my pleasure to introduce this year's edition of Biomarker, which celebrates the vibrant community of researchers we pride ourselves in at the IGB. It's through the collective efforts of our researchers, staff, and partners that we have built a thriving ecosystem for scientific exploration.

In this issue of Biomarker, you will find a series of profile pieces, aimed at shining a spotlight on some of the incredible researchers and staff who form the backbone of our community. Their stories and achievements exemplify our commitment to fostering an environment where innovation and collaboration thrive. We are proud to showcase their remarkable contributions that help position our institute on the leading-edge of science.

We believe in the power of people coming together to shape the future we want to see, and as such, the IGB has continuously embraced new collaborators and partners that assist us in bringing about this change. This year a new partnership was forged between the University of Illinois Urbana-Champaign, the University of Chicago, Northwestern University, and the Chan Zuckerberg Initiative, leading to the launch of the Chan Zuckerberg Biohub in Chicago. I am proud to say that the IGB will serve as the Urbana “satellite” for the new Biohub. This biomedical center aims to bring together a community of scientists from these leading institutions to address grand scientific challenges for the benefit of society.

Furthermore, we are thrilled to introduce the Team Science Leadership Program, a new initiative consisting of a series of workshops, providing leadership training and fostering collaborations among faculty across campus.

Our community is not limited by the walls of our institute; it extends to all those who share our passion for advancing science and making a difference in the world. To this end, we are very excited to introduce our new mobile lab, a testament to our dedication to bring hands-on science to the Urbana-Champaign community and beyond. This mobile lab is equipped with tools and technologies to be used in interactive demonstrations at local schools and in the broader community, helping to enrich the lives of those around us. Our cover is an homage to the colorful design of our mobile lab, and you'll see aspects throughout this special edition of Biomarker to celebrate this important new endeavor.

The IGB continues to make significant strides in the realm of scientific discovery, all of which would not be possible without your efforts. Thank you all for being a part of our thriving community. I look forward to seeing how the IGB’s community continues to evolve, working collectively to create a better, brighter world through science.

GET ON BOARD FOR SCIENCE!

THERE IS A PRESSING NEED FOR STEM interventions for underrepresented minorities and low-income students in Illinois: 53% of the students are low-income, and that number jumps to 91% in Chicago. Concerningly, the highest poverty districts in Illinois receive 22% less student funding than the lowest poverty districts, the worst disparity rate in the country. Over 83% of Illinois school districts are underfunded, and this funding disparity contributes to 20% of all Illinois schools being ranked as "underperforming" or "lowest performing." Statewide, 50% of all students are deemed not proficient in science. Therefore, there is a need for interventions that can provide the necessary STEM learning experiences.

The IGB has always been interested in public engagement, conducting a diverse range of activities that have reached tens of thousands of participants. With this new approach, the outreach team aims to clarify the role of genomics in all aspects of life, stressing the importance of science literacy for non-scientists.

With the help of a grant from Illumina Inc. and the Illumina Corporate Foundation, the IGB mobile lab will deliver hands-on engagement with genomics research in areas including genetically modified organisms, microbiomes, antibiotic resistance, CRISPR, and personalized health. "Growing up in a small, rural Illinois community, it means the world to me to be partnering with the IGB on the mobile STEM lab," said Melissa Spears, a Senior Staff Customer Experience Culture Specialist at Illumina. "I am humbled and proud that Illumina and the IGB are "driving" genomics forward in districts where this would otherwise not be possible."

The IGB mobile lab's mission is to provide research experiences for populations that have been traditionally underserved in STEM education. It will focus on the urban core of Chicago and St. Louis, and rural areas throughout the Midwest. To this end, the team will be partnering with the Champaign-Urbana Mass Transit District, who have provided a bus for these efforts. The completely self-contained and state-of-the-art mobile lab will allow the team to travel to economically and educationally disadvantaged locations, providing these communities with the opportunity to access equipment that is usually limited to highly funded institutions.

The mobile lab will also provide volunteering opportunities for the scientists at the IGB who represent the diversity of age, gender, race, and ethnicities that are required at any research institute. Together with these volunteers, the IGB mobile lab will create novel content for the mobile STEM curricula that will address the concerns of different communities. The students will learn science by using the tools and technology necessary to conduct research and, hopefully, will make some interesting discoveries. The mobile lab will also develop a network of schools, libraries, and community centers who are committed to implementing science education that will meaningfully connect to the unique life experiences of their learners.

Pictured, from left: Tianhao You, Haiyang (Ocean) Cui, Huimin Zhao and Guangde Jiang.

AI predicts enzyme function better than leading tools

A new artificial intelligence tool can predict the functions of enzymes based on their amino acid sequences, even when the enzymes are unstudied or poorly understood. The researchers said the AI tool, dubbed CLEAN, outperforms the leading state-of-the-art tools in accuracy, reliability and sensitivity. Better understanding of enzymes and their functions would be a boon for research in genomics, chemistry, industrial materials, medicine, pharmaceuticals and more.

"Just like ChatGPT uses data from written language to create predictive text, we are leveraging the language of proteins to predict their activity," said study leader Huimin Zhao (BSD leader/CABBI/CGD/MMG), a professor of chemical and biomolecular engineering. "Almost every researcher, when working with a new protein sequence, wants to know right away what the protein does. In addition, when making chemicals for any application—biology, medicine, industry—this tool will help researchers quickly identify the proper enzymes needed for the synthesis of chemicals and materials."

The researchers published their findings in the journal *Science* and have made CLEAN accessible online.

With advances in genomics, many enzymes have been identified and sequenced, but scientists have little or no information about what those enzymes do, said Zhao.

Other computational tools try to predict enzyme functions. Typically, they attempt to assign an enzyme commission number—an ID code that indicates what kind of reaction an enzyme catalyzes—by comparing a queried sequence with a catalog of known enzymes and finding similar sequences. However, these tools don't work as well with less-studied or uncharacterized enzymes, or with enzymes that perform multiple jobs, Zhao said.

"We are not the first one to use AI tools to predict enzyme commission numbers, but we are the first one to use this new deep-learning algorithm called contrastive learning to predict enzyme function. We find that this algorithm works much better than the AI tools that are used by others," Zhao said. "We cannot guarantee everyone's product will be correctly predicted, but we can get higher accuracy than the other two or other three methods."

"We want to predict the functions of all proteins so that we can know all the proteins a cell has and better study or engineer the whole cell for biotechnology or biomedical applications."

The researchers verified their tool experimentally with both computational and in vitro experiments. They found that not only could the tool predict the function of previously uncharacterized enzymes, it also corrected enzymes mislabeled by the leading software and correctly identified enzymes with two or more functions.

"There are a lot of uncharacterized binding proteins, such as receptors and transcription factors. We also want to predict their functions as well," Zhao said. "We want to predict the functions of all proteins so that we can know all the proteins a cell has and better study or engineer the whole cell for biotechnology or biomedical applications."

The NSF supported this work.

Protecting genomic privacy through phone apps

POLICE ARE INCREASINGLY USING GENOMIC DATABASES in their investigations. Concerningly, they often do so without a warrant requirement. A new paper co-written by University of Illinois Urbana-Champaign faculty presents possible technological solutions, such as phone applications, that will ensure Fourth Amendment protections of consumer's genomic data.

> "The idea is that if you upload your genome to a third-party website, it will not be considered private. However, if I send you a program that analyzes your data on your computer, your privacy is protected."

Over the past few years, many individuals have become interested in analyzing their data through genomics companies, such as 23andMe or Nebula Genomics. The process involves submitting a DNA sample to the company, which sequences the DNA and makes the resulting data available online through a password-protected website. Through these services, the consumers can learn about underlying health conditions or their family history. However, in all these cases, the companies control the data and the analysis tools, decreasing the user's privacy.

"According to the third-party doctrine of the Fourth Amendment, if you disclose information to a third party, they can turn over that information to the government," said Jacob Sherkow (GSP), a professor of law. "Genomic data is problematic because it can be inferred through familial sequencing. By our estimates, the genome of essentially every single person in the U.S. of European ancestry can be inferred because of these sequencing companies."

While many of us may want to help police investigations, allowing them to use our genetic data is problematic, according to Sherkow. "Disclosing genomic information necessarily implicates your relatives in a way that does not apply to other information such as your bank records," Sherkow said. "In addition to making you more susceptible to warrantless searches, it also contributes to a dystopian situation where everybody can be uniquely identified regardless of consent."

To better protect the security and privacy of genomic technology, the researchers are developing a computational system. "The idea is that if you upload your genome to a third-party website, it will not be considered private. However, if I send you a program that analyzes your data on your computer, your privacy is protected," said Carl Gunter (GSP leader), a professor of computer science. "It's like a home pregnancy test—you take it home and find out the answer. Nobody else needs to know unless you choose to tell them."

Cell phone apps are a perfect example of how the computational tools can be sent to the data: they are capable of computing large amounts of data and are private.

The researchers are hopeful that since most of us have used apps, people will be open to getting information through an app of their choice. The theme is also focused on developing these apps. So far, they have used artificial intelligence to develop apps that range from simple tests—like testing for sprinter's gene, which is associated with power athletes—to complex tests, such as predicting the progress of macular degeneration.

The paper was published in *96 Southern California Law Review* and was funded by the NIH.

The Centers for Disease Control and Prevention estimates that Salmonella cause about 1.35 million illnesses in the United States every year.

Small RNAs in Salmonella infections uncovered

***SALMONELLA* ARE FOOD-BORNE PATHOGENS THAT** infect millions of people a year. The bacteria do so by first invading the cells of the intestine using a needle-like structure, which injects proteins directly into the cells, setting off a cascade of changes that cause inflammation, and ultimately cause diarrhea. The genes that encode this system, and other genes that are needed for invasion, are found on a region of DNA known as the *Salmonella* pathogenicity island 1.

"SPI-1 needs to be well controlled," said Sabrina Abdulla, a graduate student in the Vanderpool lab, and the first author of the study. "If the needle apparatus is not made, *Salmonella* cannot cause an infection, and if too much it is made, *Salmonella* becomes sick."

SPI-1 is controlled by an extensive regulatory network. First, three transcription factors: HilD, HilC, and RtsA, all control their own and each other's DNA expression. They also activate another transcription factor, HilA, which activates the rest of the SPI-1 genes. If this isn't complicated enough, SPI-1 also needs to sense a variety of environmental cues and tune the expression of its genes in order to infect its host.

> "Small RNAs play a crucial role in determining how genes function in bacterial cells. Typically, these molecules either interact with proteins, or the mRNA, which carries the instructions for making proteins."

Small RNAs play a crucial role in determining how genes function in bacterial cells. Typically, these molecules either interact with proteins, or the mRNA, which carries the instructions for making proteins. As a result, sRNAs affect a variety of bacterial functions, including virulence and responses to the environment.

In this paper, the researchers looked at the sRNAs that regulate the *hilD* mRNA, specifically a sequence on the mRNA called the 3' untranslated region, a part of the mRNA not involved in making the HilD protein. In bacteria, the 3' UTRs are usually 50-100 nucleotides long. However, the 3' UTR of the *hilD* mRNA was 300 nucleotides long.

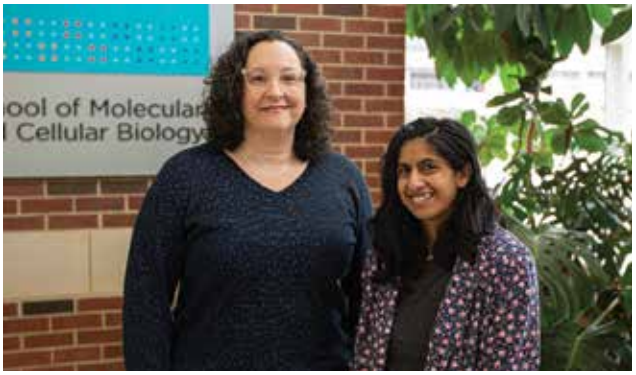
"The starting point for my work was the observation that when we deleted the 3' UTR, the expression of the *hilD* gene went up 60-fold," Abdulla said. "We then decided to look for sRNAs that might be inter acting with this region."

The researchers determined that although the sRNAs Spot 42 and SdsR can both target the 3' UTR, they do so in different regions.

"This result suggests that the entire 3' UTR is important for regulation," Abdulla said. "We showed that the sRNAs stabilize the hilD mRNA and protect it from being degraded."

"Now that we know that sRNAs play an important role in controlling SPI-1 through their regulatory effects on the *hilD* 3' UTR, we want to extend our studies in two directions. We'd like to understand more about how, at a molecular level, the sRNAs influence *hilD* mRNA levels. We'd also like to better understand how sRNAs participate in regulating expression of other important SPI-1 genes," said Cari Vanderpool (MME co-leader/IGOH), a professor of microbiology.

The study was published in the *Journal of Bacteriology* and was supported by the NIH, the University of Illinois Department of Microbiology Marie Chow Teaching Scholarship, and the Francis M. and Harlie M. Clark Microbiology Fellowship.



Cari Vanderpool, left, and Sabrina Abdulla.

Town hall spurs new ideas for promoting DEI at the IGB

THE IGB HELD A TOWN HALL MEETING IN JANUARY 2023 to introduce new changes to improve diversity and inclusion. Attendance was high, with faculty, staff, postdoctoral researchers, and students alike filling both meeting rooms to capacity in order to ask questions and weigh in on the proposed changes. The meeting was led by IGB Director Gene Robinson and guest moderator and Director of Campus Culture and Climate Kaamilyah Abdullah-Span, along with co-chairs of the DEI Task Force Julia Pollack and Sara Pedron-Haba, who moderated questions submitted anonymously online.

"Today marks an important next step in the process to address concerns and improve conditions in the IGB so that everyone feels welcome and connected in every way possible to the important activities that are going on at this research institute," said Robinson in his welcoming address.

Diversity and inclusion are cornerstones of the IGB's mission. As such, the IGB has two committees which work together towards this effort. The DEI Advisory Group, established in 2018, acts as an advisory committee that develops ideas for promoting a more inclusive community. The DEI Advisory Group is comprised of theme leaders and faculty in the IGB. The second committee, the DEI Task Force, established in 2020, is co-chaired by Julia Pollack, IGB Creative Program Manager, and Sara Pedron-Haba (RBTE), a research professor of chemical and biomolecular engineering. It is comprised of members of the IGB community, including staff and postdoctoral researchers. The DEI Task Force takes ideas from the Advisory Group and helps bring them into action.

Proposed changes discussed at the town hall included new DEI trainings for faculty and staff, exit surveys for postdocs,

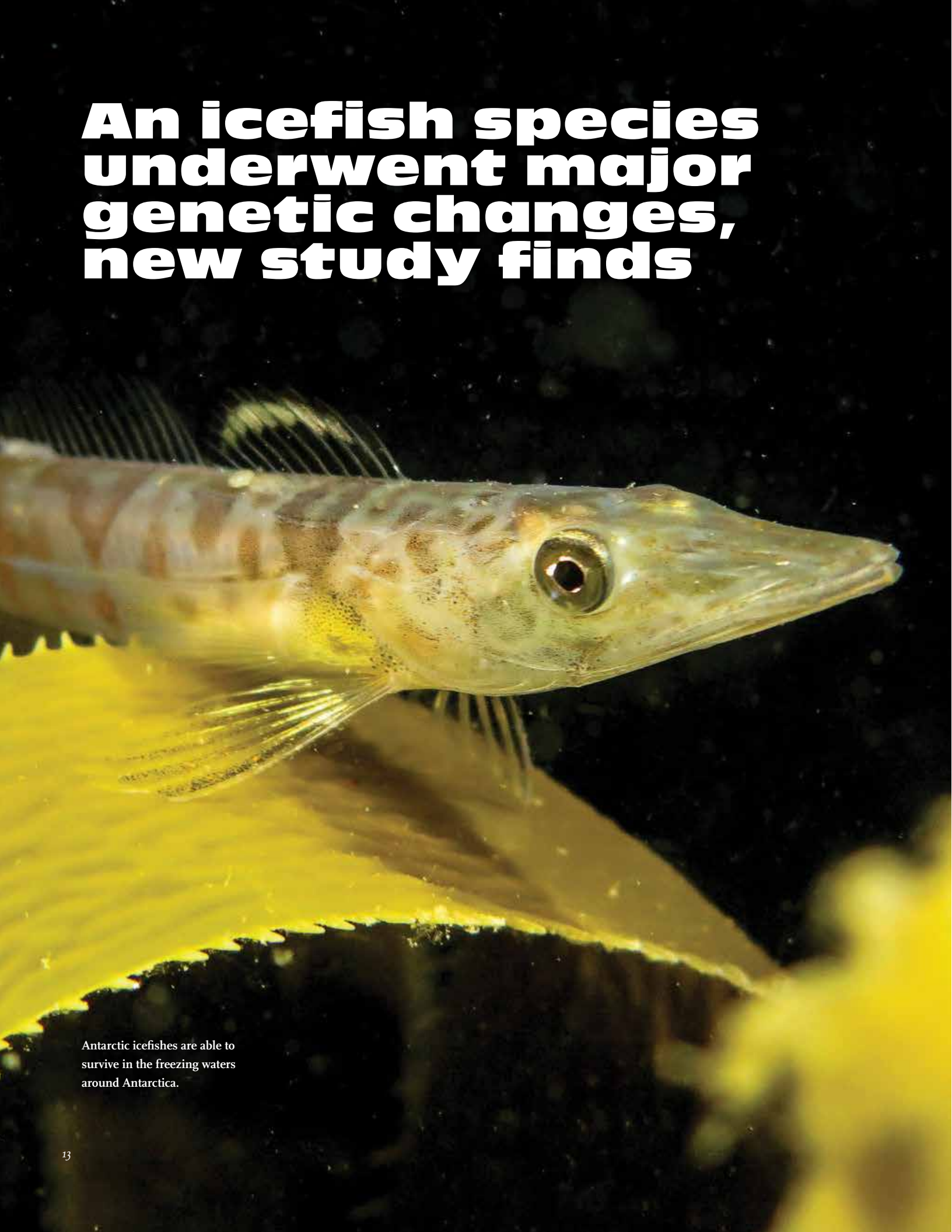
> “Too often we think of diversity, equity, and inclusion as buzz words; however, these are action-based concepts that must be operationalized in order to have the intended effect.”

faculty and staff, new language in IGB faculty and theme appointment/reappointment letters, and a more transparent process for reporting grievances. Robinson and Abdullah-Span also clarified current DEI measures in place, such as gender-neutral bathroom locations and routes for grievance reporting.

“Too often we think of diversity, equity, and inclusion as buzzwords; however, these are action-based concepts that must be operationalized in order to have the intended effect,” said Abdullah-Span. “The interest and response of the IGB community are encouraging indicators that there is strong community support and alignment with the direction in which the IGB is moving, which is important because achieving the goal of a diverse, equitable, and inclusive working and learning environment within the IGB requires the commitment and contributions of everyone.”

The IGB has reviewed questions and comments submitted on their form, as well as the feedback received during the town hall, and hopes to continue the discussion after thoughtful consideration in the near future. Anyone who wants to get involved with DEI efforts can join the Task Force, which meets online biweekly.

An icefish species underwent major genetic changes, new study finds



Antarctic icefishes are able to survive in the freezing waters around Antarctica.

MANY ANIMALS HAVE EVOLVED TO TOLERATE EXTREME environments, including being able to survive crushing pressures of ocean trenches, unforgiving heat of deserts, and limited oxygen high in the mountains. These animals are often highly specialized to live in these specific environments, limiting them from moving to new locations. Yet, there are rare examples of species that once lived in harsh environments but have since colonized more temperate settings. Angel Rivera-Colón, a postdoctoral researcher in the lab of Julian Catchen (CIS/GNDP), an associate professor in the department of evolution, ecology, and behavior, explores the genetic mechanisms underlying this anomaly in Antarctic Notothenioid fish.

Antarctic icefishes are able to survive in the freezing waters around Antarctica due to antifreeze glycoproteins they produce in their cells. They are also are the only vertebrate that has adapted to live without hemoglobin in their blood cells, causing their cells and tissues to be white in color. Hemoglobin is a protein in blood cells that helps increase oxygen uptake and results in the red coloration of cells. Normally animals need hemoglobin to get enough oxygen, but in the cold, oxygen-rich waters around Antarctica, icefishes have developed morphological changes, such as bigger hearts for pumping blood, that they no longer need hemoglobin to get enough oxygen.

> “If you’re specialized to only live in very cold environments, how do you survive and adapt to this new warmer environment?”

Despite this extreme specialization, one species of icefish called *Champsocephalus esox*, or the pike icefish, has escaped Antarctica and now lives in warmer, less oxygenated, South American waters. “The movement of this species to warmer waters posed an interesting evolutionary mystery that I wanted to try to solve,” Rivera-Colón said. “If you’re specialized to only live in very cold environments, how do you survive and adapt to this new warmer environment?”

To understand how the genome of the fish changed as it migrated into warmer waters, Rivera-Colón compared the genetics of the pike icefish to that of an Antarctic species of icefish, *C. gunnari*. The team took tissue samples collected by collaborators and fishermen from southern Chile, South Georgia, and the Sandwich Islands to sequence the genomes.

After comparing the genomes, they found that while the genome was highly conserved between the species, there was divergence in areas of the pike icefish genome associated with the physiology that would need to change as the fish moved to warmer waters.

In addition to evolving to live in warmer waters, the pike icefish would’ve also needed to adapt to a different light environment. The sea around the Antarctic is dark much of the year, and the surface ice blocks much of the light. But in temperate waters, pike icefish experience a more normal day-night cycle. The team is currently examining gene expression in related fish to see how their physiology and circadian rhythms have adapted to these new light cycles.

Rivera-Colón added “Our study just goes to show that this specialization for extreme cold is not an evolutionary dead end, and it helps explain how these transitions happen in nature.”

The study was supported by NSF and was published in *Molecular Biology & Evolution*.

Angel Rivera-Colón, left, and Julian Catchen.

Rice fields in Uttar Pradesh, a state in northern India.

Understanding the long-term impact of climate change on Indian crops

OVER THE PAST FEW DECADES, IT HAS BECOME obvious that climate change, and consequent extreme weather events, can wreak havoc on crop yields. Concerningly, there is a large disparity in agricultural vulnerability between developed and developing countries. In a new study, published in *Agricultural Economics*, researchers have looked at major food grains in India to understand the long- and short-term effects of climate change on crop yields.

> "We found that the farmers were able to adapt to changes in temperature for rice and maize but not wheat. Increased precipitation enhanced rice yield, but adversely affected wheat and maize yields."

"Most studies that measure the effects of climate change are looking at year-to-year changes, which are representative of variations in weather and not climate," said Madhu Khanna (CABBI), a professor of agriculture and consumer economics. "We used data across 60 years to examine how deviations in weather from long-term averages affect the yields of three major cereal crops: rice, maize, and wheat."

The researchers used quantile regression models to determine if farmers were adapting to the long-term changes in climate. To do so, they used data sets on temperature, precipitation, the length of the growing season, and crop yield to create different models for short-term and long-term responses of crops.

According to their analysis, if differences in temperature, for example, have no impact in either model, there have been no adaptations. On the other hand, if the short-term impact is worse, it means that the farmers have been able to adapt and smooth out the effects.

"We found that the farmers were able to adapt to changes in temperature for rice and maize but not wheat. Increased precipitation enhanced rice yield, but adversely affected wheat and maize yields," Khanna said. "We also found that farmers are customizing their strategies across different regions and crops. For example, heat-prone districts fared better in higher temperatures compared to districts in colder regions."

There are two ways by which the crops can adapt: the farmers can change their management practices, or the varieties themselves can become hardier. Although this study cannot distinguish between these possibilities, it suggests that action can be taken to improve seed varieties and educate farmers on how they can adapt to changing climate.

"This study is a part of our overall effort to build understanding across different countries. In the past we did a similar study in the US and now we're doing it for India. It's interesting that the results of this study are telling us that in both countries, although there is a negative impact of climate, the crops are adapting," Khanna said. "However, these effects differ across crops and across the type of effects they are adapting to. We need to take a holistic view of all the various ways in which changing climate effects yield, which is obviously a very challenging and complex problem, and understand that focusing on particular dimensions of climate change and adapting crops may not be sufficient."

Both parents watch over their eggs until they hatch, after which males carry the tadpoles and deposit them into small pools of water. The male will then call to the female, signaling her to feed the tadpole.

Poison frog call to feed tadpole evolutionarily derived from other calls, research finds

MANY ANIMALS PRODUCE SOUNDS TO COMMUNICATE with others, often for the purpose of attracting mates, or warning others of nearby predators. Sometimes calls evolve for new and unique purposes, such as the egg-feeding calls of the mimic poison frog. While the behaviors surrounding this call have been documented, the call itself had not been previously characterized.

> "There's a lot of overlap between the call types and their properties, so clearly, it's not the only thing that females are using to direct their behavior."

In a new study published in the *Proceedings of the National Academy of Sciences,* Eva Fischer (GNDP), an assistant professor of evolution, ecology, and behavior, first-author Jen Moss, a postdoctoral researcher in Fischer's lab, and James Tumulty, a visiting assistant professor at the College of William & Mary, characterized the acoustic properties of the egg-feeding call compared to other well-studied male call types for advertisement and courtship.

Males and females of this species watch over their eggs until they hatch, after which males carry the tadpoles on their backs and eventually deposit them into small pools of water. The male will then call to the female, signaling her to feed the tadpole an unfertilized egg, called a trophic egg.

The researchers wanted to quantitatively measure acoustic properties of the egg-feeding calls to determine whether they are actually distinct from male calls used for advertising or for courting females. The team housed frogs in pairs in tanks within the lab and set up microphones and cameras to capture the calls and behaviors of the parents. They recorded advertisement and courtship calls, as well as calls that the males produced in conjunction with egg-feeding by the females. The researchers then characterized and compared the acoustic properties of all the calls.

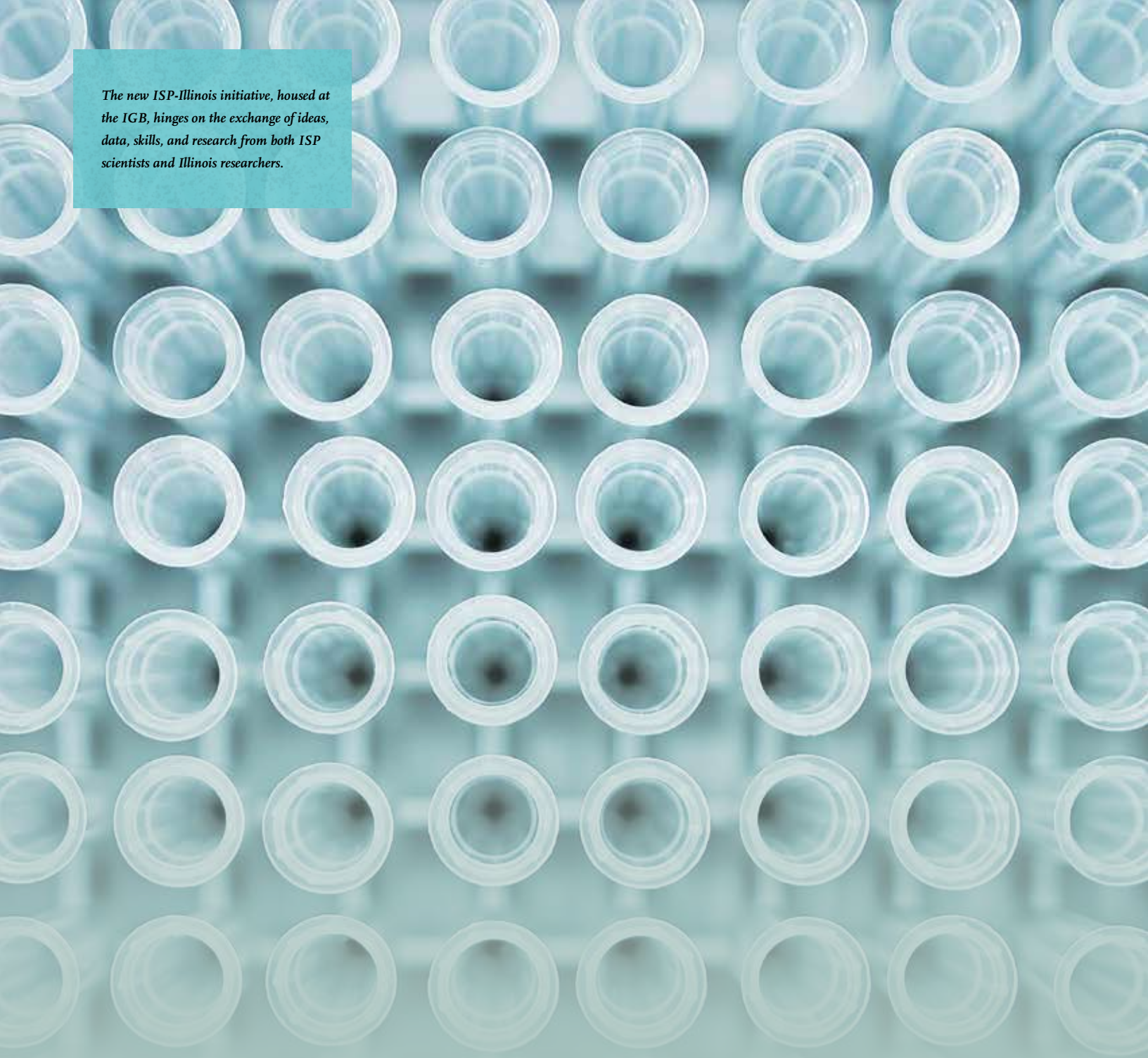
Through their analyses, the researchers found that egg-feeding calls share some acoustic properties with courtship and advertisement calls. Both egg-feeding and courtship calls were lower in frequency and volume. But egg-feeding calls also surprisingly shared some properties with advertisement calls; both are of longer length compared to courtship calls.

"There's a lot of overlap between the call types and their properties, so clearly, it's not the only thing that females are using to direct their behavior," said Moss. "We know that that males physically lead females to pools and that tadpoles beg to be fed, so there's probably visual signals involved as well. Vocal communication is clearly an important part of the story, but it's not the full story."

The team says one of the biggest unanswered questions is why the males need to signal for the females to feed the tadpoles in the first place. When the male is removed from the tank, the female will often still carry and feed the tadpoles in his absence. But this doesn't always happen, and previous work by Tumulty showed that male signaling does have a significant effect on tadpole growth rate. The researchers are currently examining which factors influence if and when females take over parental care in the absence of their male in hopes of answering this question.

This research was funded by the NSF and University of Illinois Urbana-Champaign.

Jen Moss, left and Eva Fischer in their frog housing room (left), a male and female mimic poison frog (top right), a male mimic poison frog carrying a tadpole on his back (bottom right).



The new ISP-Illinois initiative, housed at the IGB, hinges on the exchange of ideas, data, skills, and research from both ISP scientists and Illinois researchers.

New initiative to improve forensic science practices in Illinois

THE LANDSCAPE OF FORENSIC DNA HAS SHIFTED IN recent years to not only include different types of genetic data, but also expand how DNA can help improve the science and the investigations themselves. Such a shifting landscape requires new investigative strategies, and key Illinois institutions are looking towards deeper collaborations to make it happen. To this end, the Illinois State Police and the University of Illinois Urbana-Champaign have partnered to combine distinct but complementary skills and resources.

> "The partnership between ISP and the University of Illinois will put ISP on the cutting edge of forensics that advances investigations and brings justice to victims."

"ISP leads one of the largest forensics laboratory systems in the world and we always strive to be one of the best," said ISP Director Brendan Kelly. "The partnership between ISP and the University of Illinois will put ISP on the cutting edge of forensics that advances investigations and brings justice to victims."

The new ISP-Illinois initiative, housed at the IGB, is called the Investigative Technology Exchange. This partnership hinges on the exchange of ideas, data, skills, and research from both ISP scientists and Illinois researchers to solve the current grand challenges in forensic science.

"One of the earliest success stories of using a new forensic genetic technique, called investigative genetic genealogy, was in 2018 with the identification of the Golden State Killer, guilty of over 60 violent crimes," said Cris Hughes (GSP), a clinical associate professor of anthropology and appointed director of the Investigative Technology Exchange. "Though it resolved an important case that had been lingering for decades, it left a lot of unanswered questions about DNA privacy and police overreach."

Hughes realized that forensic science applications, such as genetic genealogy, could only be adequately addressed through engagement between researchers in social and physical sciences and practitioners who carry out the forensic investigations. Through the ITE, Hughes hopes to facilitate cross-disciplinary research to resolve methodological challenges and better understand the ethical, legal, social, and policy implications of current and future forensic science technologies, within DNA and beyond.

The initiative will also help develop forensic education pipelines for undergraduate and graduate students to prepare them for a career in forensics laboratories. Ultimately, this endeavor will equip the next generation of forensic scientists with both the STEM and social science skillsets, paving the way for a more interdisciplinary approach for developing and applying forensic science to investigations.

One of its first initiatives will be to assess the feasibility of moving investigative genetic genealogy away from the private sector and into Illinois public labs. This shift would increase the potential to solve Illinois current and cold cases, but carries with it many ethical, legal, and social challenges. Such complex transitions will require interdisciplinary expertise, from maximizing wet lab efficiencies for processing DNA evidence, to understanding and addressing stakeholder concerns around privacy and the security of DNA data. The ITE will be the hub for examining such issues and finding the path forward that works best for our state and our communities.

From left, Brendan Kelly, Cris Hughes, ISP Deputy Director Robin Woolery, and ISP First Deputy Director Matthew Davis.

James O'Dwyer developed a method for predicting whether pairs or groups of plants are likely to persist together in a habitat over time.

Team finds reliable predictor of plant species persistence, coexistence

LIKE MANY ECOLOGICAL SCIENTISTS, University of Illinois Urbana-Champaign plant biology professor James O'Dwyer (CAIM) has spent much of his career searching for ways to measure and predict how specific plant communities will fare over time. Which species in a diverse population will persist and coexist? Which will decline? What factors might contribute to continuing biodiversity?

In a new study reported in the journal *Nature*, O'Dwyer and his colleague, University of Illinois graduate student Kenneth Jops, report the development of a method for determining whether pairs or groups of plant species are likely to coexist over time. Using data from published studies, their approach reliably predicts the complementary life histories of pairs of plants that —while competing for many of the same resources—manage to thrive in a shared habitat.

> "Plant biodiversity is a huge and complex question and I'm glad we were able to shed some light on how life history fits into that puzzle."

"Over the last 50 or so years, people have gathered more and more data about plant life histories, death rates, reproductive rates, how many seeds they're producing, how quickly they grow into the next life stage—and all of that can be changing throughout a lifespan," O'Dwyer said. "And we write this as a matrix that roughly describes all those aspects of life history—and it's different for every species."

Certain elements of the matrix are plugged into an equation that yields the "effective population size," a number that is recorded in units of years. The key finding in the new study is that if two plant species have roughly equivalent effective population sizes, they are more likely to coexist over time.

An equal or near-equal EPS means that "there's something about the way that the life histories jigsaw together that makes it more likely that they will persist," O'Dwyer said.

The EPS equation reflects a mathematical relationship between the number of new individuals "born" each year, the average age of the parents, and the plant's reproductive success over its lifetime, the researchers said. The team found that a larger EPS also coincided with a better outcome for the species.

The data set the team used in the new study is relatively small, O'Dwyer said.

"There are around 800 to 1,000 plant species in the database we use—a drop in the ocean of plant diversity," O'Dwyer said. Further research will test the new method on larger data sets involving more plants in more types of habitats.

"Plant biodiversity is a huge and complex question and I'm glad we were able to shed some light on how life history fits into that puzzle," Jops said. "I hope this will encourage researchers to collect life history data across larger communities so we can apply our theory along with niche, fitness differences and environmental factors to better explain biodiversity patterns across the globe."

The Simons Foundation and James S. McDonnell Foundation supported this research.

Miscanthus Crop.

Cystic fibrosis is caused by mutations in the cystic fibrosis transmembrane conductance regulator gene.

Potential treatment for cystic fibrosis enters clinical trial

CLINICAL TESTING IS UNDERWAY FOR A POTENTIALLY groundbreaking new treatment for cystic fibrosis. Pioneered by scientists at Carle Illinois College of Medicine at the University of Illinois Urbana-Champaign and the Carver College of Medicine at the University of Iowa in partnership with the spin-out biotechnology company, cystetic Medicines, this promising inhalable molecular prosthetic is intended to improve lung function in people with CF who cannot benefit from current therapies.

The launch of this clinical trial is an important step forward in a joint public-private effort to develop a safe and effective treatment for everyone with CF, a progressive genetic disorder characterized by persistent lung infections that can cause severe damage over time.

> "We're hopeful that for those who have held their breath for far too long, this could be a first opportunity to regain ion-channel-like function in the airway and thereby address CF at its roots."

"We're hopeful that for those who have held their breath for far too long, this could be a first opportunity to regain ion-channel-like function in the airway and thereby address CF at its roots," said chemistry professor Martin Burke (MMG), who leads the research team in collaboration with scientists from the University of Iowa.

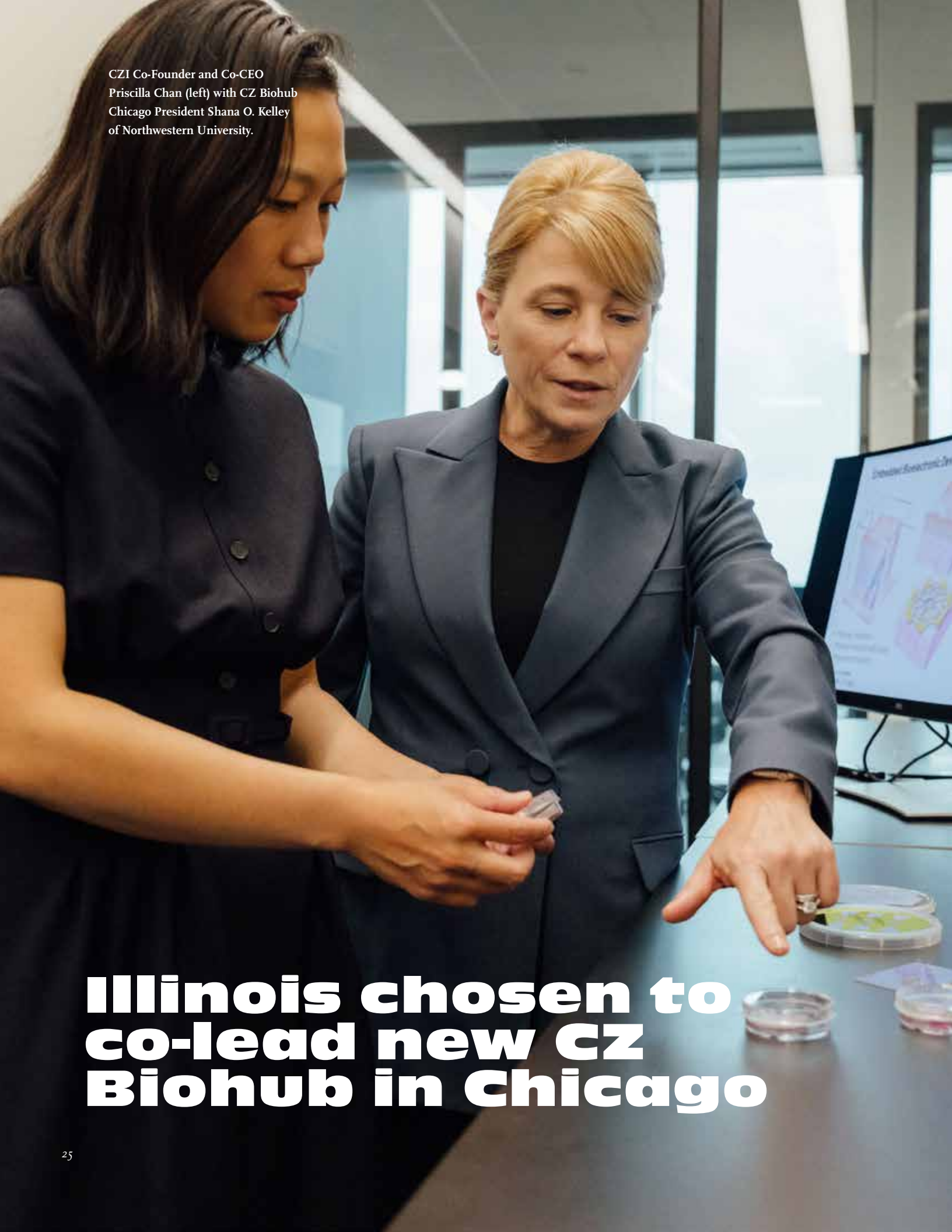
The first human volunteers in New Zealand recently began taking the new inhaled drug called CM001 (also known as amphotericin B cystetic for inhalation or ABCI), a molecular prosthetic that 'stands in' for missing or dysfunctional protein channels and is intended to restore more normal lung function in patients with cystic fibrosis. The approach combines a novel inhaled dry powder formulation to directly target the lungs and allow for more consistent dosing.

Cystic fibrosis is caused by mutations in the cystic fibrosis transmembrane conductance regulator gene responsible for producing the protein that helps regulate the balance of anions and fluid in the lining of the lungs and other organs. In the lungs, this dysfunction results in the formation of thick, sticky mucus on the lung lining that makes it difficult to breathe and causes frequent lung infections.

About 90 percent of people with CF produce CFTR protein that doesn't work properly. For these individuals, a class of drugs called CFTR modulators can often restore protein-channel function and result in improved breathing. But treatments have been extremely limited for patients whose bodies produce little or no CFTR protein. Burke and his team are optimistic that CM001 can act as a prosthetic at the molecular scale, replacing the missing protein and restoring ion channel function.

While the new drug CM001 may be a game-changer for patients who are not treatable with CFTR regulators, other CF patients could benefit as well. "The concept of molecular prosthetics has the potential to alter the treatment landscape for cystic fibrosis in a profound way; in theory, it should work for all people dealing with the disease, regardless of the type of mutation they present," said Jeffry Weers, Chief Technology Officer of cystetic Medicines and an industry leader in the development of inhalable medicines.

Results of the clinical trial are expected in 2024.



CZI Co-Founder and Co-CEO Priscilla Chan (left) with CZ Biohub Chicago President Shana O. Kelley of Northwestern University.

Illinois chosen to co-lead new CZ Biohub in Chicago

THE UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN has been chosen to co-lead the Chan Zuckerberg Biohub Chicago—a new biomedical hub—with researchers from Illinois, the University of Chicago and Northwestern University. The three-university team was selected as part of a competitive application process for a research initiative explicitly focused on measuring human biology.

> “Our role in the CZ Biohub Chicago is further evidence that our university is working at the leading edge of advancing human health.”

“Our role in the CZ Biohub Chicago is further evidence that our university is working at the leading edge of advancing human health,” said Chancellor Robert J. Jones. “When we unite our expertise with the collective strengths of our world-class research university partners, the horizon for innovation in health expands exponentially. The partnership between our three institutions is strong and growing, and that translates directly and rapidly into impact for the people of Illinois.”

The Chicago site, with a location yet to be determined, is the first expansion of the Chan Zuckerberg Biohub Network, modeled after the first CZ Biohub in San Francisco. The plan provides for state-of-the-art laboratories, meeting space, faculty-in-residence, a biofoundry and other sophisticated instrumentation. CZ Biohub Chicago will be led by Professor Shana O. Kelley of Northwestern University. “All big breakthroughs start with basic research—and the Biohub will be a destination that unites the brightest minds with one another and with the tools and resources to achieve breakthrough science that will have real implications for human health,” said Susan Martinis, Vice Chancellor for Research and Innovation at the University of Illinois. “This will create incredible opportunities for our research community at Biohub Chicago and will have ripple effects right here in Urbana-Champaign, too.”

Biohub Chicago research will focus on solving grand scientific challenges with a goal of significant progress over the next decade. “This institute will embark on science to embed miniaturized sensors into tissues that will allow us to understand how healthy and diseased tissues function in unprecedented detail,” said CZI Co-Founder and Co-CEO Priscilla Chan. “This might feel like science fiction today, but we think it’s realistic to achieve huge progress in the next 10 years.”

“The CZ Biohub Chicago gives us a springboard to unravel the design rules that govern human biology,” said Rashid Bashir (CGD/M-CELS), Dean of the Grainger College of Engineering at Illinois. “This is the kind of boundary-breaking, frontier-shaking work that our scientists and engineers crave. We’re asking some tough research questions—and we’re going to prove that answers are possible.” Bashir will be on the executive leadership committee of the CZ Biohub Chicago.

Biohub Chicago will leverage expertise and assets across disciplines and across institutions to develop engineering technologies to make precise, molecular-level measurements of biological processes and physical interactions within human tissues, with an ultimate goal of understanding and treating the inflammatory states that underlie many diseases.

From left to right, CZI Co-Founder and Co-CEO Priscilla Chan, Chan Zuckerberg Biohub Chicago President Shana Kelley, and Illinois Governor JB Pritzker with staff scientists at the CZ Biohub Chicago Launch.

From left, Jenny Davis, Christopher Prom, and Bethany Anderson, are leading the project at Illinois, which is one of seven universities that are part of the Doris Duke Native Oral History Revitalization Project.

Illinois researchers, Native American tribes working together to curate, increase access to oral histories

RESEARCHERS AT THE UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN are working with Native American tribes across the country to digitize oral histories and ethnographic materials collected from tribal members, and make them accessible online.

Illinois is one of seven universities that are part of the Doris Duke Native Oral History Revitalization Project to increase the accessibility of first-person narratives collected in the late 1960s and early 1970s. The project aims to build relationships between the universities and the Native communities documented in the collections, to return copies of the materials to the tribes and to have tribal members serve as co-curators to determine culturally appropriate access to the collections.

> "Our goals are to reconnect these recordings with their originating communities and the individuals and families represented in the materials. Above all, it is important to recognize the tribal sovereignty of the materials and to do this work collaboratively and ethically."

Bethany Anderson, the natural and applied sciences archivist for the Archives; Jenny Davis (CIS co-leader), the director of the American Indian Studies program; and Christopher Prom, the associate dean for digital strategies for the University Library, are leading the project at Illinois.

The seven universities were provided Doris Duke grants in the 1960s to collect narratives and record events of tribes throughout the U.S. and in Canada, resulting in more than 6,000 oral histories.

Anthropology professor Edward Bruner directed the work at Illinois, and anthropology graduate students lived with tribes and collected written and recorded interviews, photographs and audiovisual recordings of ceremonies and music. The materials include the journals and notes of the graduate students, transcripts, newspaper clippings, event programs and other paper materials, in addition to the recordings. In 2002, the collection of materials was transferred from the anthropology department to the Archives.

A large part of the work now is returning these materials to their originating Native communities.

"Native communities may have not realized that these materials would end up in an archival repository someday," Anderson said. "Our goals are to reconnect these recordings with their originating communities and the individuals and families represented in the materials. Above all, it is important to recognize the tribal sovereignty of the materials and to do this work collaboratively and ethically."

The tribes will determine the level of access for the materials —whether they can be made publicly available, limited to tribal members or available only to a select group of people within a tribe. Davis said some of the recordings include ceremonial practices or music that are considered sacred and are not shared beyond the tribal community or certain people within the community.

Once the project is finished, tribes from around the country will have access to pieces of their histories. The researchers will invite tribal representatives to come to campus and see the full collection, and tribes will be given original materials or copies of them.

"Building relationships and working through the complexities of the materials takes time. Folks need time to review these materials and talk about them. This is not the sort of work that can be rushed," Anderson said. "We see these as long-term relationships, beyond the bounds of the project."

Three projects chosen for the IGB DEI Awards

THE DIVERSITY, EQUITY, AND INCLUSION TASK FORCE at the IGB have awarded three projects for their DEI initiatives. Each project was representative of the different facets of IGB's mission to bring science to society, and to fulfill this mission, each project was awarded with $4000.

The first project "Frogs in Class: Using amphibians for 'ribbiting' community engagement," was proposed by Eva Fischer's (GNDP) lab, which studies parental care behavior in frogs. The lab is actively involved with several outreach initiatives, including IGB's Genome Day and STEAM TRAIN program. Their experiences have helped them recognize that science outreach serves as a powerful tool for enriching K-12 science education and opposing systemic exclusion of underrepresented groups in science. The Fischer lab will provide necessary supplies required for the classrooms to adopt tadpoles from the lab's frog colony, and present modules that teach students about research.

Melissa Flores and Malavika Venu, both graduate students in the Robinson (GNDP) lab, have proposed the second project, which will create an inclusive space for IGB graduate students through programming that promotes a sense of belonging and provides tools to cultivate professional STEM identities. Flores and Venu will organize three types of events: coffee and community-building brown bag lunches, a digital series that will celebrate graduate student excellence and diversity, and a workshop titled "Microaffirmations & Defining Time for Me." The monthly lunches will cover a wide range of themes, including science communication, cultivating intentional mentorship, and dealing with imposter syndrome. The digital series will highlight two IGB-affiliated graduate students every month and will focus on their journeys in STEM, their research, and their life outside the lab. The workshop will focus on teaching attendees to identify microaffirmations and set effective boundaries to manage their work/life balance.

The third project is a collaboration between Academic Women in STEM, the IGB Postdoctoral Association, and Parkland College. Titled "Beyond the R1: Providing Teaching Experiences for Women and Minorities at a Student-Serving/Teaching Institution," the project will be led by Christy Gibson, a postdoctoral research associate in the Bernacchi (CABBI/GEGC) lab; Chelsea Lloyd, an associate professor of microbiology at Parkland College; C. Britt Carlson, an associate professor of chemistry at Parkland College; Bethany Blakely, a postdoctoral research associate in the Bernacchi lab; Alida de Flamingh, a postdoctoral research associate in the Malhi (CIS co-leader/GNDP/GSP/IGOH) lab; Cindy Chan, a postdoctoral research associate in the Long (BSD/CABBI/GEGC) lab; Lucienne Burrus, a laboratory manager at CABBI; and Tracy Johnson, a field and greenhouse technician at CABBI. The teaching program will provide postdoctoral fellows, students, and professionals from international and historically underserved backgrounds an opportunity to learn about careers at community colleges, and hone their lectures through teaching workshops led by A-WIS and the Center for Innovation in Teaching and Learning.

Emily Terrill, left, Eva Fischer.

Melissa Flores, left, Malavika Venu.

Christy Gibson.

CABBI focuses on innovation in biofuels, bioproducts, and a clean energy future.

DOE Renews CABBI Five More Years

THE U.S. DEPARTMENT OF ENERGY HAS COMMITTED another round of funding to the University of Illinois Urbana-Champaign to lead the second phase of its Bioenergy Research Center—one of four large-scale DOE-funded research centers focused on innovation in biofu els, bioproducts, and a clean energy future for the country.

The DOE announced a five-year extension of funding for CABBI, to a total of $237.9 million for the period from 2017 to 2027. CABBI is a collaboration between the university's Institute for Sustainability, Energy, and Environment, the IGB, 11 academic departments across the Illinois campus, and 20 partner institutions across the nation.

> "To meet our future energy needs, we will need versatile renewables like bioenergy as a low-carbon fuel for some parts of our transportation sector."

"To meet our future energy needs, we will need versatile renewables like bioenergy as a low-carbon fuel for some parts of our transportation sector," U.S. Secretary of Energy Jennifer M. Granholm said. "Continuing to fund the important scientific work conducted at our Bioenergy Research Centers is critical to ensuring these sustainable resources can be an efficient and affordable part of our clean energy future."

Andrew Leakey (GEGC), Professor and Head of the Department of Plant Biology at Illinois, will continue as Director of CABBI, a position he has held since 2020.

"Energy independence has become an increasingly important security issue for the United States, and CABBI will continue to provide breakthroughs toward a new generation of sustainable, cost-effective biofuels and bioproducts that will replace fossil fuel-based products," Leakey said. "This grant represents a massive investment in CABBI and its diverse team of scientists. We are committed to help push the U.S. toward a new bio-based economy."

During Phase II, CABBI researchers will continue to develop fuels and products by integrating three highly interconnected DOE priority areas:

FEEDSTOCK PRODUCTION—Led by Emily Heaton, Professor of Regenerative Agriculture in Crop Sciences at Illinois, scientists use the "plants as factories" paradigm, in which biofuels, bioproducts, and foundation molecules for conversion are grown directly in crops that are resilient and productive.

CONVERSION—Led by Huimin Zhao (BSD leader/CABBI/CGD/MMG), the Steven L. Miller Chair in Chemical Engineering at Illinois, experts continue to develop unique tools, yeasts, enzymes, and processing methods to efficiently produce diverse, high-value molecules such as biodiesel, organic acids, jet fuels, lubricants, and alcohols.

SUSTAINABILITY—Led by Wendy Yang (GEGC), Associate Professor of Plant Biology and Geology at Illinois, researchers provide a holistic and systems-based approach to assess the economic and ecological sustainability of CABBI feedstocks, biofuels, and bioproducts from the Feedstock Production and Conversion Themes.

"One of the best ways for our nation to strengthen our competitiveness with the rest of the world is to enhance the brilliance that already exists right here in Illinois," U.S. Sen. Tammy Duckworth, D-Ill. said. "I'm pleased that CABBI will receive this federal funding to help support groundbreaking research on clean energy, create jobs, address climate change and further secure Illinois's place as a global leader."

U.S. Secretary of Energy Jennifer M. Granholm, right, visits CABBI fields at the Illinois Energy Farm with Center Director Andrew Leakey and Vice Chancellor for Research and Innovation Susan Martinis.

Galápagos yellow warblers, unlike the ones in North America, never produce a seet call in response to cowbirds.

Galápagos warbler population does not recognize call signaling mainland threat

ANIMAL COMMUNICATION CAN BE COMPLICATED, AND the information contained in their vocalizations can range from simple to complex. For example, some animals produce calls that warn of specific dangers in the environment, and these calls can contain information about the type of threat (for example, flying vs ground predator). These are known as referential calls.

It's still not clear whether and how animals learn referential calls, though evidence suggests animals need experience with the threat being referenced in order to connect the call to it. In a new study published in *Behavioral Ecology and Sociobiology,* researchers tested this using a population of birds that has been living apart from a specific threat for 300,000 years.

In North America, yellow warblers produce referential "seet" calls which warn of nearby brown-headed cowbirds. Cowbirds are brood parasites, meaning that instead of making a nest and raising their own young, they lay their eggs in other species' nests, forcing them to care for the cowbird. When yellow warblers spot a cowbird during the breeding season, they produce seet calls to warn each other about the threat.

While this behavior is common in temperate North America, where yellow warbler and cowbird breeding overlaps, seet calls are more rarely produced by warblers in northern Canada and Alaska, where cowbirds do not breed. This suggests that experience with cowbirds may be necessary for yellow warblers to produce and respond to seet calls.

> "The warblers did not seem to recognize the cowbird threat at all. One female warbler even fell asleep on her nest while a nearby speaker played cowbird calls!"

Researchers at the University of Illinois Urbana-Champaign, along with collaborators from Western Michigan University and Australia's Flinder's University, tested this hypothesis using a yellow warbler population in the Galápagos Islands that has been breeding apart from cowbirds for over 300,000 years.

The researchers presented playbacks of cowbird calls, seet calls, and controls that were recorded in North America, along with playbacks of local Galápagos predators, to breeding pairs of warblers. They then compared the warblers' aggression and vocalizations in response to the different playbacks.

They found that Galápagos yellow warblers were more aggressive towards playbacks of a local nest predator compared to cowbird and seet call playbacks, of which responses to were comparable to the controls. This response is unlike yellow warblers in North America, which are highly aggressive towards playbacks signaling nearby cowbirds. Surprisingly, Galápagos yellow warblers never once produced a seet call in response to the playbacks.

"The warblers did not seem to recognize the cowbird threat at all. One female warbler even fell asleep on her nest while a nearby speaker played cowbird calls!" said Shelby Lawson, a postdoctoral science writer at the IGB, and first author on the paper.

The Galápagos yellow warbler split off from the mainland lineage so long ago that it begs the question of whether yellow warblers had even evolved the seet call prior to the split. The researchers say testing other yellow warbler populations with varying overlap with cowbirds could help tease apart the role of experience, and identify when the seet call evolved.

The study was supported by NSF, the Austrian Science Fund, and Illinois.

Yellow Warbler (Galápagos).

BRIEFS—*NEWS*

TEAM DEVELOPS ALL-SPECIES CORONAVIRUS TEST

The virus that causes COVID-19 in humans also infects a variety of animals. The virus also mutates in these hosts, potentially leading to new variants that can endanger their—and human—health. But most coronavirus antibody tests require specialized chemical reagents to detect host antibody responses against the virus in each species tested, impeding research across species. In a new report, published in *mSphere*, researchers say they can now detect exposure to the SARS-CoV-2 virus in any animal species.

The new coronavirus test focuses on antibodies against a protein, called the N-protein, that is embedded in the virus's nucleocapsid—a structure made up of proteins and nucleic acids contained within a viral membrane.

"The N-protein is more abundant and it is more conserved than the proteins used in most tests" said Ying Fang (CGD), a pathobiology professor at the University of Illinois Urbana-Champaign who led the study. "This makes the N-protein a good target for all-species antibody tests."

The team used an N-protein-based blocking ELISA protocol, and validated it using samples from various animals with known SARS-CoV-2 infection status. The tests had more than 97% sensitivity and, in cats at least, were able to detect infection within seven days of exposure to the virus.

The development of accurate cross-species coronavirus tests provides a useful tool for SARS-CoV-2 field surveillance in animal populations, helping scientists identify potential new animal reservoirs to prevent future disease outbreaks, Fang said.

The NIH supported this research.

$9.5M AWARD TO STUDY EMERGING PATHOGENS, BETTER UNDERSTAND INFLUENZA-ANTIBODY INTERACTIONS

Aquatic birds can carry influenza viruses, but they don't often become severely ill. Scientists are exploring how this is possible in avian immune systems, and whether their immune system be engineered to thwart transmission to other animals, including humans.

Four faculty at the University of Illinois Urbana-Champaign, plus a collaborator in Colorado, are working on this topic as part of an ambitious, three-year project funded by the Howard Hughes Medical Institute.

"We are optimistic that this initiative will help these scientists develop new, untested approaches that can reveal how pathogens work and how the human immune system responds to pathogen infection," said HHMI Vice President and Chief Scientific Officer Leslie Vosshall. "With this program, we hope to gain some of the knowledge and tools we need to get a scientific head start on future epidemics."

The group's first aim is to develop ways to purify antibody-producing cells from ducks to get a better understanding of their antibody repertoire. The researchers will extract immune cells from the blood of ducks, sequence the antibodies and characterize them, ultimately assembling a pool of key antibodies.

Next, the researchers will take observations from the sequencing work and translate them into human systems. The information obtained regarding the antibodies from ducks and human cells could be used to design the cyclic peptides against avian influenza. Ultimately, the hope is the platforms developed during these studies could be easily repurposed for targeting other emerging pathogens.

REMEMBERING CARL WOESE THROUGH THE UNDERGRADUATE RESEARCH SCHOLAR PROGRAM

The Carl R. Woese Undergraduate Research Scholar Program helps students conduct research on a full-time basis during the summer. The program is designed to inspire students to pursue important scientific questions. Importantly, the research scholars all come from different majors, but all of them are fascinated by biology. This trait reflects the journey of a founding donor to this program, Daniel Wolf, whose motivation to support the program is his personal connection with Carl Woese.

Wolf studied physics as an undergraduate and got a PhD in Zoology in 1976 following a developing interest in neurobiology. He took Woese's Molecular Genetics class as a beginning graduate student after Heinz Von Foerster, a professor of electrical engineering and biophysics, introduced the two. At the time, Wolf was a student with Von Foerster's Biological Computer Laboratory group. BCL emphasized cybernetics—a field that studies communication in animals and humans by bringing together concepts from engineering, science, and humanities. Wolf occasionally met with Woese to continue discussions that had started with that class.

In 2012, some years after last visiting with Woese at his lab, Wolf was invited to an Illinois Foundation event in California that featured a presentation about the IGB by its director, Gene Robinson. At the event, Wolf learned of Woese's illness when he met Robinson. The scholarship program idea came up after Wolf spoke with Woese a few weeks later.

"I hope the program can make a difference for someone who is interested in discovering more about the nature of evolution," said Wolf.

JAMES SHARP NEW DISTINGUISHED SENIOR ADVISOR TO IGB CORE FACILITIES

James Sharp, one of the industry's leading authorities in microscopy and former President and CEO of Carl Zeiss Microscopy, has accepted a role as a Distinguished Senior Advisor to the IGB Core Facilities.

Sharp obtained his undergraduate degree in electrical engineering before starting his long career at Carl Zeiss Inc. There, he was involved with producing the world's first electron scanning microscope, as well as installing and calibrating many of the electron and industrial light microscopy instruments currently in use today. After this he worked as head of the U.S.-based Zeiss Microscopy, where he convinced ZEISS to invest in innovative companies like Cellomics and Atto Instruments.

Sharp retired as President and CEO of Carl Zeiss Microscopy, LLC, and now serves as a ZEISS Senior Advisor. However, his enthusiasm for the sciences has never wavered, and thus he has agreed to bring his talents to Illinois and to the IGB. Sharp's ties to the institute date back to 2017, when, as President of ZEISS, he started a partnership between the company and the Core Facilities at the IGB. This prestigious partnership allowed the IGB to access state of the art microscopy instruments from ZEISS before others in the field, along with receiving valuable training from ZEISS personnel.

Now, as Distinguished Senior Advisor, Sharp will use his intricate knowledge of industry and business surrounding microscopy to help Illinois commercialize system development of microscopy applications, and enhance microscope optics and usage. He also plans to provide guest lectures to inspire students to pursue careers in the industry.

ENGINEERED YEAST USED TO INFLUENCE GUT MICROBIOME OF MICE

Microbial engineering, which changes the structure of the microbiome, or the collection of microbes the live on and inside of us, has been found to be a useful strategy for improving human health. A team of researchers hopes that their new study, published in *Microbiology Spectrum*, will provide a platform that will make mechanistic studies on the microbiome more feasible.

The study was conducted by the labs of Yong-Su Jin (BSD/CABBI/MME), a professor of bioengineering, Michael Miller (MME co-leader/IGOH), a professor of food microbiology, based at University of Illinois Urbana-Champaign, and Jungyeon Kim, a former postdoctoral researcher in Jin's lab and now assistant professor at Seoul National University.

The researchers utilized a genetically engineered strain of the yeast *Saccharomyces boulardii* as their delivery vehicle to deliver bioactive proteins into the gut. When they examined the mice fed the lysozyme-secreting yeast, they found the structure of their gut microbiome was significantly altered compared to mice fed saline or wild-type yeast. The researchers concluded that the lysozyme secretions by the yeast had indeed impacted the gut microbial community.

"My vision is to use this engineered yeast in food," said Jin. "If we create these fermented foods using engineered microorganisms designed to be helpful for the gut microbiome, we can enjoy the benefits of the engineered microorganism simply through the consumption of food."

The study was funded by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry, and Fisheries, the Ministry of Agriculture, Food, and Rural Affairs, and the USDA.

GENETIC BASIS FOUND FOR SEVERE NONALCOHOLIC FATTY LIVER DISEASE

Using a unique mouse model, researchers at the University of Illinois Urbana-Champaign found that a mutant or damaged gene may be a cause of a severe, mysterious form of nonalcoholic fatty liver disease known as NASH.

The unique mouse model captures all three hallmarks of excess fat, inflammation and scarring in the liver, opening the doors to better understanding and development of treatments for NASH. The researchers published their results in the journal *Nature Communications*.

The researchers began by studying SRSF1, a protein that assists in splicing RNA in the cell, to study its splicing activity. They bred a line of mice that were lacking the gene to learn about its splicing activity. The mice soon spontaneously developed all the symptoms of NASH.

Instead of excess fat leading to cell damage, as had been previously presumed, the cell damage came first, and fat built up as a result of the cells not being able to package up digested fats. Inflammation increased as the immune system tried to clear away dead and dying cells, and then fibrosis appeared as scars formed over patches of dead tissue to try to hold the liver together.

The researchers plan to explore whether DNA damage can worsen the condition and, if so, which other genes are involved. They hope the mice will aid other researchers studying NASH, both in terms of understanding the disease and in exploring potential treatment targets.

The NIH, the Cancer Center at Illinois, the American Cancer Society and the NSF supported this work.

HONEY BEE COLONY AGGRESSION LINKED TO GENE REGULATORY NETWORKS

In honey bees, the role a bee plays in the colony changes as they age. Younger bees perform duties inside the hive, such as nursing and wax building, while older bees transition to roles outside of the hive, either foraging for food or defending the colony.

What determines whether older bees become foragers or soldiers is unknown, but a new study published in *Nature Ecology and Evolution* explores the genetic mechanisms underlying the collective behavior of colony defense, and how these mechanisms relate to the colony's overall aggression.

"Honey bees do not have a size-based division of labor. Instead, they have an age-based division of labor, where older bees tend to be foragers or soldiers," said Ian Traniello, former graduate student at University of Illinois Urbana-Champaign, now an associate research scholar at Princeton University.

When the researchers created models of brain gene regulatory networks, which control when and where specific genes are expressed, they found that the structure of these networks differed between soldiers and foragers—and the differences were bigger when the soldiers and foragers came from a more aggressive colony.

"Colonies can become more or less aggressive by influencing the aggression level of the individuals within that colony. Basically, a forager may be more or less likely to transition to a soldier-like state if the environment calls for it," Traniello explained.

The findings highlight the importance of gene regulation to our understanding of the relationship between genes and behavior.

The project was funded by the Illinois Sociogenomics Initiative.

CABBI DEVELOPS ECO-FRIENDLY ENZYME TO CREATE KEY CHEMICAL BUILDING BLOCKS

Using energy from light to activate natural enzymes can help scientists create new-to-nature enzymatic reactions that support eco-friendly biomanufacturing—the production of fuels, plastics, and valuable chemicals from plants or other biological systems.

The study included researchers from CABBI; the Department of Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign; and Xiamen University in China. Applying this photoenzymatic approach, researchers have developed a clean, efficient way to synthesize crucial chemical building blocks known as chiral amines, solving a longstanding challenge in synthetic chemistry.

Previously, the researchers used hydroamination, a complex chemical reaction, to produce chiral amines for use in agrochemicals. The problem was that this process did not allow for good control over the nitrogen-centered radicals—key intermediates in the catalytic process. Natural enzymes, on the other hand, can generate and control radicals, allowing the team to deploy enzymes to act on specific substrates and create valuable products.

Moreover, this new photoenzymatic system demonstrates that chiral amines—precursors for other valuable molecules—can be produced from fatty acid-derived material in the lab, and thus offers a promising platform for biomanufacturing. This finding will help researchers develop efficient methods for transforming the fatty acids derived from bioenergy grasses into high-value manufacturing products.

By collaborating with researchers around the world, the CABBI team has taken a giant step toward understanding the fundamentals of this system.

The study was published in *Nature Catalysis* and was funded by the DOE.

BRIEFS—RESEARCH

ILLINOIS RESEARCHERS CREATE 3D IMAGES OF C4 PLANT CELLULAR COMPONENTS

A team from the University of Illinois Urbana-Champaign has quantified the plant cell properties in two C4 species, including cell shape, chloroplast size, and distribution of cell-to-cell connections called plasmodesmata, providing information that can change how people model photosynthesis thanks to their 3D reconstructions.

"Our motivation for this project was to provide critical missing baseline information about C4 plant cell structure," said Moonsub Lee, a postdoctoral researcher at Illinois who, along with Ryan Boyd. Boyd, also a postdoctoral reasearcher at Illinois, led this work for a research project called Renewable Oil Generated with Ultra-productive Energycane (ROGUE).

ROGUE is a research project that aims to create an abundant and sustainable supply of oil that can be used to produce biodiesel, biojet fuel, and bioproducts with support from the DOE. Much of ROGUE's work focuses on two C4 plants, energycane and miscanthus.

Published recently in *New Phytologist*, their work shows detailed structures, opening the door for more analysis than was possible with previous 2D images.

"The most exciting aspect of this work to me was the ability to visualize the plasmodesmatal interconnections among the different cell types" said Don Ort (GEGC leader/CABBI/BSD), the Robert Emerson Professor of Plant Biology and Crop Sciences at the University of Illinois.

"This work was our initial attempt at 3D quantification and visualization of C4 plant structures, said Lee. "The images we were able to observe with these microscopy techniques have facilitated new ideas and questions that we are excited to explore."

ILLINOIS STUDY REVEALS GENETIC SECRETS OF AMERICA'S FAVORITE SNACK

In its simplest form, popcorn is pretty uncomplicated. But there's more to popcorn than meets the eye. New research reveals a wealth of untapped diversity lurking in popcorn's genetic code.

Analyzing 320 publicly available popcorn lines, crop sciences researchers found variation at more than 308,000 locations across the genome. The team documented the genetic differences in a process known as genotyping by sequencing, which narrows the focus of genetic sequencing efforts to the most information-packed parts of the genome.

According to the analysis, North American popcorns fall into two groups: Yellow pearl types and Latin American types. The results showed a high level of inbreeding among yellow pearl popcorns. Although this has resulted in better popping traits, material from the other group will likely contain versions of genes that could be useful but are not present in the yellow pearl popcorns.

With popcorn's genetic code spelled out, the researchers were eager to tackle a longstanding mystery related to herbicide application labels. Nicosulfuron has been killing weeds in cornfields since the early 1990s, but it's only labeled for yellow-kerneled hybrids; farmers are specifically warned against using it on white-kerneled popcorn.

While nicosulfuron did injure more white-kerneled popcorns, the effect had nothing to do with kernel color itself. Instead, nicosulfuron sensitivity correlated with genetic heritage and population structure, with the pointed and Latin American types being more sensitive than yellow pearls.

The study was published in *Crop Science* and received funding from the University of Illinois Urbana-Champaign and the Illinois Corn Growers Association.

MICROELECTRONICS GIVE RESEARCHERS A REMOTE CONTROL FOR BIOLOGICAL ROBOTS

First, they walked. Then, they saw the light. Now, miniature biological robots have gained a new trick: remote control.

The hybrid "eBiobots" are the first to combine soft materials, living muscle and microelectronics, said researchers at the University of Illinois Urbana-Champaign, Northwestern University and collaborating institutions. They described their centimeter-scale biological machines in the journal *Science Robotics*.

Rashid Bashir (CGD/M-CELS), an Illinois professor of bioengineering and Dean of the Grainger College of Engineering, and his group has pioneered the development of biobots, small biological robots powered by mouse muscle tissue grown on a 3D-printed polymer skeleton.

Though the team has presented biobot models in the past, the newest model integrates tiny wireless microelectronics and battery-free micro-LEDs. This allows the researchers to remotely control the eBiobots by sending a wireless signal that prompts the LEDs to pulse. The LEDs stimulate the light-sensitive engineered muscle to contract, moving the polymer legs so that the machine "walks." The micro-LEDs can activate specific portions of muscle, making the eBiobot turn in a desired direction. The researchers also used computational modeling to optimize the eBiobot design for robustness, speed and maneuverability.

"In developing a first-ever hybrid bioelectronic robot, we are opening the door for a new paradigm of applications for health care innovation, such as in-situ biopsies and analysis, minimum invasive surgery or even cancer detection within the human body," said co-first author Zhengwei Li, an assistant professor of biomedical engineering at the University of Houston.

The NSF and the NIH supported this work.

LONG RECEIVES HONORARY DOCTORATE FROM UNIVERSITY OF ESSEX

The founding plant scientist at the University of Essex, Steve Long (BSD/CABBI/GEGC) returned to Colchester to receive an honorary doctoral degree. Long joined the Department of Biology, now the School of Biological Sciences, at Essex as a lecturer in 1975.

During his time at Essex, Long identified the most productive plant on Earth and conducted one of the first two field trials in the world of Miscanthus, a plant currently being used as an alternative energy and fuel source. He established *Global Change Biology*, the most highly cited journal on climate change; and began developing mathematical models of photosynthesis, among many other achievements. Because of these contributions at Essex, he was elected a Fellow of the Royal Society of London in 2013.

In 1999 he joined the University of Illinois Urbana-Champaign where he now holds the Ikenberry Endowed Chair of Crop Sciences and Plant Biology. At Illinois, Long has led the establishment of three major research programs with funding totaling more than half a billion dollars; he has established two more international plant science journals; and become one of the most highly cited scientists in the world. Additionally, Steve has mentored over 40 PhD students and 20 postdoctoral researchers.

During Long's commitment address he stated:

"Think big. Be fearless. If you're committed, there is nothing you cannot achieve. You will be spending most of your life working, so take time to find what you're passionate about and do it. Collaborate, because the whole is always greater than the sum, and have fun doing it."

CAR-T IMMUNE THERAPY ATTACKS OVARIAN CANCER IN MICE WITH A SINGLE DOSE

CAR-T immune therapies could be effective against solid tumors if the right targets are identified, a new study led by University of Illinois Urbana-Champaign researchers suggests. The researchers successfully deployed CAR-T in a mouse model of ovarian cancer, a type of aggressive, solid-tumor cancer that has eluded such therapies until now.

T cells are the white blood cells in the immune system that recognize and attack specific foreign invaders to the body. CAR-T therapies use special molecular receptors, called chimeric antigen receptors, that bind to cancer biomarkers. These CARs help a patient's own T cells target the cancer in their body as though it were an outside invader.

While such therapies are effective against blood cancers such as leukemia and lymphoma, cancers that produce solid tumors have remained difficult to treat with CAR-T immune therapies.

In the new study, published in the *Journal of ImmunoTherapy for Cancer,* the researchers focused on a carbohydrate found on the surface of solid tumor cells, but not healthy cells. They developed CAR molecules with varying affinity for the molecule and tested them first in ovarian cancer cell cultures, and then in live mice with ovarian cancer tumors.

They found that the receptors with the highest affinity for the carbohydrate were highly effective at helping T cells find and destroy the cancer, shrinking or eliminating tumors after just one intravenous dose – and continuing to work more than a year after the initial dose, extending the lives of the mice.

The NIH supported this work.

NEW DRUG DELIVERY METHOD CAN REVERSE SENESCENCE OF STEM CELLS

As we age, our bodies change and degenerate over time in a process called senescence. Stem cells also experience senescence, which presents an issue when trying to maintain cell cultures for therapeutic use. Once the cells enter a senescent state, they stop producing them, and worse, they instead produce biomolecules antagonistic to these therapeutics.

A study by the labs of Hyunjoon Kong (M-CELS leader/EIRH/RBTE), a professor of chemical and biomolecular engineering, and Hee-Sun Han (GNDP/IGOH), an assistant professor of chemistry, describes a new method of delivering antioxidants to stem cells that is reliable, and long-lasting. By utilizing antioxidants in the form of polymer-stabilized crystals, they can pull the cells out of their senescent state and make them behave like a healthy stem cell.

According to Ryan Miller, a postdoctoral fellow in the Kong lab, the method could be used for patient-derived stem cell treatments, where the biomolecules from a patient's own body are used to help with various tissue ailments.

"I think the beauty here is that this is a technology development paper, so this can be applied to various hydrophilic drugs, disease models, and methods applications," said Han. "We're showing that we can maintain a sustained release of this drug at a relatively constant rate for an extended period of time. There are a lot of exciting studies and directions that we can go with this technology."

The study is published in *Advanced Functional Materials* and was supported by NSF, National Research Foundation, Alzheimer Association, and the NIH.

NEW AI METHOD CAN PREDICT METABOLOMIC PROFILES OF MICROBIAL COMMUNITIES

Human bodies contain trillions of microbes that help shape many of our biological functions. For example, microbes in the gut break down food into small molecules called metabolites, many of which are important for human health. Measuring the concentrations of metabolites produced by those microbes, a process called metabolomics, however, is difficult and expensive.

In a new study published in *Nature Machine Intelligence*, researchers have developed a machine learning algorithm called Metabolomic profile predictor using Neural Ordinary Differential Equations, or mNODE, which can predict metabolite concentrations based on the species composition of the microbial community.

The study was conducted by Yang-Yu Liu (CAIM), an associate professor of medicine at Harvard Medical School, Tong Wang, a postdoctoral researcher in Liu's lab, and Sergei Maslov (CAIM co-leader/CABBI), a professor of bioengineering and physics. The microbe-metabolite interactions inferred from mNODE were confirmed by comparing them to the results from metabolomics experiments and genomic evidence.

The researchers say mNODE can not only use microbial composition to predict metabolomic profiles, but it can also incorporate some dietary information to enhance the accuracy of its predictions. Although it needs more development, mNODE could be a great tool towards personalized nutrition in healthcare.

"This is one of those early success story projects that exemplifies the type of modern science projects that the Center for Artificial Intelligence and Modeling was created for," Maslov declared. "We believe all three elements are necessary for really successful, modern, and interpretable projects."

The published study was supported by the NIH.

PROBE CAN MEASURE BOTH CELL STIFFNESS AND TRACTION, RESEARCHERS REPORT

Scientists have developed a tiny mechanical probe that can measure the inherent stiffness of cells and tissues as well as the internal forces the cells generate and exert on one another. They detail their findings in the journal *Science Robotics*.

"Living cells generate forces and it's very hard to measure these forces," said Ning Wang (RBTE), a professor of mechanical science and engineering. "Most probes can either measure the stiffness or the internal forces – but not both."

To measure cell stiffness, researchers need a rigid probe to quantify how robustly the tissues resist. But to measure the cells' own internally generated contractions or expansions, a probe must be soft and supple.

To tackle this challenge, Wang and graduate student Erfan Mohagheghian looked for ways to alter the mechanical characteristics of a probe. They developed a precise method for embedding a magnetic "microcross" into a rigid polyethylene glycol hydrogel.

In a series of experiments, the researchers injected their probes into 3D lab-grown tumor masses and into zebrafish embryos. The scientists were able to measure both tissue stiffness and the forces generated by the cells within the tissues.

The probes revealed for the first time that while malignant tumors may become stiffer in response to surrounding tissues, the cancer cells do not. The probes also captured the push and pull of cells during embryonic development, which could offer new insight into how animals develop from single cells into complex tissues.

The NIH, NSF, and the National Natural Science Foundation of China supported this research.

BRIEFS—RESEARCH

RESEARCHERS DESIGN COURSE ON TICK-BORNE DISEASES FOR ILLINOIS PRACTITIONERS

Anyone who enjoys taking walks through the woods or grassy fields when the weather is warm knows that checking for ticks afterward is a must. Ticks can spread numerous diseases to humans as well as to our pets, and some of these diseases can be life-threatening. However, getting a tick-borne disease tested and confirmed by physicians can often be tricky.

In a recent survey-based study, a team led by Rebecca Smith (IGOH), a professor of epidemiology at the University of Illinois Urbana-Champaign, explored how knowledgeable doctors in Illinois are regarding ticks and tick-borne diseases.

The researchers found that while physicians were relatively knowledgeable about diagnosis and treatment of Lyme disease, they did not know much about other diseases. Practitioners were least knowledgeable about Alpha-Gal syndrome, which Smith says is concerning given how abundant Lonestar ticks have become in Southern Illinois. The researchers found only one factor that influenced how knowledgeable participants were about TBDs, and that was how recently they had completed training on the topic, if ever at all.

In response to the troubling findings, Smith's team is designing a continuing education course that will inform practitioners on current ranges of ticks and risk of disease, as well as practices they can implement into their care to increase prevention of TBDs.

This study was supported by the Centers for Disease Control and Prevention as part of the Midwest Center of Excellence in Vector-borne Disease, and is published in *One Health*.

RESEARCHERS DISCOVER NEW CLASS OF RIBOSOMAL PEPTIDE WITH HEMOLYTIC ACTIVITY

Microbes have become the main source for natural products, including a growing family called ribosomally synthesized and post-translationally modified peptides, or RiPPs. The labs of Douglas Mitchell (MMG), John and Margaret Witt Professor of Chemistry, and Huimin Zhao (BSD leader/CABBI/CGD/MMG), Steven L. Miller Chair of Chemical and Biomolecular Engineering, have been working in tandem to identify and analyze new RiPPs that could be good candidates for drug development and therapeutics.

In a new paper co-first authors Shravan Dommaraju, a PhD student in Mitchell's lab and Hengqian Ren, a postdoctoral researcher in Zhao's lab, have reported the discovery of a unique, novel class of RiPPs, named "daptides." Unlike most peptides which have one positively charged and one negatively charged end, daptides have two positively charged ends.

The researchers explained that while this change in termini may seem small, it gives daptides the potential to interact with negatively charged objects, such as cell membranes. To test this, the team added the daptides to a dish with red blood cells. They found that the daptides showed disrupted the membranes of the cells, causing them to rupture.

The researchers say the next steps are understanding the enzyme functions of the daptides and exploring potential therapeutic uses for daptides.

"There is such a large frontier right now of undiscovered RiPP classes, and it's exciting to be at the cutting edge, discovering new possibilities," said Ren.

The paper is published in *Nature Communications* and was funded by the NIAID and the NIGMS.

RESEARCHERS REVEAL REAL-TIME GLIMPSE INTO GROWTH HABITS OF NANOPARTICLES

For the first time, researchers have observed the process of nanoparticles self-assembling and crystalizing into solid materials. In new videos produced by the team, particles can be seen raining down, tumbling along stairsteps and sliding around before finally snapping into place to form a crystal's signature stacked layers.

Published in the journal *Nature Nanotechnology,* the study was led by Qian Chen (M-CELS), a materials science and engineering professor at the University of Illinois Urbana-Champaign, and Erik Lutijen, materials science and engineering professor at Northwestern University.

In the new study, researchers used differently shaped nanoparticles—cubes, spheres and indented cubes—to explore how shape affects behavior. In experiments by Illinois graduate students Binbin Luo, Chang Liu, Ahyoung Kim and Zihao Ou, the particles collided, sticking together to form layers. The particles formed a horizontal layer and then stacked vertically to form the layer-by-layer crystalline structure. Sometimes, after sticking to each other, the particles briefly detached to fall onto a layer below. They further visualized crystal formation with advanced computer simulations, verifying the universal trend of distinctive assembly structures from different-sized particles.

Luijten said this information will help engineers design new materials. The insight could help design thin-film materials used to build flexible electronics, light-emitting diodes, transistors and solar cells.

"Knowing how particles come together will enable us to control the shape of a surface," Luijten said. "Do you want a flat or rough surface? Changing particle shape or how fast the particles fall can affect the surface."

The DOE and the NSF supported the research.

RESEARCHERS TRACK ANTIMICROBIAL RESISTANCE IN E. COLI ISOLATED FROM SWINE

The spread of drug-resistant microbes has become a global health concern that threatens our ability to treat infections. The widespread use of antimicrobials in livestock, such as swine farms, exacerbates this problem. Therefore, we need surveillance systems to monitor these microbes to support the public health authorities. To this end, researchers have tracked the antimicrobial resistance of *Escherichia coli* isolated from swine.

The researchers focused on *E. coli* since these bacteria are ubiquitous in the intestinal tract of humans and pigs, and they are good indicators to test whether meat and meat products have been contaminated. *E. coli* can also acquire and transfer resistance genes to other bacteria in the intestinal tract, making them ideal for monitoring programs of livestock and humans. The study used publicly available surveillance data from 2013 to 2019 of cecal samples, which were collected from the intestine after slaughter.

Using different statistical methods, the researchers found that since 2013, the number of antimicrobials to which *E. coli* is resistant has either remained steady or increased over the years. In particular, the resistance to ceftriaxone, an important antimicrobial drug in both human and veterinary medicine, increased from 0.8% in 2013 to 7.7% in 2019. Even though these numbers are not high compared to the resistance to other antimicrobials, the increasing trend is concerning.

"By gathering this data, we hope that the public health authorities will be able to develop mitigation strategies." said Csaba Varga (IGOH), an assistant professor of epidemiology.

The study was published in *Microorganisms.*

BRIEFS—RESEARCH

TWO NOVEL EFFECTS PAIRED FOR SUPERIOR BIOMARKER DETECTION METHOD

Researchers from the lab of Brian Cunningham (CGD leader), Intel Alumni Endowed Chair of the Department of Electrical and Computer Engineering, in collaboration with researchers at Washington University, have demonstrated a new capability to detect and count individual biomolecules at low concentrations. This technology may significantly improve the efficacy of current cancer detection and measurement methods.

Biomarkers play a significant role in diagnostics because their presence and quantity correlate to the presence of diseases like cancer. Low signal-to-noise ratios hamper current biomarker detection technology, posing a threat to cancer diagnostics, especially for patients whose cancer therapies can cause a reduction of detectable biomarker quantities in their system.

Cunningham's team successfully met their goal, achieving an unprecedented ultrasensitive detection limit for protein biomarkers as low as 100 femtograms (fg) per milliliter (ml) (a femtogram is 10^{-15} grams).

"This kind of detection limit is not achievable with other technologies, except for one other that uses a complex procedure and expensive instrumentation that isn't viable for point-of-care cancer diagnostics," said Cunningham. "The ability to go down to concentrations this low provides us with more information for early cancer detection and also for seeing the effects of cancer therapy on protein biomarkers that otherwise wouldn't be known."

Now that the team has demonstrated the principle of this new method, they will seek clinical collaborators who will pilot this technology's capability for biomarker detection at small concentrations.

The study was published in *Small* and supported by the NSF, NIH, and Cancer Center at Illinois.

RESEARCHERS MAKE RECOMMENDATIONS FOR DIVERSIFYING SYLLABI IN HIGHER EDUCATION

Over the past decade, there has been a growing awareness that environmental and life science fields need to diversify their teaching syllabi. Through this paper, the researchers wanted to set up a structure that would help them systematically go through different types of resources and figure out if they meet the aims of diversifying syllabi.

"In general, syllabi can benefit from having more considered curricula. Especially in genetics, data accountability, data sovereignty, health implications for data analysis, and the ethical, legal and social implications of your data should be fundamental aspects of the syllabi," said Alida de Flamingh, a postdoctoral researcher at the University of Illinois Urbana-Champaign.

Broadly, there are three steps that the instructors need to follow to amend their syllabi. First, they should choose content that not only highlights BIPOC historical figures, but discusses the challenges they face, and provides a critical assessment of scientists by discussing their contributions to a field without ignoring their problematic views on race. Second, the educators should discuss their lesson plans with their network to identify problematic areas. Finally, they can share their work with other faculty through online repositories.

"Work that involves challenging paradigms can be very uncomfortable. However, allowing students to ask questions and being able to answer them will help everyone understand the issues better," said Tolulope Perrin-Stowe, a postdoctoral research associate in virology at the University of Wisconsin-Madison. "Even though it is the toughest part, it is where the most important work is done."

Published in *Ecology and Evolution*.

STUDY MODELS THE CAUSES OF INSOMNIA IN MENOPAUSAL WOMEN

One of the most common symptoms that women experience during menopause is sleep disruption, which is thought to be associated with depression, hot flashes, and fluctuating hormone levels. In a new study, researchers have modeled what factors influence sleep in menopausal women.

The researchers used data from the Midlife Women's Health Study. Over 700 women participated in the four-year study.

In the initial clinic visits women completed questionnaires regarding their medical history and they submitted blood and urine samples. For the next three years they continued to do so when they returned to the clinic once a year. The researchers then modeled the most likely reason for self-reported insomnia in midlife women.

Surprisingly, they did not find that hormone levels predict sleep disruption. However, women who have hot flashes at night also have insomnia. Additionally, women who had insomnia in the fourth year of the study also had it in the first year, indicating that the symptoms don't necessarily go away over the course of menopause.

The researchers would like to understand if there are lifestyle factors, such as high cholesterol, that can predict insomnia in menopausal women. If so, exercise and diet could go a long way to help. They are also interested in learning the extent to which exposure to environmental chemicals leads to sleep disruption.

The study was published in *Journal of Women's Health* and was supported by the NIH, the Interdisciplinary Environmental Toxicology Program and the Carle Foundation Hospital Seed Grant.

TEAM USES MRI TO IMAGE EPIGENETICS IN THE BRAIN

Epigenetics is a key mechanism by which gene expression is regulated. A new approach—called epigenetic MRI—will open up new avenues of research into how such changes mold the brain, according to a new study reported in the *Proceedings of the National Academy of Sciences*.

DNA methylation is one mechanism that cells use to regulate which genes are actively expressed, said King Li, a professor emeritus in the Carle Illinois College of Medicine who led the research with bioengineering professor Fan Lam (GNDP) and IGB Director and entomology professor Gene Robinson (GNDP).

Scientists have been unable to precisely capture the molecular changes that take place in the living brain over time. For the new approach, the team realized that an essential amino acid, methionine, could carry an atomic marker known as carbon-13 into the brain, where it could donate the carbon-13-labeled methyl group needed for DNA methylation.

The team first tried the method in rodents, then switched to working in piglets, whose larger brains are more like human brains. For this, they relied on the expertise of co-author Ryan Dilger (GNDP), a professor of animal sciences. The researchers found that in piglets the MRI could detect an increasing signal from carbon-13-labeled methyl groups in the brain.

"We now expect to apply this technique in humans, with and without neurodegenerative diseases. Getting this label into the brain is easy and does no harm to the body. We'll give it to people through the diet and then we can detect the signal," Li said.

TEAM STREAMLINES DNA COLLECTION, ANALYSIS FOR ELEPHANT CONSERVATION

A new DNA-collection approach allows scientists to capture genetic information from elephants without disturbing the animals or putting their own safety in jeopardy. The protocol yielded enough DNA to sequence whole genomes not only of the elephants but also of the associated microbes, plants, parasites and other organisms—at a fraction of the cost of current approaches.

The researchers report their findings in the journal *Frontiers in Genetics*.

"We combined existing methodologies in such a way that we are now able to use noninvasive samples to generate genome-scale data," said Alida de Flamingh, a postdoctoral researcher who led the work with animal sciences professor Alfred Roca (EIRH/GNDP). "This allows us to assess wildlife populations without having to dart, capture or immobilize animals."

De Flamingh used postcard-sized data-collection cards that have been treated to prevent the samples from degrading. Previous research has shown that once samples are smeared on the cards, they can be stored for months without refrigeration. The researchers tested their approach on samples collected from wild African savanna elephants. By running the sequence data obtained from the cards through genomic databases, the team found a treasure trove of information in the dung.

"You can explore the connectivity of different elephant populations, the level of genetic diversity, and the level of inbreeding and relatedness among elephants," Roca said.

The International Fund for Animal Welfare, the Conservation Ecology Research Unit of the University of Pretoria, and the U.S. Fish and Wildlife Service African Elephant Conservation Fund supported this research.

TEAM IDENTIFIES KEY DRIVER OF CANCER CELL DEATH PATHWAY

Scientists have identified a protein that plays a critical role in the action of several emerging cancer therapies. The researchers say the discovery will likely aid efforts to fine-tune the use of immunotherapies against several challenging cancers. They report their findings in the journal *Cancer Research*.

"Most anticancer drugs cause cancer cells to shrivel up and die in a controlled process known as apoptosis. But apoptosis does not usually strongly activate immune cells," said David Shapiro, a professor of biochemistry who led the research with former graduate student Santanu Ghosh. "Instead, a few emerging cancer therapies cause cancer cells to swell up and burst. The protein we identified, a sodium-ion channel known as TRPM4, is critical for cancer therapies that promote this type of cell death, called necrosis."

TRPM4 is the first protein mediator of anticancer therapy-induced necrosis to be described. By targeting the TRPM4 pathway in solid tumors, scientists may further enhance the necrosis-inducing anticancer therapies available to fight such tumors, he said.

"We found that the cancer drug ErSO acts like the starter on a car that turns over the engine and then is no longer needed once the engine is running," Ghosh said. "It is the swelling caused by TRPM4 that drives the lethal stress that kills the cancer cells. Even a one-hour exposure to ErSO effectively killed cancer cells days later."

The NIH, the Cancer Center at Illinois, the DoD Breast Cancer Research Program, the Susan Komen Foundation and the Breast Cancer Research Foundation supported this research.

BRIEFS—OUTREACH

NANOTECHNOLOGY-THEMED FORUM WEEK HAS MIDDLE SCHOOLERS EXPLORING QUESTIONS

In an effort to expose young girls to different career opportunities, Campus Middle School for Girls has been running an event called "Forum Week" since the school's establishment in 1994. The event is organized by Tami Adams, the current director of the middle school.

This year's topic was nanotechnology, which is the manipulation of atomic-sized objects in order to create new technologies. Faculty, postdocs, and graduate students from the University of Illinois Urbana-Champaign led various activities to demonstrate different uses and techniques in nanotechnology. The students also spent one day visiting the Illinois campus.

When asked about their campus visit during Forum Week, the students enthusiastically described their favorite activities: "One of my favorite things was putting together a Lego police car while wearing oven mitts! It showed it's hard to work with little things if you don't have the right tools," said one student.

"It was cool to learn how they measure things that are super small," said Abby. "And getting to interact with things like that [points to the atomic force microscope replica] helped me visualize it." When asked if she would now consider doing science like this in the future, Abby said "Yes, it's pretty cool."

"We really want to help students develop their sense of self and recognize their place as a global citizen," said Adams. "It's all about exposure, taking them outside their little bubble and showing them the bigger picture, how they can make an impact in the bigger world."

GENOMICS FOR FAITH CONNECTS SCIENTISTS AND FAITH MEMBERS IN THE COMMUNITY

Scientific advancements, particularly in the area of genomics research, continue to penetrate nearly all areas of society. Yet most of the public do not have access to the tools necessary to understand how this new research may affect both their lives and careers. Genomics for Professionals was developed as a series of educational programs designed to teach basic concepts in biology and genomics to professionals within different public sectors.

A new program debuted in May at the Channing-Murray Foundation, where scientists, faith leaders, and faith-holding members of the community gathered for a discussion regarding 'what is life?', 'what does it mean to be alive?', and ultimately, 'what is death?'. Participants were able to ask questions to a panel of three community members with diverse experiences.

After a short presentation on the science, the floor was opened for discussion on the meaning of life and death. The panel and audience members shared unique perspectives on the topic, which stemmed from various experiences, faiths, and backgrounds in science. Conversations arose regarding how one's view of what life means to them shapes where they draw the line of when life ends.

The event's organizers say the goal of Genomics for Faith is to provide a safe space to have discussions where personal beliefs and scientific information intersect.

Currently, the IGB is planning future Genomics for Faith sessions to branch into other topics of interest that lean more heavily into genomics research, such as the role of stem cells in health, and genome editing techniques.

NEW OLLI WORKSHOP FOCUSES ON GENOMICS

The Osher Lifelong Learning Institute has been partnering with the IGB and the Beckman Institute for Advanced Science and Technology since 2009. OLLI will be partnering with Illinois researchers to introduce a new workshop "What's in my blood? Genomics Testing and You."

Genomics-based tests are increasingly becoming a part of our lives, including detecting COVID-19 in our saliva and helping us discover our ancestry. The workshop series will describe how the information in our genomes is decoded and used by technologies to detect specific genes in body fluids, foods, and crime scenes.

"We work on state-of-the-art technologies and the participants represent the seniors in our community, who are very intelligent. Although they might not necessarily be scientists or engineers, they are curious about these things," said Brian Cunningham (CGD leader), the Intel Alumni Endowed Chair of Electrical and Computer Engineering.

"As a professor, communicating science to different audiences is always interesting," said Yang Zhao (CGD), an assistant professor of electrical and computer engineering. "Although I have done outreach events with other age groups, I have never tried it with the senior citizens. I know the audience is very bright and inquisitive, so I am looking forward to it."

In addition to Cunningham and Zhao, Andrew Smith (CGD), a professor of bioengineering; Xing Wang (RBTE), a research associate professor of chemistry; and Hong Jin (CGD), an associate professor of biochemistry and a professor of biophysics and quantitative biology, will also be leading the lectures.

STEAM TRAIN PULLS INTO THE STATION FOR ANOTHER SUCCESSFUL YEAR

An engineered bazooka designed to launch candy, a 3D-printed novel board game, an ecological experiment with fish, and a magnetically powered trebuchet. These projects are the curiosity-driven creations of middle schoolers as part of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) TRAIN (Transdisciplinary Research Across Institutional Near-peers) program, which completed its third successful year.

STEAM TRAIN, which partners the University of Illinois Urbana-Champaign with the Champaign Franklin STEAM Academy, is organized by the IGB's Senior Outreach Activities Coordinator Daniel Urban, Franklin's Magnet Site Coordinator Zanne Newman, and University Laboratory High School's teacher Melinda Tidrick, and is funded by the University of Illinois' Community Research Partnership Program.

The program encourages independent, student-inspired research by allowing middle school students to dream up any kind of science or engineering project they want. Mentors in the program then help guide the design of the project and provide the necessary tools to make the idea feasible and achievable.

This year, four groups of students met weekly after school to work on their research projects from September 2022 till May 2023. During these meetings, they received mentoring from researchers at the IGB, along with high school students from Uni High.

At the end of the semester, the teams gathered to show off their final creations or research findings, complete with impressive slideshow presentations with data and graphs to match. Some project presentations even rivaled the caliber and level of design that might be expected of college students.

BRIEFS—OUTREACH

Campers and staff from the 2023 Pollen Power camp pose in front of the IGB.

Pollen Power camp inspires new generation of budding young scientists

Everyone knows about space camp, but have you heard of plant camp? Pollen Power summer camp, hosted by the IGB, offers local middle schoolers a unique experience filled with plant science-based summer fun. Throughout the week, campers participate in a variety of activities aimed at teaching them not only about plants and pollinators, but also about working in a team, communication, and how to look at the world through the eyes of a scientist.

"At Pollen Power, students take something they consider an "ordinary everyday thing" in nature and learn to see it in a new light," said Sarah Choi, the IGB's Outreach and Education Coordinator and lead organizer of Pollen Power camp. "They start to appreciate the plants and pollinators around them. And through our activities and experiments they leave feeling like scientists, with more curiosity about the world around them." The camp is funded by CABBI and the Champaign Unit 4 School District. This is the first Pollen Power held in-person at the IGB since the COVID-19 pandemic.

Campers participated in many different experiments and learning activities throughout the week led by members of the IGB and CABBI, and were given tours of the state-of-the-art campus labs and facilities. Under the mentorship of staff member from Franklin STEAM Academy, campers also designed week-long experiments to test the growth rate of cress seeds under various conditions and presented the results at the end of the week.

PROFILES—COLBY BEHRENS

Growing up on a dairy farm in northeast Iowa, Colby Behrens, a current PhD candidate in the Evolution, Ecology, and Behavior department, says he learned early on the importance of understanding the behavioral cues of animals.

"If you're going to be around cattle, you have to know when it's safe to stand behind them or if they're ok with people approaching them, otherwise they will kick and wreck you," described Behrens. "I became very interested in behavior when learning about our farm animals and how to interact with them properly."

Behrens attended Iowa State and obtained his bachelor's in biology, with the goal of working with animals in a zoo when he finished. However, after a summer internship at the Omaha Zoo during college, he decided it wasn't exactly what he wanted.

Though he was involved in many projects at Iowa State with a variety of animals, he became inspired by a project he conducted on paper wasps. The project involved studying the wasps' personalities at the individual level, and examining how genomics influenced their behaviors. This experience drove Behrens to apply to the graduate program at the University of Illinois Urbana-Champaign with Alison Bell (GNDP leader), a professor of evolution, ecology, and behavior, who specializes in studying the mechanisms of personality and behavioral differences among stickleback fish.

Behrens' doctoral research looks specifically at two different populations of *Gasterosteus aculeatus*, the three-spined stickleback: the common morph and white morph. These two populations are genetically very similar, and often overlap in the habitats they preside in, but they display drastically different parental behavior.

Behrens says these differences make stickleback fish an excellent system to test the interplay between genomics and behavior. The two populations of fish can also interbreed in the lab, which allows Behrens to see how changes in parental care across generations changes with the mixing of genotypes from the two species. When the species are bred together, the offspring of that pairing display everything across the spectrum of parental care.

In his free time Behrens enjoys reading classic books. "There's this quote from Oscar Wilde's 'The Picture of Dorian Gray' that I really like, that goes 'Nowadays most people die of a sort of creeping common sense, and discover when it is too late that the only things one never regrets are one's mistakes,'" said Behrens. "Basically, if you want to live a good life you have to take some risks every now and then and be willing to make mistakes."

Over the past few years, universities have come to recognize the importance of diversity, equity, and inclusion in their academic environments. Although most measures aim at increasing the representation of populations who have been long overlooked because of race, ethnicity, nationality, gender, or sexual identity, few have considered the effects of poverty. Long hours and low pay is enough to turn anyone off from such jobs, and yet, Joseph Fernandez persevered.

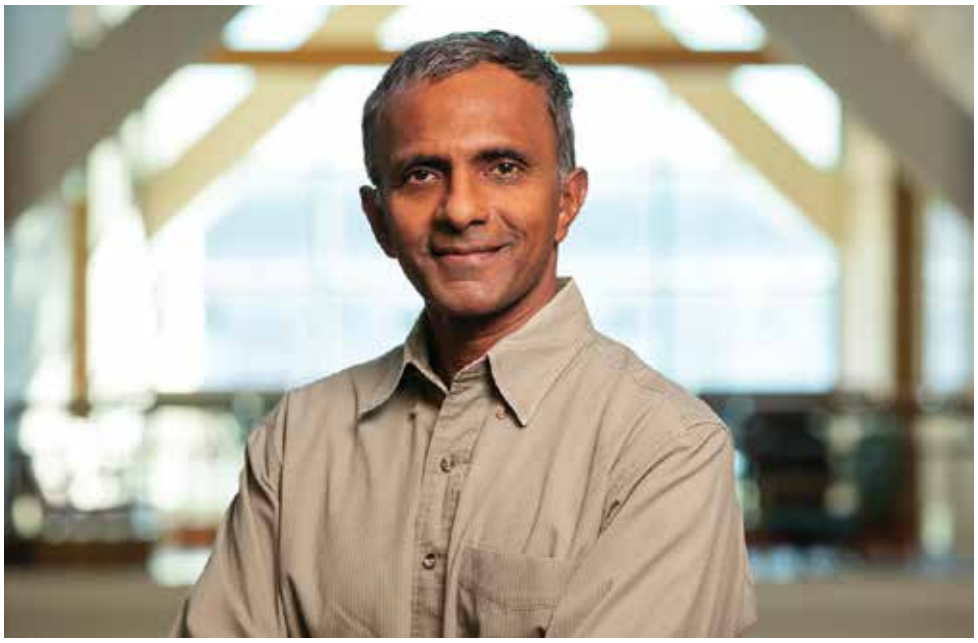
Growing up in Bangor, Maine, Fernandez was always interested in science. "Even as a little kid, I dreamt of becoming a scientist," he said. "I would read magazine articles or read all the chapters in the book during science class. I wanted to help make the world a better place."

Although he was initially interested in going into medicine, Fernandez decided to pursue a PhD degree. After completing his undergraduate degree in neuroscience at Yale, he enrolled in the graduate program for biomedical engineering at Purdue University. There he focused on central auditory processing disorders, in which the ears and the brain do not work well together, following traumatic brain injury.

It was during his PhD program that Fernandez first encountered the financial challenges that PhD students can encounter. "I come from a poor family and my whole PhD experience was painful because of the financial stress," Fernandez said. Ultimately, Fernandez was able to graduate and now he tries to advocate for other financially disadvantaged students.

Fernandez is currently a postdoctoral researcher in the labs of Cari Vanderpool (MME co-leader/IGOH), a professor of microbiology, and Katy Heath (IGOH), a professor of plant biology. He studies the symbiotic interactions between beans and their microbe partners, which supply nitrogen to their plant host. "I compare the RNA expression levels in the bacteria under different conditions, for example in the presence of high nitrogen concentrations," Fernandez said.

When he's not working on plants in the lab, Fernandez spends time working on his garden. As a member of 4-H, a US-based network of youth organizations, Fernandez learned how to cultivate a garden when he was a child. "If we had the apocalypse right now, you would want me on your team because I have learned so many skills from them," Fernandez said. "I love gardening because experiencing the beauty of nature is the closest I have gotten to spirituality. I also like cooking with food from my garden; a good summer day is when I make a fresh pico de gallo from my garden tomatoes."



Often scientists are portrayed as single-minded in their love for a particular research topic. Their childhood interest in chemistry, for example, ultimately translates to a PhD in chemistry, a postdoctoral position in a chemistry lab, and finally a faculty position in a chemistry department. However, there are several researchers who sample a range of disciplines before settling on one. Sometimes it can take one or two years, or, in the case of Joseph Irudayaraj (CGD/EIRH), it can take more than a decade.

Growing up in Coimbatore, a city in South India, Irudayaraj was interested in coming to the U.S. to pursue a career in science. After completing a Master's degree in biosystems engineering as well as in information and computer sciences at the University of Hawaii, Honolulu, Irudayaraj joined Purdue University, Indiana, for his PhD. There he focused on developing computational models to understand the viscoelastic behavior of biomaterials under hydrothermal stress. Concurrently, he also focused on his love for biology.

After holding faculty positions at Purdue, Pennsylvania State University, and Utah State University, he joined the University of Illinois in 2017. "Given my broad interests, it took several years for my research to come together," he said. "It's like visiting an island in an archipelago. You gradually go from one island to the next as you discover more things."

Currently, his group works on two main themes: treating medical conditions using nanoparticles as drug delivery systems and studying the environmental effects of cancer. "We are working very closely with the IGB for the second project. Our goal is to establish a center on environmental toxicology that will bring together over 20 faculty from across the campus and outside Illinois," Irudayaraj said.

Although his lab thrives on cross-campus collaborations, Irudayaraj recognizes how difficult it can be to find the right people especially when you want to develop large grants. "The biggest challenge I've faced is finding the right connections. Sometimes collaborations can be spontaneous, but after a while it withers away. You want sustained collaborations for long-term research, which can be difficult if your work does not get funded within a short timeframe," Irudayaraj said. "During such challenging times, teams need to stick together and weather the storms so we can reach the calm afterwards."

Despite all his research accomplishments, Irudayaraj takes the most pride in his students. "I am proud of all my students who have gone on to do great things. Hearing back from my students is always a highlight," he said.

Growing up in South India, Ratna Karatgi found herself moving between cities as her dad relocated for work. Though living in the city meant she was not exposed much to wildlife, she quickly became interested in zoology after working as a volunteer at the Madras Crocodile Bank Trust, an educational outreach-focused reptile zoo. There, she says that presentations and experiments by visiting researchers lit the spark for her.

"Researchers from everywhere would visit the zoo and talk about their work, and I thought it was fascinating that people could study animal behavior for a living," Karatgi said.

Following this path, she obtained a bachelor's degree in Zoology from Stella Maris College before attending Jawaharlal Nehru Centre for Advanced Scientific Research to complete her masters in evolutionary biology. Afterwards, Karatgi took up a job as a research assistant in a lab at the Indian Institute of Science in Bangalore.

After cold-emailing faculty in the US about taking her on as a PhD student, she says Rebecca Fuller (GNDP), a professor of ecology, evolution, and behavior at the University of Illinois Urbana-Champaign, was eager to have her join the team.

Currently, Karatgi is a 5th year PhD candidate, studying how variation in killifish coloration is maintained across populations. Killifish are small fish that vary in their coloration, which are used for signaling aggression and attracting mates. Karatgi has also served as the Outreach Coordinator for the Graduates in Ecology and Evolutionary Biology organization, where she helped connect researchers with the community.

"I like engaging in outreach," Karatgi said. "I was not aware of outreach opportunities when I was in India. But here in a university town, as a researcher, you can go talk to the librarian and say, 'Hey, can we come put up a showing or do a demonstration here?' and they're totally up for it."

When asked about hobbies, she said "I like to read historical fiction, and when I need to de-stress, I like to do nail art. I picked that up after coming to graduate school, I find it very meditative and a nice way to calm down."

When graduate school becomes too stressful, Karatgi says she thinks of an Urdu/Hindi saying by Faiz Ahmed Faiz that helps keep her optimistic:

Dil na-umid to nahin, nakaam hee to hai,
Lambee hai gam ki shaam, magar shaam hee to hai

which translates to:

The heart has not lost all hope, but just a fight that is all,
The dusk of sadness is long, but it is just a dusk after all.

PROFILES—*KATHURE MUGAMBI*

Growing up in Fort Wayne, Indiana, Kathure Mugambi wanted to be a marine biologist. Even when she was in kindergarten, she would tell everyone about her interest, which eventually led her to join the Molecular and Cellular Biology program at the University of Illinois Urbana-Champaign.

"The MCB professors are so knowledgeable," Mugambi said. "One of my professors, Erik Nelson, just had a drug approved by the FDA. It is really cool to see and you can tell that all the professors love the material."

Her interest in MCB also drew her to the IGB Lunchbox series, which highlights the intersection of food, science, and culture. Each lecture features food tailored by campus chefs and is paired with lectures delivered by campus faculty.

"As an MCB student, I was looking for something that I could apply my knowledge to, and share with others. Sometimes science and research can seem to be devoid of human experience. It's like the data is just floating around," Mugambi said. "The goal of the Lunchbox is to humanize science and connect it with people's personal experiences with food. Each talk is unique: each researcher brings in a new perspective and we learn about their interests."

The series started in 2021 and, so far, Mugambi's favorite speaker was Bobby J. Smith II, an Assistant Professor in the Department of African American Studies whose talk focused on the relationship between race, food security, and civil rights in the history of Black people. "Before the talk, what I knew about the civil rights movement was not related to food at all. Hearing his perspective was very interesting to me," Mugambi said.

In her spare time, Mugambi loves reading books, especially psychological thrillers. She also loves cooking, a hobby she learned from her mother. "I used to watch her in the kitchen when I was young and as I grew older, I would help her cook Kenyan food," Mugambi said. "My favorite dish is pilau—the whole house smells like spices for two days."

Mugambi also has fond memories of food in Kenya. "My favorite memory is seeing my maternal grandmother because she lives at the base of Mount Kenya. The weather is crisp and the scenery is beautiful," Mugambi said. "My grandmother has these huge rosemary plants, which we put in our chai in the morning." It's no surprise that Mugambi brings the same passion to the IGB and helps spread the feeling of community using food as a vehicle.

If you walked into the RIPE High-Throughput Phenotyping Facility, located on the southern part of the Illinois campus, the first thing you would notice is the never-ending rows of plants. If you come in during the afternoon, you might also notice Victoria Kramer walking around the greenhouse, sorting through the different plants and organizing them for the researchers.

Kramer is a Field and Greenhouse Technician at the RIPE HPTF. She has a unique journey that brought her to the RIPE greenhouse. Born at 34 weeks, in Palo Alto, California, Kramer was diagnosed with vision and speech issues, autism, and cerebral palsy. The only reason she can work for 30-40 hours a week is due to Botox injections in both her legs that cuts off misfiring nerves, preventing her muscles from constantly firing.

Despite all the different and numerous challenges she faces daily, Kramer pours her energy into her time at the greenhouse. Kramer's interest in science stemmed from her parents—both of whom are computer scientists. After moving to Illinois in 2009, she graduated Summa Cum Laude with an Associate degree in Environmental Horticulture from Danville Area Community College. Kramer then worked at Central Illinois Produce for 2.5 years during the pandemic. The food that Kramer helped grow was sold to restaurants and the Illinois dining halls. It was also donated to the Mobile Market, a converted MTD bus that Carle Health used to give the community an opportunity to get free, fresh produce.

After the freight farm at CIP was shut down in 2021, Kramer was hired by the RIPE HTPF greenhouse. Her current tasks include preparing the pots, planting seeds, transplanting plants to larger pots, inspecting and measuring plants as they grow and putting that data into logs, harvesting the seeds, and organizing them into vials for shipping to researchers on campus and around the world.

"I am very proud of being a small part of a much bigger effort to improve the world's food supply—particularly for poorer countries and in the face of climate change," Kramer said. "The people I work with are great."

In her spare time, Kramer enjoys recycling old objects into beautiful garden art, which she sells at art and craft fairs. Some of her flowers are on display at the door of the RIPE greenhouse for all to enjoy. "It combines my love for horticulture with my love of reuse, creating, and selling art, along with being an advocate for persons with special needs," Kramer said.

Ask Lisa Surber her thoughts on science and the natural world and you'll find passion and excitement practically radiate off her as she responds. For Surber, who is currently a 3rd year PhD candidate in the Evolution, Ecology, and Behavior department at University of Illinois Urbana-Champaign, this interest in science and nature has been present within her ever since she was young.

"I grew up in Sonoma County in California, and didn't realize what a privilege it was to grow up there until after I moved away," said Surber. "You get spoiled because you're next to the redwoods, beautiful creeks, and the beaches there too. So, I got a lot of experiences in nature early on."

From her youth, Surber found herself bouncing between different career aspirations, from veterinarian to astronaut to ophthalmologist, to name a few. By the time she was working on her undergraduate degree at Mills College, a small women's college in California, she was set on becoming a pediatrician. However, she found the enormous amount of learning material daunting, and this experience almost intimidated her away from science.

Later in her undergraduate career, she tried her hand at animal behavior research, studying stress responses in ground squirrels under her mentor, Jennifer Smith. It was actually Smith that connected Surber with her current graduate advisor Eva Fischer (GNDP), an assistant professor in evolution, ecology, and behavior at Illinois. Surber studies how dyeing poison frogs detect cues from the environment, and change their behavioral and morphological phenotypes in response to these cues.

Surber is also very passionate about mentoring undergraduates, both when teaching classes and when hiring assistants in her research. The mentoring she received from Smith back when she was an undergraduate inspired her to want to do the same for others.

"I want to give back to the community and make sure people have good experiences in science, even if they don't end up pursuing a career in it," said Surber. "I just want them to remember that science can be fun, and sometimes hard, but mostly fun, and it helps you grow."

Surber hopes to instill this sense of curiosity and excitement about the natural world in all of her students, and states that Sir David Attenborough, her favorite narrator of nature documentaries, said it best:

"It seems to me that the natural world is the greatest source of excitement; the greatest source of visual beauty; the greatest source of intellectual interest. It is the greatest source of so much in life that makes life worth living."

Walking into the IGB can be intimidating. If you're a researcher, the main building has a similar layout to most of the laboratories on campus. If you're not, you might enter the gatehouse instead, where you will be greeted by numerous displays of Carl Woese and IGB research. Confused, and maybe a little overwhelmed, you might turn to the office, where Kathy Millage, a former Office Administrator at the IGB, made it a point to greet you with a smile.

"Some of the people who come in are extremely nervous, especially the undergraduate students. Since I'm a talker, I try to make people feel comfortable and I tell them that the IGB is full of nice people and a great place," Millage said.

To many of us, starting our work days at 8 am is challenging; not so for Millage. Born and raised in Cissna Park, a small farming community approximately 50 miles north of Urbana-Champaign, Millage has always been an early riser. "I was raised on the farm and we primarily had cattle. My older brother and I had to feed them before we went to school," Millage said.

Growing up, Millage was fascinated by forensics. She wanted to be a crime scene investigator, collecting evidence to help the police. Unfortunately, her high school career counselor told her that it was not a job for a woman. "It was 1975 and things were different for women. It's so great that things have progressed since then," Millage said.

Millage joined the University of Illinois in 2007. She first worked at the University of Illinois Foundation at Harker Hall, and joined the IGB in 2008. "Although the Foundation was a great place, it wasn't a good fit for me," she recalled. "The IGB building looked modern and gorgeous. Everything clicked."

On a day-to-day basis, Millage helped people obtain I-cards in the IGB system, instructed them on required trainings, and provided them with the building keys. After 15 years, Millage retired in March 2023. "This is the best job I have ever had. I knew the IGB was going to be a good fit because my bosses always told me that everything is fixable," Millage said.

Millage plans on spending her time with her family and traveling with her husband. Their bucket list includes Yellowstone National Park and Millage is excited to explore it through the lens of the research she has seen at the IGB. It's a fitting parting gift considering everything she has done to help the IGB community.

THE AARUSH M. PATEL FOUNDATION

For Maternal-Fetal Medicine & Fertility Research

In 2018, Mitul Patel and his wife, Aditi Patel, got married and were looking to start a family when they first experienced issues with infertility. Over the course of two years and various doctor's appointments, Patel says they were surprised by the lack of research and options addressing infertility. The couple was overjoyed when Aditi finally became pregnant, and they began preparing for life with their new son, until tragedy struck at 37 weeks, when Patel says a true umbilical knot took his son's life. Currently, there is no medical technology that allows umbilical knots to be detected early enough.

"In a moment we went from excitement to devastation," said Patel. "In hindsight, I think we were naively going through that process as if nothing could go wrong, because it doesn't go wrong for too many people, and when it does, you often don't hear about it."

Afterwards he says many people started opening up to them about their own infertility journeys, pregnancy complications, and issues in women's health that they had experienced. After multiple conversations with friends, universities, and hospitals, Patel realized there was a critical lack of research and innovation in the area of women's health.

"When you peel back every woman's health disease or concern or issue, it's the same thing no matter where you look, whether it's pharmaceuticals, clinical trials, or tracking the health of women and pregnancies," said Patel. "It really is just abysmal, the lack of research compared to other areas."

It was then that Patel decided to start the Aarush M. Patel Foundation, named after their late son, in order to fund more research on maternal-fetal medicine and fertility, and change the landscape of women's healthcare. Patel's entrepreneurial background allowed him to assemble a team and create the foundation within just 3 months. The goal of the foundation is to inspire new technologies and techniques that can improve women's health and bolster pregnancy outcomes, and ultimately prevent other families from suffering the same loss that they did.

The foundation just donated a $100,000 award to Patel's alma matter, the University of Illinois Urbana-Champaign, towards research on fertility and miscarriages. Specifically, the fellowship will support one Master's or Ph.D. student in their studies on the effects of different external factors on implantation failure. Patel hopes the research will provide new insights as to why some people have more difficulty becoming pregnant compared to others, and can be used to improve fertility treatments in the future. The research will be conducted at the IGB as part of the Environmental Impact on Reproductive Health theme.

"This is obviously just one topic amongst a million in women's health that need to be researched," said Patel. "But we're just getting started, and we hope to be able to double, triple, quadruple that gift year over year as we continue growing our foundation, increasing our fundraising, and getting more people to join in."

The foundation has also recently pledged $50,000 to Northwestern Feinburg School towards research on improving fertility outcomes and providing emotional support to parents. Patel says they also started distributing care packages to hospitals in Illinois to give to post-partum families after fetal loss, as a way to support them during times of uncertainty and grief. The foundation ultimately hopes to inspire research into less-explored areas of women's health, and spark more conversations surrounding the current state of women's health and medicine. Patel says the foundation is also a way to make a legacy for his son, Aarush.

"Our son's name, Aarush, means the first light at dawn," Patel explained. "Our foundation's website, sunshineson.com, reflects this, as it could be read as Sun Shines On and Sunshine Son depending on how you want to interpret it. It's meant to be inspirational, and a way to make a name for my son who can't make a name for himself. By naming the foundation after him, it's my hope that over the course of my life his name reaches further than mine, and leaves that legacy."

More information about the Aarush M. Patel Foundation's initiatives and upcoming events, as well as how to donate, can be found on their website: https://sunshineson.com/.

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RUOQING ZHU
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NIH

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"Integrated experimental and statistical tools for ultra-high-throughput spatial transcriptomics"
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PAUL HERGENROTHER
TIMOTHY FAN
GEE LAU
WILLIAM METCALF
"FabI Inhibitors as Potent, Gut Microbiome-Sparing Antibiotics"
NIH

WILLIAM METCALF
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"Optimizing Bioactive Metabolites In Fermented Foods To Improve Human Immune Function"
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DAVID HEATH
"IL Antimicrobial Resistance Dashboard"
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ANGAD MEHTA
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THANH NGUYEN
"Wastewater-Based Epidemiology and Clinical Surveillance for Antimicrobial Resistance"
Water Research Foundation

BETH STADTMUELLER
NICHOLAS WU
"Investigating and engineering the avian and human antibody response to target emerging influenza viruses"
HHMI

LISA AINSWORTH
USDA Agricultural Research Service (ARS); Adjunct Professor, Plant Biology and Crop Sciences (CABBI/GEGC)
Woolhouse Lecture Award, Society of Experimental Biology

RASHID BASHIR
Dean, Grainger College of Engineering, Professor of Bioengineering (CGD/M-CELS)
National Academy of Medicine

ALISON BELL
Professor of Evolution, Ecology, and Behavior (GNDP leader)
Excellence in Guiding Undergraduate Research, Office of the Provost

ISAAC CANN
Professor of Animal Sciences and of Microbiology (MME)
Fellow, American Academy of Microbiology

KATHRYN CLANCY
Professor of Anthropology (EIRH)
Center for Advanced Study Associate

BRIAN CUNNINGHAM
Intel Alumni Endowed Chair Professor; Professor of Electrical & Computer Engineering (CGD leader)
Michael S. Feld Biophotonics Award

WAWRZYNIEC DOBRUCKI
Associate Professor of Bioengineering (RBTE)
Neil and Carol Ruzic Faculty Scholar, Carle Illinois College of Medicine

JODI FLAWS
Professor of Comparative Biosciences (EIRH co-leader)
Research Award, Society for the Study of Reproduction

KAIYU GUAN
Associate Professor of Natural Resources & Environmental Studies (CABBI)
James B. Macelwane Medal, American Geophysical Union (AGU); Center for Advanced Study Fellow; University Scholar; GroundBreaker Prize, FoodShot Global

SARA PEDRON HABA
Research Assistant Professor of Chemical and Biomolecular Engineering (RBTE)
Elected, American Association for Cancer Research Women in Cancer Research Council

CECILIA LEAL
Associate Professor of Materials Science and Engineering (M-CELS)
University Scholar

STEPHEN LONG
Ikenberry Chair of Crop Sciences and Plant Biology (BSD/CABBI/GEGC)
Honorary doctoral degree, University of Essex

ZEYNEP MADAK-ERDOGAN
Associate Professor of Nutrition, Sylvia D. Stroup Scholar (CGD/EIRH/GSP)
2023 NAM Emerging Leaders Forum; Associate Dean, Graduate College

JASON RIDLON
Associate Professorof Animal Sciences (MME)
E.L.R. Stokstad Award, American Society for Nutrition

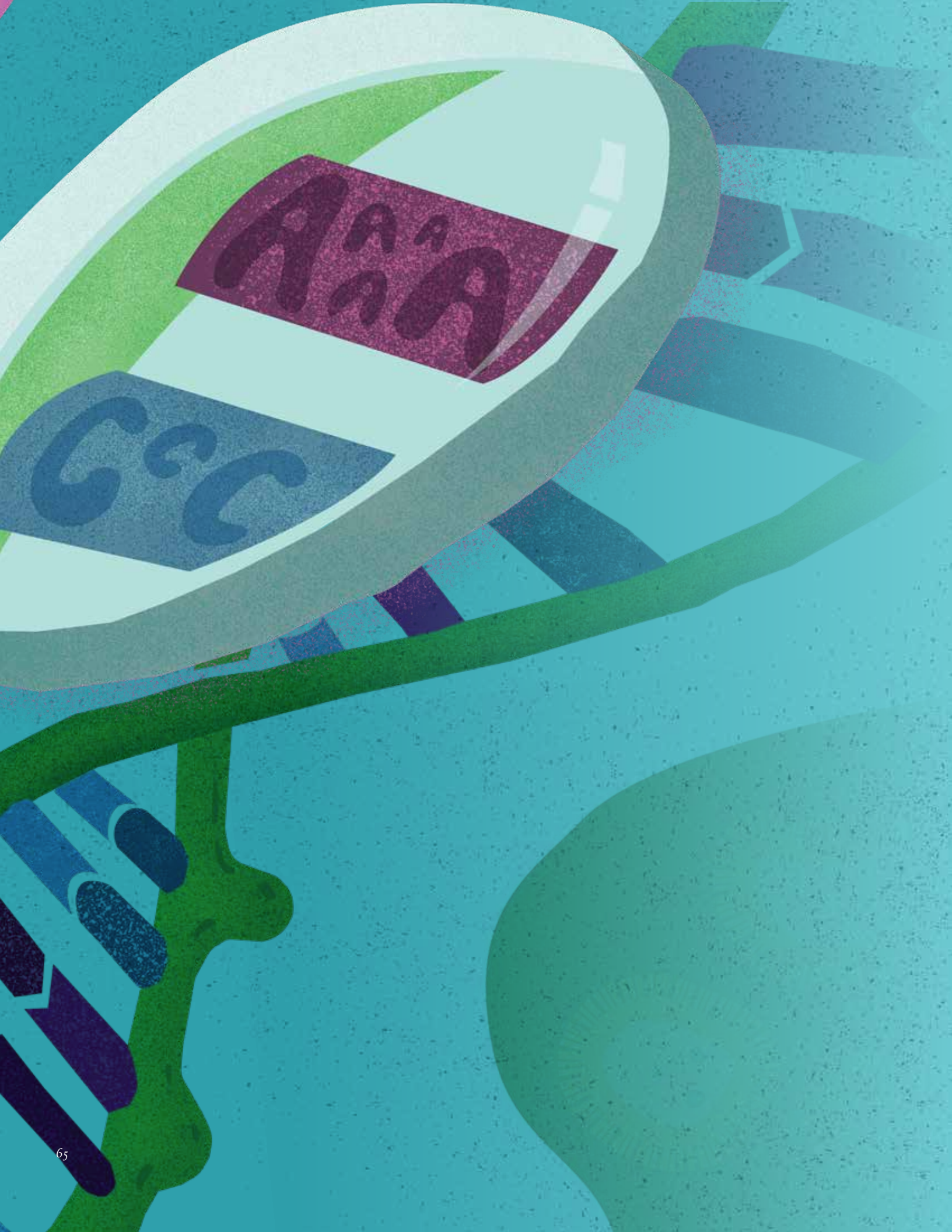
M. TAHER SAIF
Edward William and Jane Marr Gutgsell Professor of Mechanical Science & Engineering (M-CELS/RBTE)
Fellow, American Association for the Advancement of Science

CHARLES SCHROEDER
James Economy Professor of Materials Science and Engineering (BSD)
Fellow, American Association for the Advancement of Science

SHANNON SIRK
Assistant Professor of Bioengineering (MME/MMG)
Trailblazer R21 Award, NIH National Institute of Biomedical Imaging and Bioengineering

RACHEL SMITH-BOLTON
Associate Professor of Cell & Developmental Biology (GNDP/RBTE)
Teaching Excellence Award, School of Molecular & Cellular Biology

CARI VANDERPOOL
Professor, Associate Head of Microbiology (MME co-leader/IGOH)
Associate Dean for Research, College of Liberal Arts & Sciences


ABA
CSC

Give to the IGB

The vision of scientific research is limited by the pace of innovation. New technologies let us see the physical world more clearly, in greater detail, in finer scales of space and time. Genomic research, around which the IGB is focused, is particularly tied to advancing technologies.

To continue our record of high-quality research, we need to maintain our position at the forefront of the field. We move past traditional divisions between disciplines of study by constructing a network of collaborations. With your help, we will continue to forge a path toward our vision of a better world.

CARL R. WOESE RESEARCH FUND

Donations may be made to the Carl R. Woese Research Fund to support research on evolution, systems biology, and ecosystem dynamics at the IGB. Professor Woese approved this fund in his name to help the next generation of scientists and to recognize his discoveries and work that spanned nearly half a century at the University of Illinois Urbana-Champaign.

STAY CONNECTED WITH THE IGB

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FOR MORE INFORMATION

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IGB ANNUAL FUND

Gifts to the IGB help us to foster the collaborative environment that we believe is vital for progress in genomic research. Philanthropy helps us create opportunities for building strong working relationships with intelligent, talented researchers from our own campus, and from across the world. It allows us to provide grants for promising, but risky, research projects that more traditional funding agencies might be hesitant to support. Research needs evolve quickly and unrestricted gifts to the IGB Annual Fund permit us to optimize funds by allocating them for the projects that need them most.

IGEM UNDERGRADUATE TEAM

The IGB hosts a team of undergraduates from multiple departments to participate in the International Genetically Engineered Machine (iGEM) competition. This opportunity provides students the development of open community and collaboration for the advancement of synthetic biology. Funds for the iGEM team will give undergraduates the chance to present their research to an international audience in Boston.

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