BIOMARKER

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Carl R. Woese Institute
for Genomic Biology

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 for anti-infectious Molecules from Genomes
RBTE Regenerative Biology & Tissue Engineering

IGB Strategic Partnerships

ABP African BioGenome Project
CZI Chan Zuckerberg Biohub Chicago
GEMS Genomic and Eco-evolution of Multi-scale symbioses
HPCBio High-performance Biological Computing
MSI Microbial Systems Initiative
MMLI Molecule Maker Lab Institute
PNI Personalized Nutrition Initiative

IGB Funding Agencies

DoE U.S. Department of Energy
NASA National Aeronautics and Space Administration
NIH National Institutes of Health
NSF National Science Foundation

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Biomarker

Director
Gene Robinson

Associate Director
Subha Srinivasan

Director of Communications & Engagement
Nicholas Vasi

Writers

African BioGenome Project
Allie Arp
Katie Brady
Jonathan King
Shelby Lawson
Tony Mancuso
Office of the Vice Chancellor for Research and Innovation
RIPE Communications
Sarah Schwartz
Ananya Sen
Liz Ahlberg Touchstone
Trinity Challenge Communications
Julie Wurth
Diana Yates
Lois Yoksoulian

Design

Isaac Mitchell

Images

Claire Benjamin, CZ Biohub Chicago, Sarah Choi, digitale.de, Eric Engbretson, Scott Fisher, Flickr, Michelle Hassel, Institute for Sustainability, Energy, and Environment, Jonathan King, Sarah Kim, Mirhee Lee, Ling-Hsiu Liao, Sergei Maslov, Isaac Mitchell, Brian Mosley, NASA Marshall Space Flight Center, National Institute of Allergy and Infectious Diseases, Heidi Peters, Julia Pollack, Vanessa Quan, Jamestown Rediscovery, L. Brian Stauffer, Nicholas Vasi, Sarah Westrick, Julie Wurth, and Fred Zwicky.

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Director's Message

For over 15 years, the Carl R. Woese Institute for Genomic Biology has upheld its mission to harness the power of genomics by using team science to better understand the world around us and develop cutting-edge technologies to address societal challenges. The collective efforts of our researchers, staff, students, and partners push us every day towards making significant strides in scientific discovery, while fostering an environment of inclusive excellence.

It is my pleasure to introduce this year's edition of Biomarker, which highlights the research innovations of our institute and shines a spotlight on new opportunities to expand our footprint and drive global impact. Our researchers continue to advance science and exemplify the IGB's mission to tackle grand challenges. Spanning across disciplines, our scientists are designing new antibiotics, investigating the history of RNA, improving crop yields, and developing new detection technologies and machine learning tools. In addition, the Chan Zuckerberg Biohub Chicago recently selected 12 IGB investigators from 9 different research themes to conduct projects focusing on instrumented tissues, inflammation, and the function of the immune system, underscoring the research excellence of our institute.

As we strive to make a difference, the IGB has taken critical steps to broaden our research portfolio and further our impact. I am thrilled to announce that the University of Illinois Urbana-Champaign will be the site of one of five new NSF funded BioFoundries which will focus on expanding automated systems, machine learning, and artificial intelligence to advance synthetic biology, biotechnology, and genomics. The new iBioFoundry signifies the greater belief in our mission to solve global problems and positions the IGB to become a leading hub of innovation.

We celebrate the generosity of Julie and Bill Kellner to establish our first named, interdisciplinary research center, the Kellner Center for Neurogenomics, Behavior, and Society. Through this center, we forge new collaborations with the Center for Social and Behavioral Science and the School of Social Work to perform high-risk, high-payoff research projects. These studies will not only push the boundaries of science, but also inform treatment methods, policies, and educational training programs for mental illness.

We also celebrate the generosity of Scott Fisher to establish the IGB's first named research theme, the Scott H. Fisher Multi-Cellular Engineered Living Systems (M-CELS) theme. Fisher's endowment will support research focused on studying the genomics and proteomics of engineered living systems and creating biomachinery to solve real world problems. We are very grateful to Scott, Julie, and Bill for their generosity and confidence to help us live up to our motto of "where science meets society."

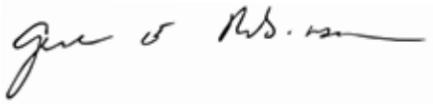
While working towards cutting-edge scientific discovery, we also are committed to engaging with our local community. Through programing including the Pollen Power Camp and STEAM TRAIN, our IGB outreach team continues to encourage local elementary and middle school students to explore science and connect with nature and the world around them. The "Genomics for ™" program is a prominent outreach effort which has allowed our institute to develop collaborations with different sectors of the community. This year, we had valuable discussions with faith leaders and judges to provide trustworthy information on genomics related to their professions.

The IGB also remains steadfast in our commitment to improve inclusive excellence. Success is driven by diversity of thought, background, and experience, and I thank you all for being the backbone of our vibrant community. As we continue to evolve to meet our growing potential, our goals remain the same. Together, we will push the limits of science to solve global challenges and collaborate to create a better, brighter world.

Gene Robinson

DIRECTOR,

CARL R. WOESE
INSTITUTE FOR GENOMIC BIOLOGY



Genetic genealogy

Can it restore family narratives disrupted by the transatlantic slave trade?

Some political figures seek to remove references to slavery from the study of American history, adding to the vast knowledge gaps that stem from the transatlantic slave trade. To better understand these histories, scholars and individuals are turning to genetic genealogy to discover and retrace descendant-family lineages. In a recent paper published in the journal *American Anthropologist*, University of Illinois Urbana-Champaign anthropology professor LaKisha David (CIS/GSP) described these efforts. This article summarizes David's remarks during a conversation with News Bureau life sciences editor Diana Yates.

For African Americans descended from enslaved ancestors, genealogical records alone are often insufficient to trace lineages prior to 1870 when the U.S. census began recording African Americans by name. This makes it incredibly difficult to trace family lineages through documentation alone. Moreover, slavery systematically fractured African American family structures through the domestic slave trade and forced family separations, leading to huge gaps in knowledge about ancestral identities, homelands and kinship ties.

Genetic genealogy offers a way to restore some of these lost connections by combining DNA testing with traditional family history research to help people discover ancestral origins and living relatives. Autosomal DNA tests from consumer companies like 23andMe and Ancestry DNA can identify shared genetic segments that indicate cousin relationships going back several generations.

This technology is particularly valuable for descendants of ancestors who left little or no documentary trace due to social, political or economic marginalization.

Discovering African relatives and hearing those new family narratives provides African Americans with new sources of socialization to reshape identity and belonging. African Americans in David's research experienced an intensified connection to African heritage and oftentimes incorporated the ethnicities and family histories of their African relatives into their self-concepts. By engaging with distant cousins who share specific ancestral lineages, people can recover lost branches of their family trees and gain a more complete sense of the histories that may have impacted their lives.

Genetic genealogy also contributes to dialogues about how slavery and colonialism have impacted Black identities worldwide. By revealing genetic relatedness across Africa and the diaspora, genetic genealogy empowers African descendants to redefine identities and kinship beyond the slaveholding frame.

The inhumanity of chattel slavery relied on the legal and cultural negation of African family integrity and history. Efforts to restore descendant family ties, therefore, constitute a form of restorative justice—not as a substitute for material reparations, but as a meaningful reclamation of personhood and heritage. For African Americans who have grown up with a sense of ancestral loss and disconnection, this reclamation of family history is deeply humanizing and healing.

Identifying African genetic relatives also contributes to a larger process of historical truth-telling, cultural healing and diasporic community reconstruction, supplementing identification with one another based on psychological connections. In this sense, identifying African ancestors and living relatives is an act of restorative justice. It is ultimately about (re)claiming the humanity, dignity and agency of enslaved Africans and their descendants, which is an essential component of repairing the harms of slavery.

Many African Americans descended from enslaved ancestors are working to trace their family histories by combining genealogical records and historical documents. Such efforts can connect them to living relatives and forge new sense of identity rooted in specific ancestral lineages and homelands, says University of Illinois anthropology professor LaKisha David. / *Fred Zwicky*

Early Innovator Program pitch contest winners announced

Postdoctoral and graduate student researchers participated in the 10-week Early Innovator Program at the IGB. The program was designed to teach participants the skills necessary to become innovative leaders in their fields, and to support IGB scientists in considering creative ways to bring science to society. The trainees learned from subject matter experts about the process of innovation, protecting and developing discoveries beyond the laboratory, and bringing new technologies and services to the marketplace.

After making their final pitches to a judging panel, three were awarded tiered funds ranging from $2,000-$5,000 to continue to advance their novel innovations.

Shraddha Shirguppe, a graduate student in the Perez lab (ACPP), received first prize for Genvivo Solutions, a platform technology focused on the development of cancer animal models across a range of species.

Jongwon Lim, a graduate student in the Bashir lab (CGD/M-CELS), was awarded second prize for his D3 Solution (Direct, Dry, Diagnostic), which would allow rapid detection of sepsis utilizing low-cost techniques.

Kyle Timmer, a graduate student in the Harley lab (RBTE), received third prize for RotatorRenew, an implantable, regenerative biomaterial for rotator cuff repair.

Other participants in the pitch competition included Shivali Banerjee, a postdoctoral researcher in CABBI developing products based on natural pigments; Joe Crawford, a postdoctoral researcher at CABBI developing a tool to measure water use based on leaf structures; and Nora Liu, a graduate student in BSD working to discover natural products for use in antibiotics.

From left to right, Shraddha Shirguppe, Sarah Schwartz, Kyle Timmer, Jongwon Lim, Nora Liu, Joe Crawford, and Tracy Parish. / *Isaac Mitchell*

Establishing grassroots genomics and bioinformatics programs to train over 400 Africans yearly

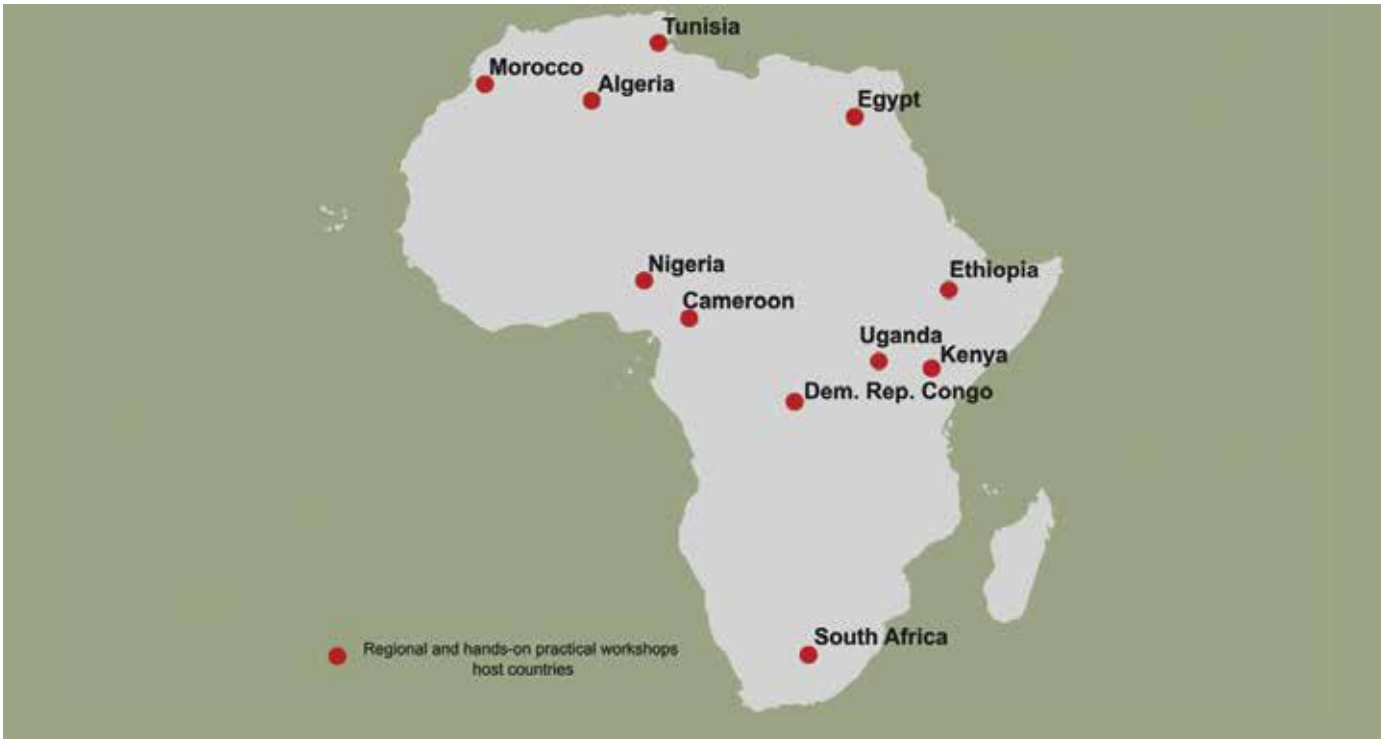
The African BioGenome Project is an affiliated project partner of the Earth BioGenome Project, Vertebrate Genomes Project, and the 10,000 Plants Genome Project. In 2023, it implemented a successful series of workshops referred to as the Open Institute for Genomics and Bioinformatics Regional Workshops, as reported in *Nature Genetics*.

The AfricaBP Open Institute conducted workshops across 11 African countries, covering 5 African geographical regions and attracted over 3700 registered participants. The workshops covered genome sequencing; bioinformatics analysis; basic molecular biology; ethical, legal, and social issues; sample collection; and biobanking through hands-on and interactive practical sessions.

"The AfricaBP Open Institute regional workshops were a resounding success. This is something that we in AfricaBP will build on, to ensure that we sustainably and deliberately build capacity in genomics and bioinformatics across the continent," said Anne Muigai, Chair, AfricaBP, and Deputy Vice-Chancellor of National Defence University-Kenya.

The workshop led to several outcomes directly impacting the future of genomics and bioinformatics across Africa, including the launch of the African Genome Center-AfricaBP Open Institute Fellowship and the African Biodiversity Fellowship for Emerging Genomics Leaders in partnership with the African Genome Center in Morocco and IGB, respectively, and establishing an African Digital Sequence Information Databank for Biodiversity and Agriculture.

The strategy for expanding the successful model will focus on increasing locations for practical sessions to scale the regional workshops, creating future fellowship opportunities as well as group leader and professional chair positions, and engaging with genomics funders to strategically mobilize resources to better target African scientists.



Map showing African countries where 28 AfricaBP Open Institute regional workshops were held in 2023./ *African BioGenome Project*

NSF funds iBioFoundry

NSF funds new iBioFoundry at Illinois to spur innovation

A newly funded U.S. National Science Foundation BioFoundry at the University of Illinois Urbana-Champaign will build on more than a decade of research at Illinois to integrate synthetic biology, laboratory automation and artificial intelligence to advance protein and cellular engineering. This is one of five new biofoundries to be established in the U.S.

According to the NSF, these facilities will "spur innovation, provide tools and technologies to researchers and help advance biology, biotechnology and the broader science, technology, engineering and math enterprise."

Each biofoundry will focus on a different area of biology or biotechnology, said Chemical and Biomolecular Engineering Professor Huimin Zhao (CSD leader/CABBI/CGD/MMG), who will lead the NSF BioFoundry. The Illinois facility will expand the use of automated systems, machine learning and AI to promote and optimize advances in synthetic biology, biotechnology and genomics.

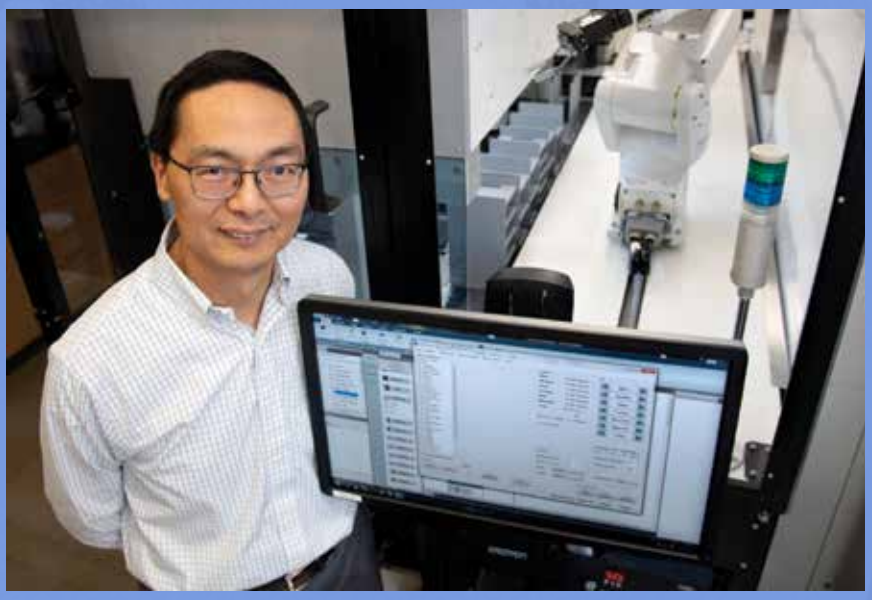
Previous efforts at Illinois have led to major advances in integrating these elements, Zhao said. Earlier milestones include the development of BioAutomata, an AI-driven, robotic biomanufacturing platform that uses living cells to produce useful chemicals; and FAST-RiPPs, an automated platform for discovering new bioactive compounds. In 2014, Illinois researchers established iBioFab, a facility at the Carl R. Woese Institute for Genomic Biology (IGB) that supports the efficient design, construction, validation and analysis of genetic constructs and organisms.

"The NSF iBioFoundry will serve as a hub for innovation, bringing together researchers, industry experts and policymakers to foster collaboration and accelerate the development of sustainable biomanufacturing processes," Zhao said. "By centralizing resources and expertise, it will streamline the creation of new bio-based products and technologies, ranging from renewable chemicals to advanced medical treatments."

Another key focus of the NSF iBioFoundry will be to share its capabilities with a diverse community of external

users who will work to solve important scientific problems through a peer-reviewed, competitive proposal process," Zhao said. "It also will be an open ecosystem of disruptive thinking, education and community engagement that will revolutionize the way biology is taught and train the next generation workforce in biology, artificial intelligence and robotics."

The total NSF award to Illinois is $15 million for six years, Zhao said.



Chemical and biomolecular engineering professor Huimin Zhao. / *Jim Vattano*

Genetic determinism

Researchers address concerns over genetic determinism of behavior

It has long been known that there is a complex interplay between genetic factors and environmental influences in shaping behavior. Recently it has been found that genes governing behavior in the brain operate within flexible and contextually responsive regulatory networks. However, conventional genome-wide association studies often overlook this complexity, particularly in humans where controlling environmental variables poses challenges.

In a new perspective article published in the open-access journal *PLOS Biology* by researchers from the University of Illinois Urbana-Champaign and Rutgers University, the importance of integrating environmental effects into genetic research is underscored. The authors discussed how failure to do so can perpetuate deterministic thinking in genetics, as historically observed in the justification of eugenics movements and, more recently, in cases of racially motivated violence.

The authors proposed expanding GWAS by incorporating environmental data, as demonstrated in studies on aggression in fruit flies, in order to get a broader understanding of the intricate nature of gene-environment interactions. Additionally, they advocated for better integration of insights from animal studies into human research. Animal experiments reveal how both genotype and environment shape brain gene regulatory networks and subsequent behavior, and these findings could better inform similar experiments with people.

"Advances in genomic technology have really illustrated how changes in the environment lead to changes not only in behavior, but in the expression of genes, in a way that's not determined just by heredity," said co-author Matthew Hudson (CABBI/GNDP), a professor of crop sciences at Illinois. "We now understand that even the same genes can function very differently across individuals depending on their expression."

Furthermore, the authors stressed the importance of multidisciplinary collaboration to understand the roots of behavior, especially among the animal and human research communities. Co-author Rina Bliss, professor of sociology at Rutgers, added, "We really need these kinds of collaborations among social scientists and biologists to illuminate the complexity of gene-environment interactions, especially as they relate to human behavior." The article also suggested that emerging technologies such as brain organoids and new forms of brain imaging will be necessary to elucidate the molecular mechanisms linking genetic and environmental influences on behavior.

Ultimately, the authors stressed that a paradigm shift is needed in human social and behavioral genomics towards a nuanced comprehension of gene-environment interactions. "Studying the roots of behavior holds great potential for insights that can help better understand brain function, in health and disease. We hope this article helps researchers to make the most of the opportunities while avoiding reductionist pitfalls," said co-author Gene Robinson (GNDP), IGB Director and professor of entomology and neuroscience at Illinois.

The authors suggested that a holistic perspective and fostering interdisciplinary collaboration could help researchers navigate the complexities of human behavior, while mitigating the risks associated with deterministic thinking in genetics.

Digital illustration of DNA. / *digitale.de*

Ancient DNA reveals Indigenous dog lineages found at Jamestown, Virginia

Dogs reflected the tension between European and Indigenous cultures—the settlers described Indigenous dogs as mongrels to emphasize the perception that Indigenous people did not breed or own their dogs. Indigenous peoples identified European dogs as a direct threat to their existence and took measures to limit the use of European dogs.

"Previous studies had suggested that there were a lot of Indigenous dogs in the continental United States and that they were eradicated," said Ariane Thomas, a recent PhD graduate of anthropology at the University of Iowa. "We wanted to understand what that entailed."

The researchers worked with Jamestown Rediscovery to select 22 remains that spanned multiple time points of the early settlement at Jamestown, between 1607 and 1619. They extracted the DNA in the IGB Core Facilities and sequenced the data at the Roy J. Carver Biotechnology Center to better understand the ancestry of these dogs.

The team discovered that most of the Jamestown dogs weighed between 22-39 lbs. The DNA sequences demonstrated that at least six of the dogs showed evidence of Indigenous North American ancestry. Although the identification of dogs with Indigenous ancestry is not surprising, the results suggest that the colonists and Indigenous tribes may have traded dogs.

The researchers are interested in expanding to other sites to shed light on whether these dogs had full Indigenous ancestry or whether they were the product of mating with European dogs.

The study was published in *American Antiquity* and supported by the NIH, the Wenner-Gren Foundation, Illinois, and the University of Iowa.

An aerial view of James Island and James Fort. The Jamestown colony was established in Tsenacomoco, the Algonquian name for the Powhatan chiefdom in the tidewater areas of the Chesapeake Bay and later became the Commonwealth of Virginia. / *Jamestown Rediscovery*

CZ Biohub Chicago announces first cohort of Investigators

Sixteen Illinois researchers, including twelve from the IGB, have been selected to become part of the inaugural cohort of Chan Zuckerberg Biohub Chicago Investigators. The group, which will focus on instrumented tissues, inflammation, and the functions of the immune system, also includes investigators from Northwestern University and University of Chicago.

Chan Zuckerberg Biohub Chicago, which was announced in 2023, brings together researchers to develop technologies capable of making precise, molecular-level measurements of biological processes within human tissues. Understanding and treating the inflammatory states that underlie many diseases is its ultimate goal.

"The CZ Biohub Chicago is focused on high-risk, high-reward research, and the selection of these 16 Illinois investigators—from so many colleges and institutes across the university—underscores the breadth of research excellence on our campus," said Susan Martinis, the vice chancellor for research and innovation at Illinois.

The CZ Investigator Teams consist of the following: Amy Wagoner Johnson, Mechanical Science & Engineering (EIRH/RBTE), Indrani Bagchi, Comparative Biosciences (EIRH co-leader), Bradley Sutton, Electrical & Computer Engineering, and Ayelet Ziv-Gal, Comparative Biosciences; M. Taher Saif, Mechanical Science & Engineering (M-CELS/RBTE); Hyunjoon Kong, Chemical & Biomolecular Engineering (M-CELS leader/EIRH/RBTE), and Qian Chen, Materials Science & Engineering (M-CELS); Bumsoo Han, Mechanical Science & Engineering (M-CELS) and Martha Gillette, Cell & Developmental Biology (GNDP/M-CELS); and Catherine Murphy, Chemistry, and Rohit Bhargava, Bioengineering (CGD). The remaining investigators are Auinash Kalostra, Biochemistry (CGD/GNDP); Mei Shen, Chemistry (GNDP); Shannon Sirk, Bioengineering (MME/MMG); Jonathan Sweedler, Chemistry (BSD/CABBI/MMG), and Yurii Vlasov, Electrical and Computer Engineering.

CZ Biohub Chicago announced its first cohort of 48 Investigators from their three partner universities: Northwestern University, University of Illinois Urbana-Champaign, and University of Chicago. / *CZ Biohub Chicago*

New research funding

Endowment by Scott Fisher to support IGB theme

Scott Fisher has established an endowment, which will support the research of a theme at the Carl R. Woese Institute for Genomic Biology. The Scott H. Fisher Multi-Cellular Engineered Living Systems theme (M-CELS) will use the funds to create machines made of living cells that can be used to solve real-world problems.

After earning a bachelor's degree in psychology and a master's degree in computer science, Fisher started his career with the computer manufacturer Digital Equipment Corporation. He then served as the Director of Information Technology at Philips NV and Remmele Engineering. Fisher recently retired from his position as a program manager with the water, hygiene, and energy technologies firm Ecolab.

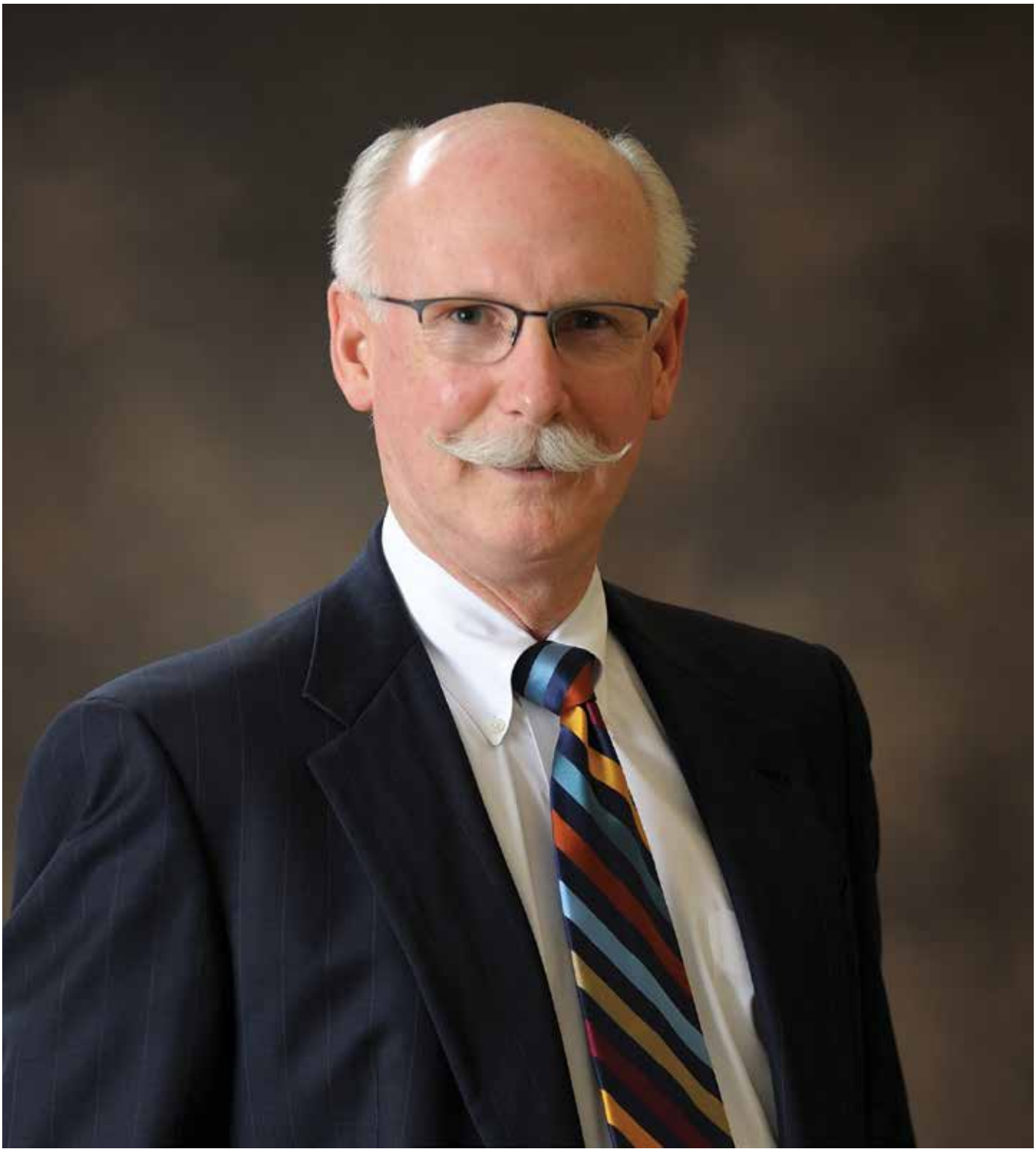
Over the past few years, Fisher has been an enthusiastic supporter of the University of Illinois Urbana-Champaign, establishing several funds, including the Scott and Bonita Fisher Graduate Student Research Support fund at the IGB, Scott H. and Bonita J. Fisher Endowment in the Department of Computer Science, Scott H. and Bonita J. Fisher Endowment in the Department of Mathematics, and gifts to Illinois main library and Grainger engineering library.

"It's wonderful to see all the new developments at the university," Fisher said. "Although I was in computer science, I have become interested in genomic and medical research. I had the opportunity to meet Gene Robinson and a few of the IGB researchers on one of my visits, and I realized that they were doing spectacular work in translational medicine."

Fisher was particularly interested in the M-CELS research theme because of its focus on cellular biology, neuroscience, engineering, and computer science. The theme works on systems that are composed of living cells and extracellular matrices and are able to perform functions that are absent in natural systems. Two research programs, bio-hybrid robots and biological processors, form the foundation of the research theme.

"Although I am not an expert, I was stunned at how cells can align themselves to accomplish different things. It seems like there are interesting possibilities that can come out of this, like having a biological engine that can repair different types of injuries," Fisher said. "These are the sorts of topics that you can study at a place like the IGB, where you have extraordinarily smart people who come together in a theme."

"We are grateful to Scott for his generosity. This continuous source of support will significantly enhance the capabilities of the entire M-CELS theme, and we are deeply appreciative of Scott's commitment to our team science mission," said IGB Director Gene Robinson.



The IGB research theme Multi-Cellular Engineered Living Systems is supported by an endowment from Scott Fisher, pictured. / *Photo provided by Scott Fisher*

For middle schoolers at Pollen Power camp, curiosity blooms

Hosted by the IGB, Pollen Power has been transforming the way young minds see the world around them since its inception in 2013. The camp provides a dynamic learning environment filled with a blend of hands-on learning and scientific exploration that encourages campers to see 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 K-12 Project Manager and lead organizer of Pollen Power camp.

The camp, funded by the CABBI theme within the IGB and the Champaign Unit 4 School District, welcomed fourth to eighth graders from June 3-7. Throughout the week, campers engaged in various activities designed to teach them about plants and pollinators, teamwork, communication, and scientific observation.

In line with Pollen Power tradition, campers broke into small groups mentored by Franklin STEAM Academy staff, and designed and conducted week-long experiments to observe the growth rates of cress seeds under different conditions, such as varying liquids, temperatures, and light exposure. Their results gave them practical insights into plant care and environmental factors.

Besides their experiments, the week's itinerary was packed with diverse and engaging activities, including collecting cicadas, a storytelling session with children's author Janice Harrington, and touring Prairie Fruit Farms. By the end of the camp, it was evident that campers had gained a profound appreciation for the plants and pollinators in their environment.

Campers practice identifying plants in the Conservatory Greenhouse on campus. / *Julia Pollack*

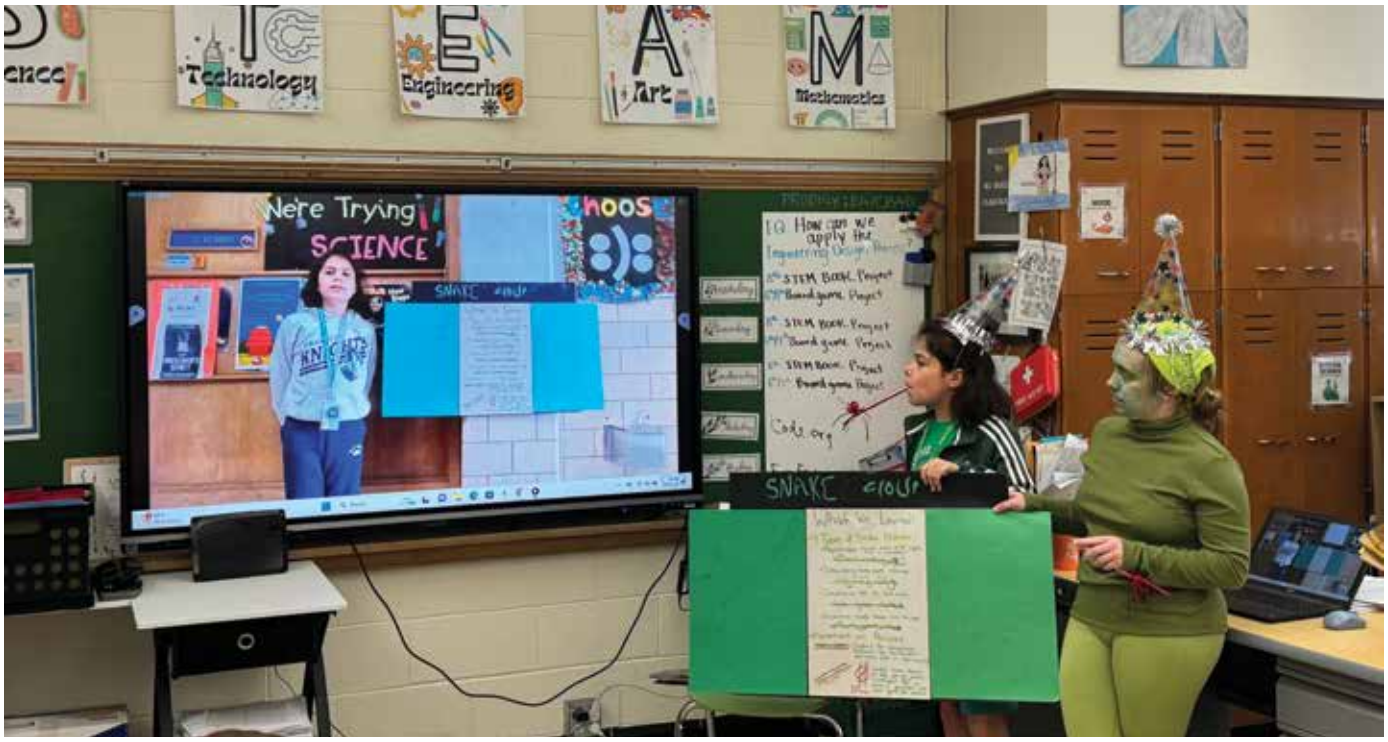
Full STEAM ahead for science! Another year of STEAM TRAIN comes to completion

The STEAM (Science, Technology, Engineering, Arts, and Mathematics) TRAIN (Transdisciplinary Research Across Institutional Near-peers) program is a collaboration between IGB, Franklin STEAM Academy, and Uni High, that encourages middle school students to explore any science or engineering projects that interest them, with no limits other than their own creativity.

STEAM TRAIN is organized by IGB's Senior Outreach Activities Coordinator Daniel Urban and Franklin's Magnet Site Coordinator Zanne Newman, and funded by the University of Illinois' Community Research Partnership Program. With guidance from their near-peer mentors, middle schoolers learn to formulate hypotheses, refine their research questions, collaborate effectively, and take the lead on their investigations. This year's program started in September 2023, and the five groups presented the culmination of their projects in May 2024.

Some groups researched the ecology of different animals, with one focusing on habitats, diets, and potential threats to marine species, and another examining the different locomotions of snakes and the environments those movements are used in. The third group explored computer science, coding a Pong-like video game using Python. Another group, fascinated by the regenerative abilities of planaria flatworms due to their stem cells, conducted an experiment in which worms were bisected and observed for regrowth. The last group took an engineering approach, deciding to test the tensile strength of different materials, including wood, plywood, cloth, silk, and various metals.

The STEAM TRAIN program exemplifies the power of creativity and mentorship in inspiring the next generation of scientists and engineers, showing that with guidance and resources, young minds can achieve extraordinary things.



STEAM TRAIN engages middle school students to pursue whatever research projects interest them, with topics ranging from computer programming, flatworm regeneration, and snake locomotion. / *Sarah Choi*

Improving crop yields

Engineered increase in mesophyll conductance improves photosynthetic efficiency in field trial

It is possible to engineer increased mesophyll conductance in plants according to new research from the University of Illinois Urbana-Champaign. Mesophyll conductance plays a key role in photosynthesis and refers to the ease with which carbon dioxide can diffuse through a leaf's cells before reaching the chloroplast—the location where it is ultimately turned into sugar to feed the plant in a process called carbon fixation. Researchers found that by increasing permeability and slightly reducing the thickness of cell walls, they could increase CO_2 diffusion and uptake in a model crop.

"Theory shows us that increasing mesophyll conductance to increase photosynthesis can be achieved without the cost of more water. This is important considering the urgent need for increased crop production and sustainable water use," said Coralie Salesse-Smith, a postdoctoral researcher in Long Lab (BSD/CABBI/GEGC) and lead author of their recent publication in the *Plant Biotechnology Journal*.

Photosynthesis is the natural process all plants use to convert sunlight, water, and carbon dioxide into energy and yields. CO_2's journey to becoming useful sugar for the plant begins when it passes through tiny holes in the leaves known as stomata. In order for the CO_2 to undergo carbon fixation, it must travel through many barriers, including the cell wall.

"Targeting the cell wall was very important because it is one of the main components limiting mesophyll conductance. Decreasing its thickness and making it more permeable would make it easier for CO_2 to get to the chloroplast," said Salesse-Smith.

Salesse-Smith focused on overexpressing, or increasing the amount of, *CGR3*, a gene that has been shown to alter cell wall components. This gene was inserted into a tobacco species and grown alongside plants without the gene in a field trial during the 2022 growing season. Tobacco was used because it is easier and quicker pace to work with in laboratory and field settings.

The plants overexpressing the *CGR3* gene showed a decrease in cell wall thickness of 7-13% and an increase in porosity of 75% when compared to the plants without this added gene. The true measure of success was when the data also showed an 8% increase in photosynthesis in the field.

"We hoped this modification would allow for more CO_2 to get into the chloroplast and be used to create energy in the form of sugar. But just because it worked in a model crop doesn't mean you get the same results with a food crop," said Salesse-Smith.

Armed with these results, the team is working to test this modification in soybean to see if increased photosynthesis, water use efficiency, and yield can be obtained in a food crop. Soybean field trials could take place as early as the 2025 growing season.

The project was carried out with Realizing Increased Photosynthetic Efficiency, an international research project led by Illinois, which engineers crops to be more productive by improving photosynthesis. It is supported by the Bill & Melinda Gates Foundation, Foundation for Food & Agriculture Research, and the U.K. Foreign, Commonwealth & Development Office.

Coralie Salesse-Smith (right) and Steve Long have proven in a model crop that an increase in mesophyll conductance can be engineered, and that it leads to an increase in photosynthesis. / *Claire Benjamin*

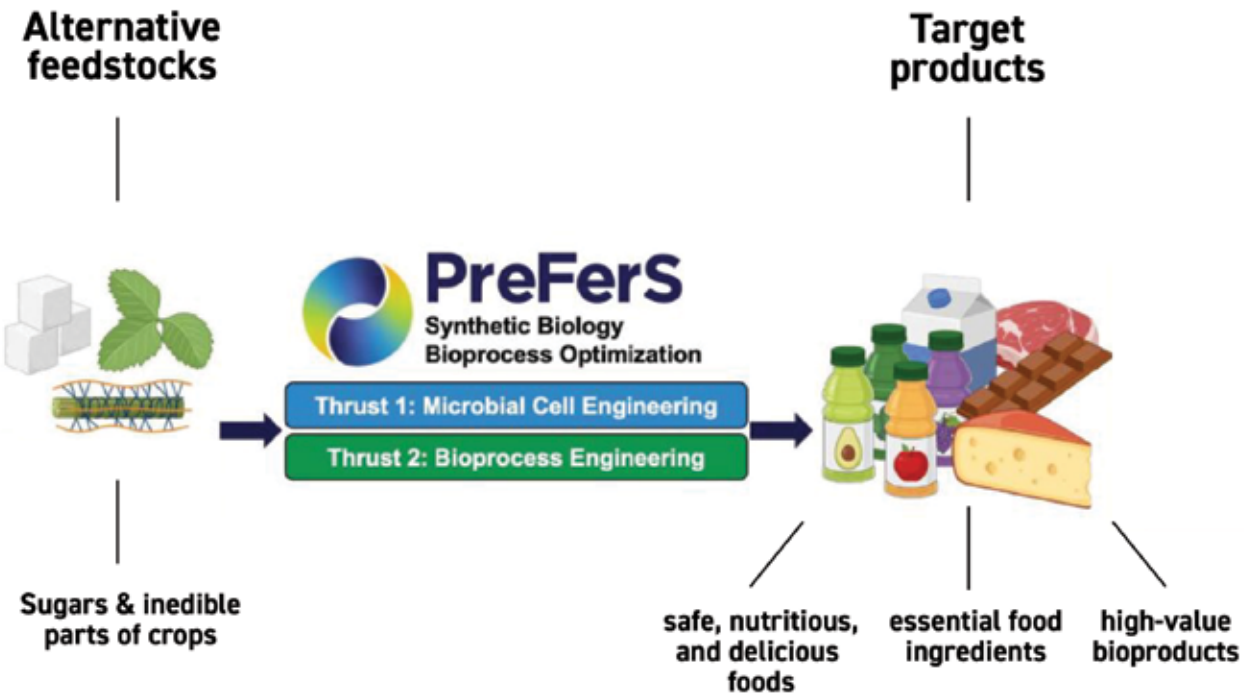
$14.8M grant supports Singapore partnership on precision fermentation

Led by Food Science & Human Nutrition Professor Yong-Su Jin (BSD/CABBI/GEGC/MME), a team of researchers from Illinois and partners in Singapore have received a five-year, $14.8 million-dollar grant to develop the Centre for Precision Fermentation and Sustainability.

PreFerS will focus on enhancing the reliable, cost-effective production of safe, nutritious, and appetizing foods. Through this work, PreFerS seeks to improve food supply chain resilience, reduce environmental impacts of food and nutrient production, and directly address hidden hunger—the growing epidemic of micronutrient deficiency.

"By converting sugars and inedible parts of crops into healthier foods, we can take what is already provided in plants and use it to create a more balanced, nutritious, and good-tasting diet," Jin said.

The PreFerS leadership team from Illinois also includes Ting Lu (BSD/CABBI/GEGC), Professor of Bioengineering; Michael Miller (MME co-leader/IGOH), Professor of Food Science and Human Nutrition; and Vijay Singh (CABBI/GEGC), Professor of Agricultural and Biological Engineering. Illinois co-investigators include Christopher Rao (BSD/CABBI/CGD) and Huimin Zhao (BSD leader/CABBI/CGD/MMG), Professors of Chemical and Biomolecular Engineering; Jeremy Guest (CABBI) and Na Wei (IGOH), Associate Professors of Civil and Environmental Engineering; and former Illinois Research Scientist Yalin Li, Assistant Professor of Civil and Environmental Engineering at Rutgers University. The PreFerS team is supported by the Institute for Sustainability, Energy, and Environment and assisted by Guest, iSEE's associate director for research; and Madhu Khanna (CABBI), iSEE's director and Alvin H. Baum Family Chair.



The Centre for Precision Fermentation and Sustainability, or PreFerS, will look to convert common compounds into proteins, lipids, and vitamins.

Illinois team awarded £1M to help combat antimicrobial resistance

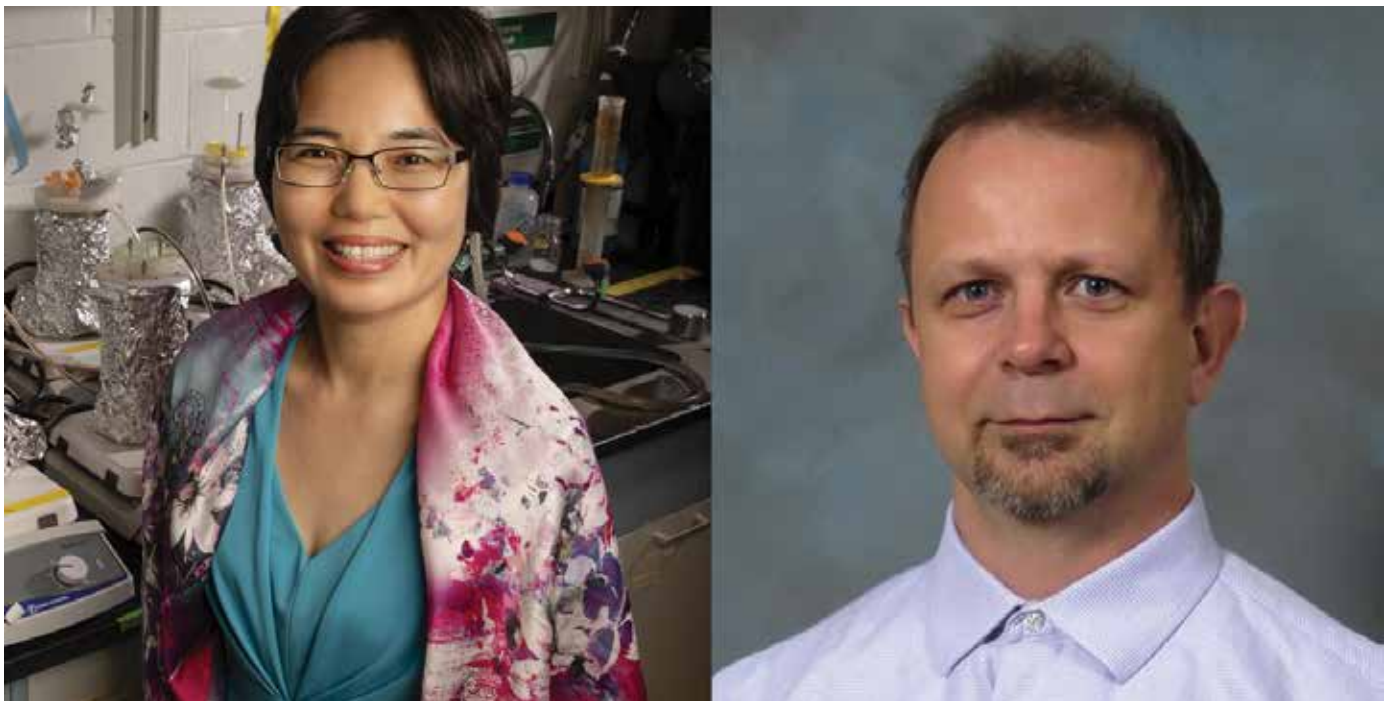
The Trinity Challenge announced four winning teams of its second competition aimed at tackling the growing threat of antimicrobial resistance. The projects were focused on addressing significant data gaps in communities and lower-income countries that are disproportionately affected by antibiotic-resistant infections.

The winner of the grand prize of £1 million was Farm2Vet: Combating Antimicrobial Resistance on the Farm Frontier. Led by a team of researchers from the University of Illinois Urbana-Champaign, Farm2Vet, based in Vietnam, aims to create a new platform that will encourage responsible antibiotic use in food-producing animals by offering farmers instant, low-cost access to trusted veterinary services for disease diagnosis and treatment advice. As well as directly supporting farmers, the data gathered by the platform will inform policymakers by identifying hotspots of antibiotic resistance and allowing action to be taken to prevent outbreaks.

"We can tackle AMR in a way that has never been done before. We will use the power of technology to extend the reach of veterinary services to remote farmers in many corners of Vietnam and, hopefully, learn lessons that can be extended to other countries too," said civil and environmental engineering professor Helen Nguyen (IGOH), Team Lead, Farm2Vet.

"Providing trusted veterinary advice for farmers will improve disease management on farms and reduce the use of antimicrobials and the development of antimicrobial resistance," added Illinois professor of pathobiology Csaba Varga (IGOH).

The team will also receive ongoing post-award innovation and scaling support as they implement their solutions from a network of technological and health organizations.



Civil and environmental engineering professor Helen Nguyen (left) and pathobiology professor Csaba Varga. / *L. Brian Stauffer*

Genomics for society

Genomics workshop series reaches out to faith leaders and judges

The IGB hosted multiple workshops designed to disseminate scientific knowledge and foster interdisciplinary discussions on emerging scientific technologies with various professional sectors of society.

The Genomics for Faith workshop series, supported by the Wayfarer Foundation, aims to bridge the gap between scientific knowledge and faith-based perspectives. Building upon previous discussions on the definition of life and gene-editing technology, the latest workshop delved into the realm of stem cell research. Stem cells, known for their remarkable capacity to differentiate into various cell types, hold much potential for medical applications. Stem cells can be used to regenerate and repair diseased or damaged tissues, and to create drugs to treat degenerative conditions.

Prior to the workshop, several faith leaders who volunteered to co-lead workshop discussions had the opportunity to tour university labs and gain firsthand knowledge of stem cell research methodologies to facilitate informed discussions during the workshop.

Throughout the discussions, a consensus emerged that the controversy surrounding stem cell research primarily stems from the sourcing of embryonic stem cells. It became evident that a prevailing misconception in society equates the term "stem cell" with "embryonic stem cell," when in fact stem cells are also sourced from numerous adult organs, tissues, and blood.

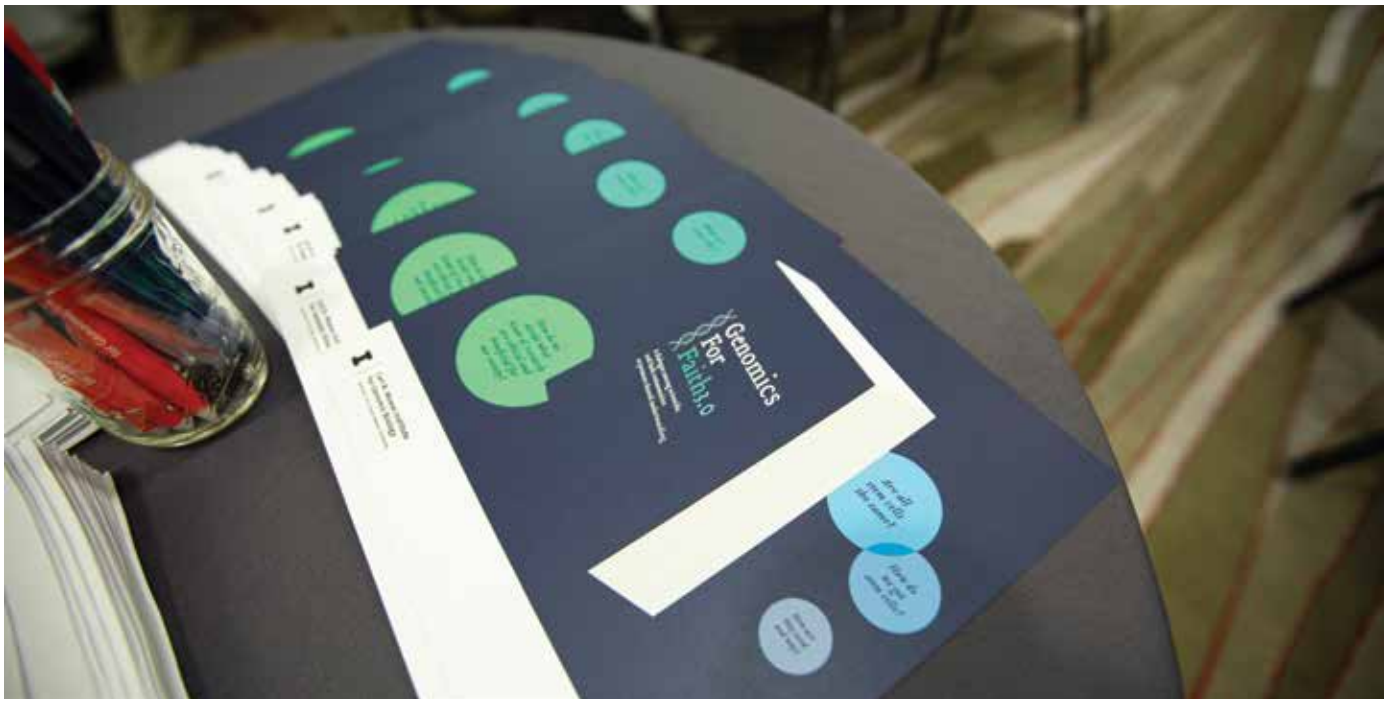
Discussions also featured praise for ongoing efforts to bioengineer stem cells by reprogramming adult cells to act like embryonic stem cells, potentially alleviating ethical concerns associated with embryonic stem cell research while advancing medical innovation.

The second workshop was organized in partnership with the National Courts and Sciences Institute. These aimed to equip judges with the knowledge necessary to navigate the legal landscape shaped by advances in genomics. The workshop was funded by the State Justice Institute. The event included expert seminars and panels, interactive discussions, and hands-on experiments. By examining the intersection of genomics with the legal system, the event sought to prepare judges for the challenges and opportunities genomics and artificial intelligence present.

A highlight of the workshop was a hands-on experiment led by Dan Urban, IGB's Senior Outreach Activities Coordinator. Judges pipetted DNA samples from various commercially available foods into gels and used electrophoresis to separate the DNA, testing whether the snacks labeled as GMO-free actually contained GMOs. This experiment offered a practical demonstration of genetic testing techniques and their applications, and quickly became a favorite among the judicial participants.

"The Genomics for™ program is a prominent element of our efforts in outreach, and a vivid demonstration of our commitment to engage all sectors of the public with clear and trusted information on genomics," said IGB director Gene Robinson.

The workshop underscored the critical role of education in bridging the gap between advancing technology and the judiciary. By equipping judges with a robust understanding of genomics and AI, the IGB aims to ensure that legal decisions involving these technologies are informed, fair, and just.



Participants from both workshops appreciated the expertise provided by Illinois researchers. / *Mirhee Lee*

New additive process can make better—and greener—high-value chemicals

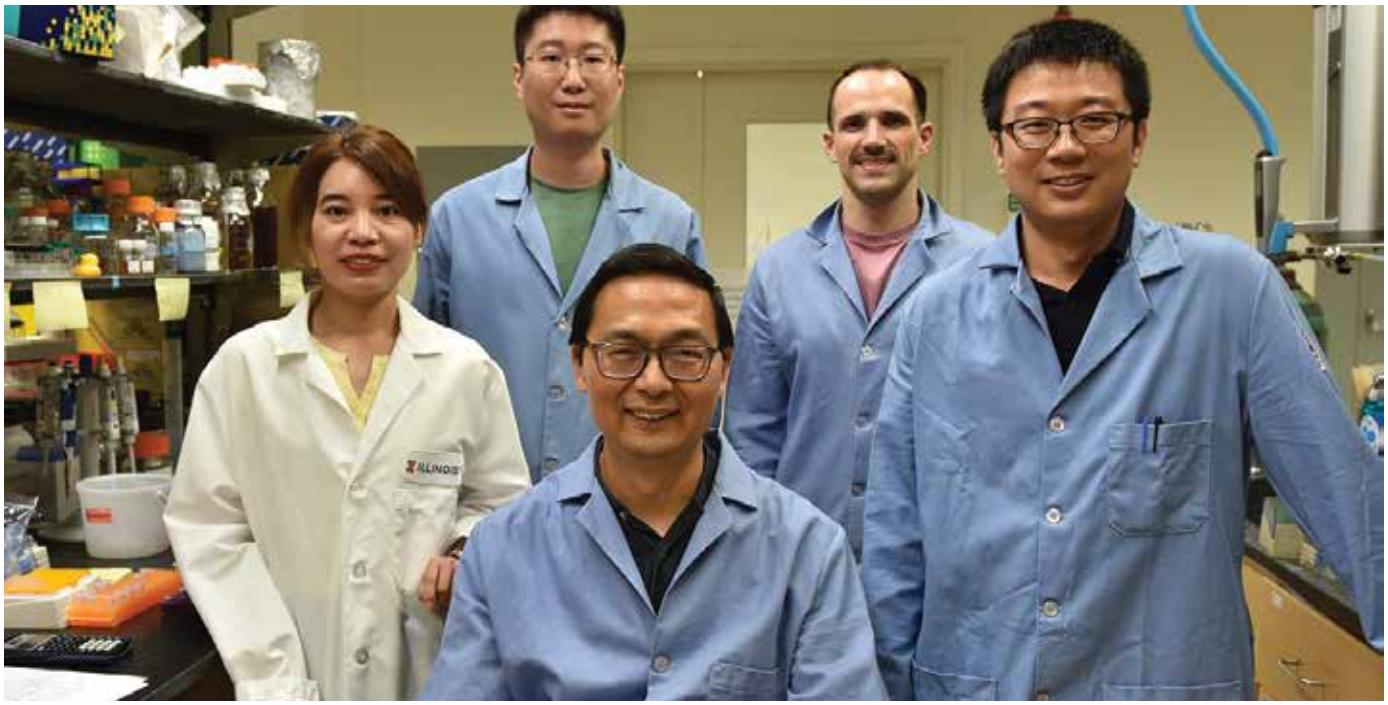
Researchers at CABBI have achieved a significant breakthrough that could lead to better—and greener—chemicals. Using a process that combines natural enzymes and light, the team from the University of Illinois Urbana-Champaign developed an eco-friendly way to precisely mix fluorine, an important additive, into chemicals called olefins that are used in a vast array of products, from detergents to fuels to medicines.

The study, published in *Science*, was led by CABBI Conversion Theme Leader Huimin Zhao, a professor of chemical and biomolecular engineering (BSD leader/CGD/MMG) and Director of the NSF Molecule Maker Lab Institute at Illinois; and lead author Maolin Li, a postdoctoral research associate with CABBI, IGB, and the Department for Chemical & Biomolecular Engineering.

As an additive, fluorine can make agrochemicals and medicines work better and last longer. However, adding fluorine is tricky and usually requires complex processes that are not environmentally friendly.

The scientists in this study used a "photoenzyme"—a repurposed enzyme that works under light—to help bring fluorine into these chemicals. This approach fills a large gap in molecular chemistry, as previous methods to add fluorine were limited. It also opens up new possibilities for creating better medicines and agricultural products, as fluorinated compounds are often more effective, stable, and longer-lasting than their non-fluorinated counterparts.

"This breakthrough represents a significant shift in how we approach the synthesis of fluorinated compounds," Zhao said. "This work could pave the way for new, greener technologies in chemical production, which is a win not just for science, but for society at large."



From left, Yujie Yuan, Zhengyi Zhang, Huimin Zhao (seated), Wesley Harrison, and Maolin Li. / *Julie Wurth*

New photonic crystal approach can enable sensitive and affordable detection of biomarkers

Biomarkers are small molecules of interest to researchers, because they can indicate underlying diseases, often before symptoms even appear. In a recent paper published in *Applied Physics Letters*, researchers at the University of Illinois Urbana-Champaign have unveiled a novel approach to detecting low quantities of biomarkers that paves the way for biodetection technology that is simple to use, highly sensitive, and surprisingly affordable.

There are many strategies for measuring the presence and concentration of biomarkers, but a common approach involves binding them with a fluorescent molecule, called a fluorophore, which emits fluorescence when excited with light. Seemesh Bhaskar, a postdoctoral researcher in the Cunningham lab and first author on the study, noted that while there are technologies adept at detecting these low levels of fluorescent biomarkers, they are often bulky and expensive, limiting their accessibility in healthcare, particularly in resource-limited areas.

Their new approach encompasses a novel phenomenon for detecting light, called radiating guided mode resonance, which utilizes photonic crystals—thin pieces of glass with small gratings on the surface. These crystals can result in a fluorescence output that is 100 times stronger.

"We are creating biosensing systems that are extremely sensitive while utilizing simple and inexpensive detection instruments," said Brian Cunningham (CGD leader/MMG), a professor of electrical and computer engineering and program leader at the Cancer Center at Illinois. "This is what creates a path toward sophisticated health diagnostics making their way to our health clinics, farms, and homes."

The study was funded by The NIH, NSF, and Cancer Center at Illinois.

The authors of the study, from left to right: Joseph Tibbs, Brian Cunningham, Seemesh Bhaskar and Weinan Liu. / *Isaac Mitchell*

Deciphering RNA's history

Model suggests how ancient RNA may have gained self-cutting ability essential for life

Scientists have long pondered the beginnings of life on Earth. One theory is that RNA, which is ubiquitous across all domains of life, played a central role in early life. However, to initiate life's processes, early RNA must have also possessed the capability to self-replicate and catalyze biochemical reactions independently, without the assistance of specialized enzymes.

Previously, it was unclear how a molecule this complex could arise without any precursors. However, in a new study published in *eLife*, Alexei Tkachenko, a physicist at Brookhaven National Laboratory, and Sergei Maslov (CAIM co-leader/CABBI), a professor of bioengineering and physics at the University of Illinois Urbana-Champaign, describe their model that demonstrates how such a molecule could gain functionality.

While modern RNA relies on enzymes for replication and catalytic activity, the origins of these enzymes themselves remain a puzzle. However, the discovery of ribozymes, RNA molecules exhibiting enzymatic properties, suggests a plausible pathway for the emergence of early functional polymers. The challenge lies in understanding how these ancient RNA molecules could have possessed the ability to "cut" other molecules, a crucial step in the replication process of DNA and RNA.

To tackle this question, the researchers devised a model simulating basic RNA molecules devoid of enzymatic activity. Within this model, random bond breakage was allowed to occur, mimicking real-world chemical processes. The researchers observed that breakage led to more copies of the polymer that was broken, meaning that molecules capable of self-cleavage would have been favored by evolution due to their ability to replicate.

"When RNA is cut, it regrows itself from individual building blocks. That was the connection to explain why the first ribozyme was selected to cut things—because cutting is how RNA exponentially grows," said Maslov.

In a second model, the researchers demonstrated how RNA molecules could evolve into complex ecosystems with functional properties. Their model simulated a pool of polymer chains competing for nucleotide "building blocks" and cutting other polymers they encountered. Polymer chains pair in specific ways, such as the A-T nucleotide pairing in modern DNA, and the chains in the simulation formed template and complementary strands, essentially working together.

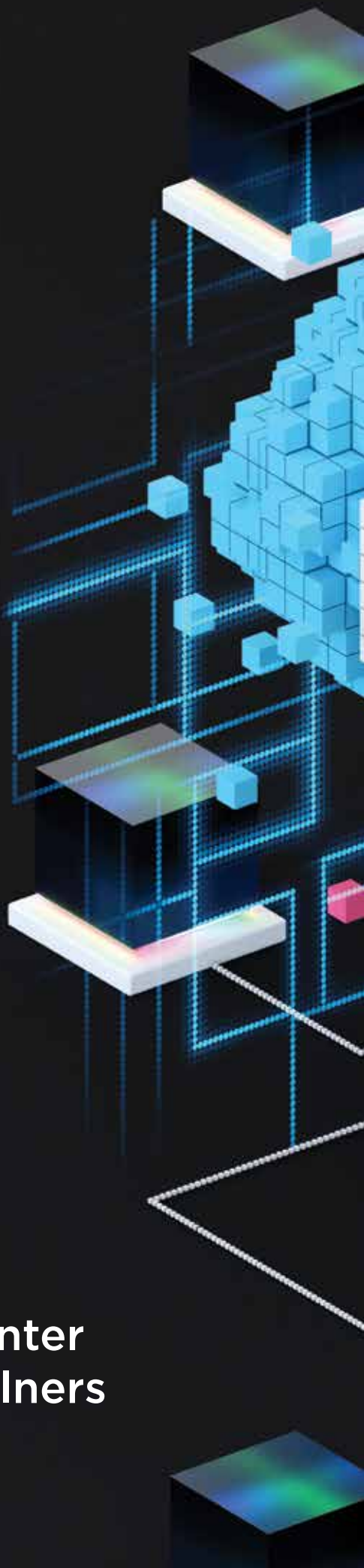
"Pairing rules are the basis for how information is preserved and propagated in the future," said Maslov. "And it's also important for function because it gives way to hairpins in the strands that lead to a three-dimensional shape, and these are the ones which are capable of enzymatic activity."

These findings offer compelling insights into the natural emergence and selection of ribozymes with enzymatic activity, shedding light on a crucial aspect of early life evolution.

"It is not a coincidence that Carl Woese used pieces of ribosomal RNA to make his trees of life," said Maslov. "RNA inside ribosomes is universal to every single organism. This paper doesn't solve the problem of origin of life, but it fills a tiny gap in our understanding of how early RNA may have functioned to bring about life."

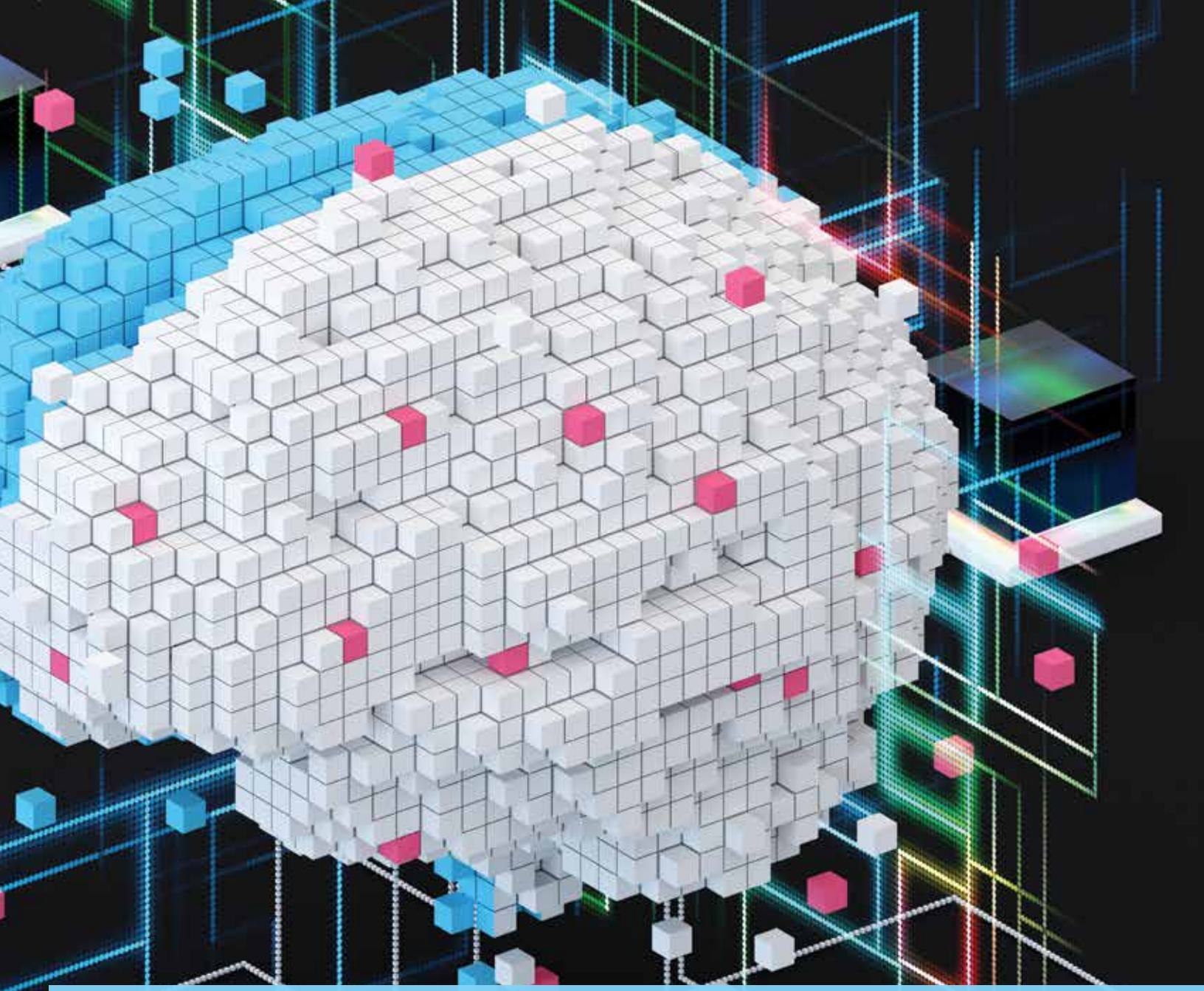
This study was partially funded by the DoE.

Alexei Tkachenko (behind), a physicist at Brookhaven National Laboratory with Sergei Maslov, a professor of bioengineering and physics. / *Sergei Maslov*



New IGB research center

New interdisciplinary research center established with gift from the Kellners



The Bill and Julie Kellner Center for Neurogenomics, Behavior and Society will bring together a breadth of fields, including genomic biology, neuroscience, the social sciences, and social work. The Kellner's generous commitment will create the first named center of its kind in the US. The Center will bring together researchers from the Carl R. Woese Institute for Genomic Biology, the Center for Social & Behavioral Science, and the School of Social Work, and will provide a platform for new collaborations across the University of Illinois System with the goal of furthering research and education in these disciplines that will better inform practitioners and policy makers in addressing society's most pressing challenges.

One of IGB's research objectives includes the use of genomics to study animal behavior. Specifically, the Gene Networks in Neural and Developmental Plasticity theme has broadened the discipline of neuroscience to include neurogenomics, which has led to the recent discovery that genes operate in the brain as part of complex gene regulatory networks, which in turn drives behavior.

"The gift from the Kellners will allow us to pursue high-risk, high-payoff projects that we could only dream about in GNDP up to now, and will facilitate building interdisciplinary collaborations that are needed for contemporary studies of genes, brain and behavior from both scientific and societal perspectives," said Alison Bell, a professor of integrative biology and the GNDP theme leader.

CSBS was established in 2019 to harness the expertise of over 700 social and behavioral scientists at Illinois to understand a spectrum of mental and physical

Julie and William Kellner. / *Julia Pollack*

health conditions and develop interventions. According to Eva Pomerantz, a professor of psychology and the Director of the Center for Social & Behavioral Science, CSBS aims to facilitate research on health that takes a "cells-to-society" approach, considering a range of biological and social determinants.

"Our researchers focus exclusively on humans, so we are excited for them to make connections to the work on neurogenomics and behavior in non-human animals that the Kellner Center will support," Pomerantz said. "The Center will also contribute to our Policy Research Legislative Fellows program in which graduate students are placed in local legislators' offices to use their research expertise to develop evidence-based policies."

The work at CSBS aligns closely with the School of Social Work, where the faculty focus on child welfare, health, and mental health, poverty, social innovation, social work research in schools, and workforce development.

"The Kellner Center presents a unique opportunity for cross-cutting integration of research findings across discplines —research that will inform the development of innovative treatment methods, policies, and training programs for those on the front lines," said Benjamin Lough, Dean of the School of Social Work. "It will enable us to ultimately transform the lives of those affected by severe mental illnesses."

With cutting-edge research across these areas, the Kellner Center will help researchers advance their knowledge of the complex processes by which genes, the environment, and society as a whole shape individuals in a number of ways. The Kellner Center will also prioritize innovative programs in science com-

"The Kellner Center presents a unique opportunity for cross-cutting integration of research findings across disciplines—research that will inform the development of innovative treatment methods, policies, and training programs for those on the front lines."

munication and translation to treatment methods, inform policy decisions, and provide educational opportunities for a variety of audiences.

"Bill and Julie have been part of the Illinois family for 50 years. We remain grateful for their continued investments in our university and their tireless passion to improve the human condition through innovative programs in research and its translation to enhance treatment methods, inform policy decisions, and provide educational opportunities for our community," said Barry Benson, the Vice Chancellor for Advancement.

William and Julie Kellner both graduated from the University of Illinois System—he graduated from Urbana-Champaign in 1973 with a BA in Political Science and she obtained a BA in Management from Springfield in 1986. They are excited to support collaborative opportunities among the three University of Illinois campuses. "Each campus has something they can contribute, and they all have wonderful people who focus on basic studies of the brain, mental health, and social work," said Bill Kellner.

"Neurogenomics encompasses all aspects of the human experience. Our main focus is mental illness and we hope that at some point neurogenomic discoveries in this field will help those who have serious illnesses, whether through therapies or medication," said Julie Kellner.

"We are deeply grateful to the Kellners for their vision, generosity, and confidence in us," said Gene Robinson, Professor of Entomology and Director of the IGB. "We are very excited about the potential of this center to make major breakthroughs in our understanding of the roots of behavior and the implications for treating mental illness, and we can't wait to get started."

Leaky blood brain barrier

Nanoparticle transport across the blood brain barrier increases with Alzheimer's and age

In a new study, an interdisciplinary team of researchers at the University of Illinois Urbana-Champaign have developed nanoparticles that are able to selectively bind to activated astrocytes and microglia cells that mediate brain inflammation in Alzheimer's disease. They found that both AD and aging strongly affect the ability of nanoparticles to cross the blood brain barrier and localize to the hippocampus.

The BBB consists of a network of blood vessels surrounding the brain that tightly regulate what molecules can enter the brain. Although nanoparticles can prevent the drugs from being "washed away", or losing their activity when passing through the BBB, it is difficult for nanoparticles carrying drugs to enter the brain. However, research has suggested that the BBB weakens with AD and age. This inspired a team of researchers led by Joon Kong (M-CELS leader/EIRH/RBTE), a professor of chemical and biomolecular engineering, and Hee Jung Chung (M-CELS), an associate professor of molecular and integrative physiology, to synthesize a nanoparticle that could take advantage of this compromised BBB.

"We thought, let's just make the nanoparticles small enough that they can take advantage of the leaky BBB and engineer these particles in a way that lets them remain in the brain in a stable manner," said Kong.

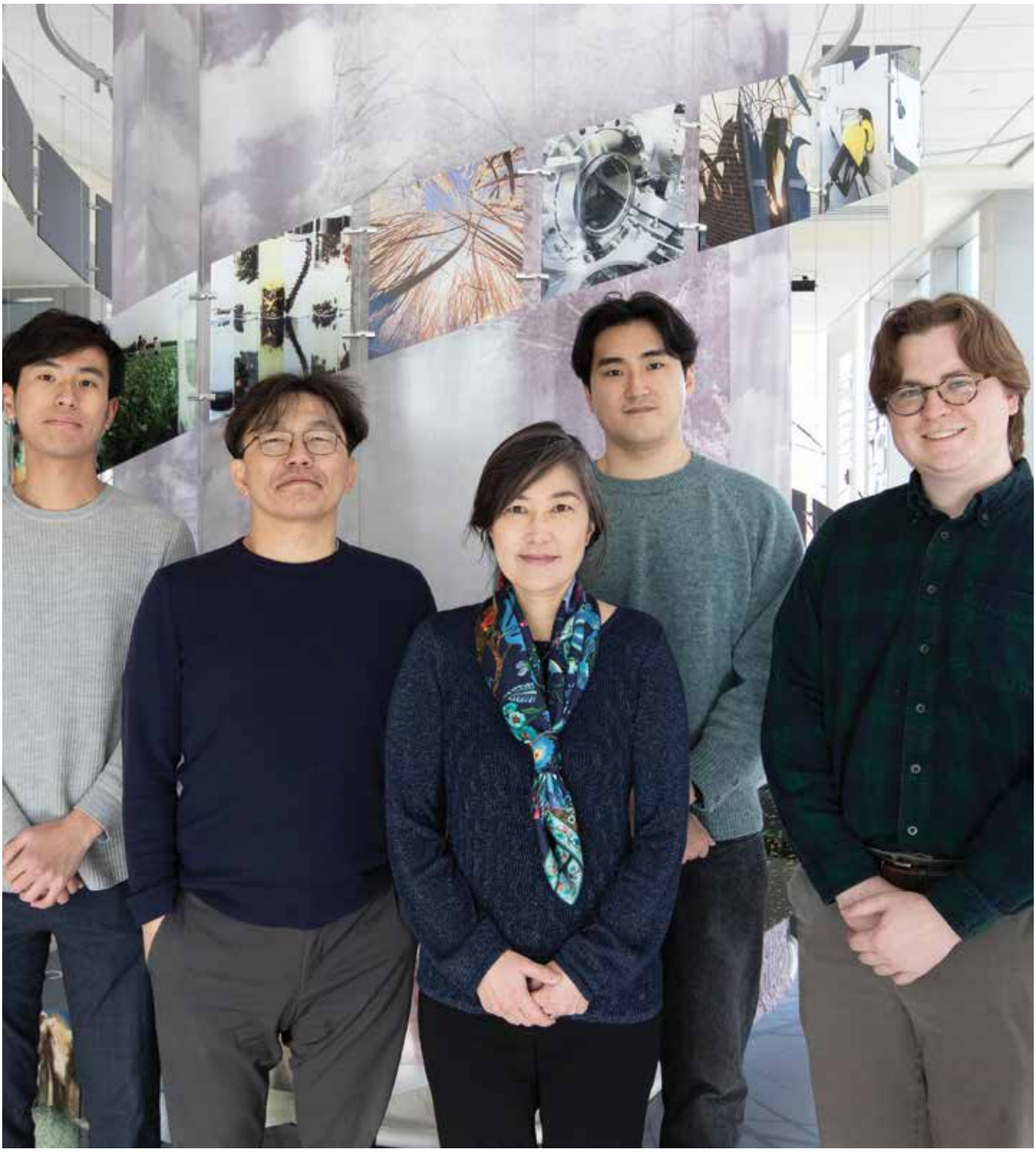
The nanoparticles are designed to bind to CD44, a cell surface protein that is produced by reactive astrocytes and microglia cells. The advantage of nanoparticles binding to these CD44-expressing cells is that the nanoparticles are retained longer in the hippocampus, rather than quickly being washed out. The researchers injected the CD44 seeking nanoparticles into both older and younger mice that either had AD or were healthy, and then looked at the distribution of nanoparticles.

In the hippocampi of AD mice, they found high concentrations of nanoparticles regardless of age, though older AD mice had stronger concentrations than younger AD mice. In the brains of healthy young mice no nanoparticles were found, meaning that their BBBs were intact. However, to the team's surprise, they found a significant amount of nanoparticles in the brains of healthy older mice, suggesting that the BBB weakens considerably with increasing age, even in those without AD.

"We knew there would be some leakiness of the BBB with age, but we thought there would be much less penetration of nanoparticles into the brain than we found," said Chung. "This highlights that there is age-dependent and disease-dependent penetration of the nanoparticles across the BBB to deep brain regions affected by AD."

"This study offers valuable insights into advancing our understanding of nanoparticle transport to the brain in aging and Alzheimer's patients," said Kai-Yu Huang, a graduate student in Kong's lab. "It prompts us to think about future strategies for the development of nano-scale drug carriers to target inflamed brain cells across different phases of aging-related brain disorders."

This research was supported by the Alzheimer's Disease Association, the NIH, the National Institute of Neurological Disorders and Stroke, the Chan Zuckerberg Biohub Chicago Acceleration Research Award, and Illinois.



From left to right: Kai-Yu Huang, Hyunjoon Kong, Hee Jung Chung, Ki Hyuk Lim, and Hayden Noblet. / *Julia Pollack*

Researchers discover a new natural product, a RiPP-fatty acid hybrid molecule

Living organisms produce a diverse suite of natural products which can be harnessed for medicinal and therapeutic purposes. Among these products, ribosomally synthesized and post-translationally modified peptides, or RiPPs, have garnered increasing attention.

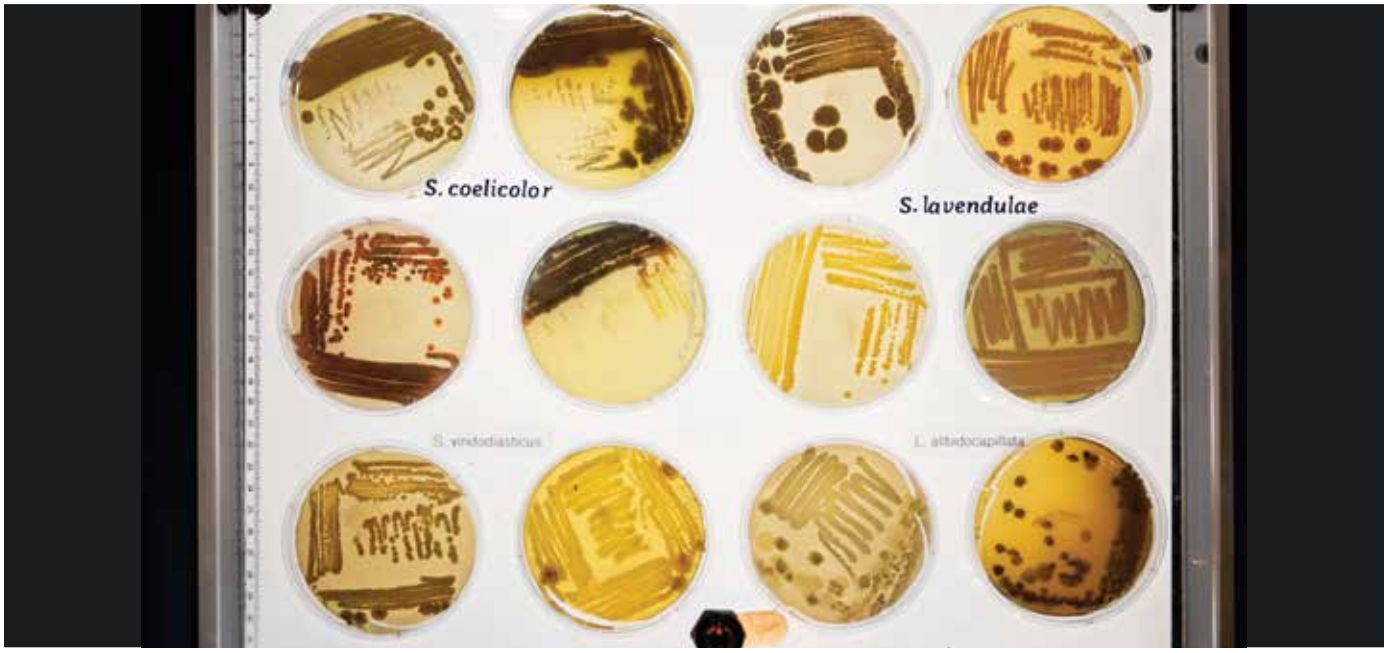
In a new study published in *Nature Chemistry*, a team of researchers at the University of Illinois Urbana-Champaign uncovered a novel class of hybrid gene clusters that combines elements of RiPP biosynthesis with enzymes responsible for fatty acid synthesis. They named this newly discovered RiPP hybrid 'lipoavitide'.

According to Huimin Zhao (BSD theme leader/CABBI/CGD/MMG), Steven L. Miller Chair of Chemical and Biomolecular Engineering at Illinois and author on the study, hybrid molecules theoretically possess increased versatility and functionality due to their mixed origins from different natural product classes, making them highly sought after.

Lipoavitides are uniquely amphiphilic, consisting of both a hydrophobic fatty acid and a hydrophilic peptide. This allows them to interact with the membranes of cells, something that peptide-based RiPPs alone cannot do. While testing the lipoavitides for bioactivity, Zhao's team discovered that the fatty acid component of the molecule also allowed for hemolytic activity, the ability to break down the cell walls of blood cells, which could have potential applications in medicine.

The discovery and characterization of lipoavitides represent a significant advancement in understanding the biosynthesis of ribosomally derived lipopeptides. Moreover, it opens up promising pathways for leveraging hybrid biosynthetic pathways in drug development, potentially leading to the creation of innovative therapeutics.

The study was funded by the NIH.



The researchers first identified RiPP gene clusters of interest within *Streptomyces* bacteria. / *Heidi Peters*

Researchers find unique adaptations of fungus associated with bee bread

Researchers have discovered that the fungus, *Aspergillus flavus*, is uniquely adapted to survive in bee colonies. The western honey bee stores large quantities of food in the form of bee bread, which is used as a main food source for the hive. Despite the inhospitable nature of bee bread, the microbiome in hives consists of several bacterial and fungal species that are important to honey bee food preparation, storage, and digestion.

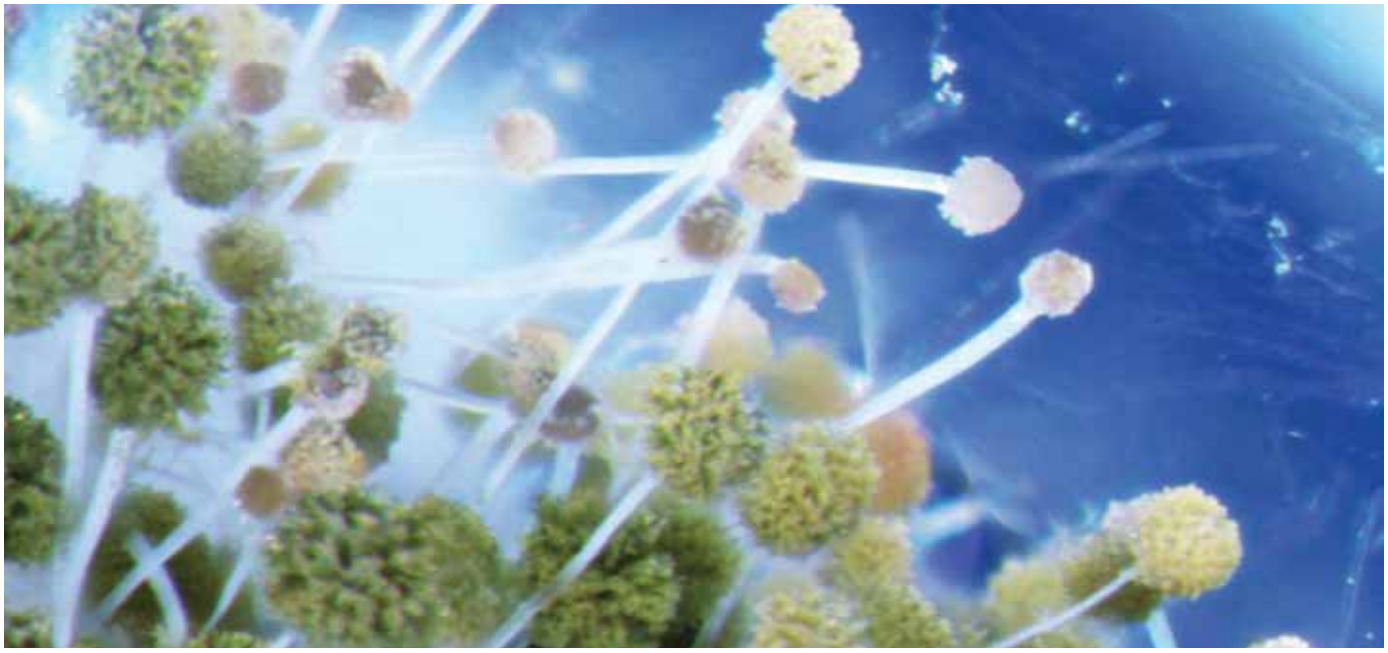
In the study, the researchers tested three strains of *A. flavus*: one that is not found in bee hives, a strain that was isolated from hives in central Illinois, and a pathogenic strain from a honey bee colony that had a stonebrood infection.

To better understand how the hive-associated fungal species were able to adapt, the researchers sequenced the *A. flavus* strain and found that it had several genetic mutations that allowed it to tolerate the harsh conditions of the bee bread environment.

"We believe that these are signs that there is a level of adaptation for the fungus that helps it cohabitate with the bees," said Daniel Bush, a graduate student in the Berenbaum (IGOH/GEGC/GNDP) lab.

The researchers are now hoping to study how the fungus performs on different compositions of bee bread during their life cycle. They hope that their work will shed light on how fungicides that are routinely used to protect the bee hives will affect these microbes. The study was published in *Ecology and Evolution*.

The work was supported by the Agriculture and Food Research Initiative.



Aspergillus flavus is uniquely adapted to survive in bee colonies. / *Ling-Hsiu Liao*

Exercise boosts brain health

Nerves prompt muscles to release factors that boost brain health

Exercise prompts muscles to release molecular cargo that boosts brain cell function and connection, but the process is not well understood. New research from the University of Illinois Urbana-Champaign found that the nerves that tell muscles to move also prompt them to release more of the brain-boosting factors.

"The molecules released from the muscle go into the bloodstream and then to the brain, producing so-called crosstalk between the muscle and brain. But the muscle itself is highly innervated. So we wondered, what is the effect of the neurons on this activity of the muscle, and further down to the communication between muscle and brain?" said chemical and biomolecular engineering professor Hyunjoon Kong (M-CELS leader/EIRH/RBTE), leader of the study published in the *Proceedings of the National Academy of Sciences*.

Research on exercise has found that muscles secrete hormones and extracellular vesicles, tiny packages that carry molecules between cells, containing small fragments of RNA that enhance connection, signal transmission, and communication between brain cells. However, while much attention has been paid to the function of muscle-derived factors, the role of the nerves that stimulate the muscle is poorly understood, said graduate student Kai-Yu Huang, the first author of the study.

To fill this gap, the researchers compared two muscle tissue models—one with neuron innervation and one without. They found that the innervated muscle produced more molecules that promote brain neuron activity and regulate muscle development than the muscle without nerves.

Then, the researchers stimulated the nerves with glutamate, a neurotransmitter. They found that the innervated muscle had greater expression of a gene important for regulating secretion. Correspondingly, it emitted higher levels of the hormone irisin, which is associated with beneficial effects of exercise, and released more extracellular vesicles than plain muscle.

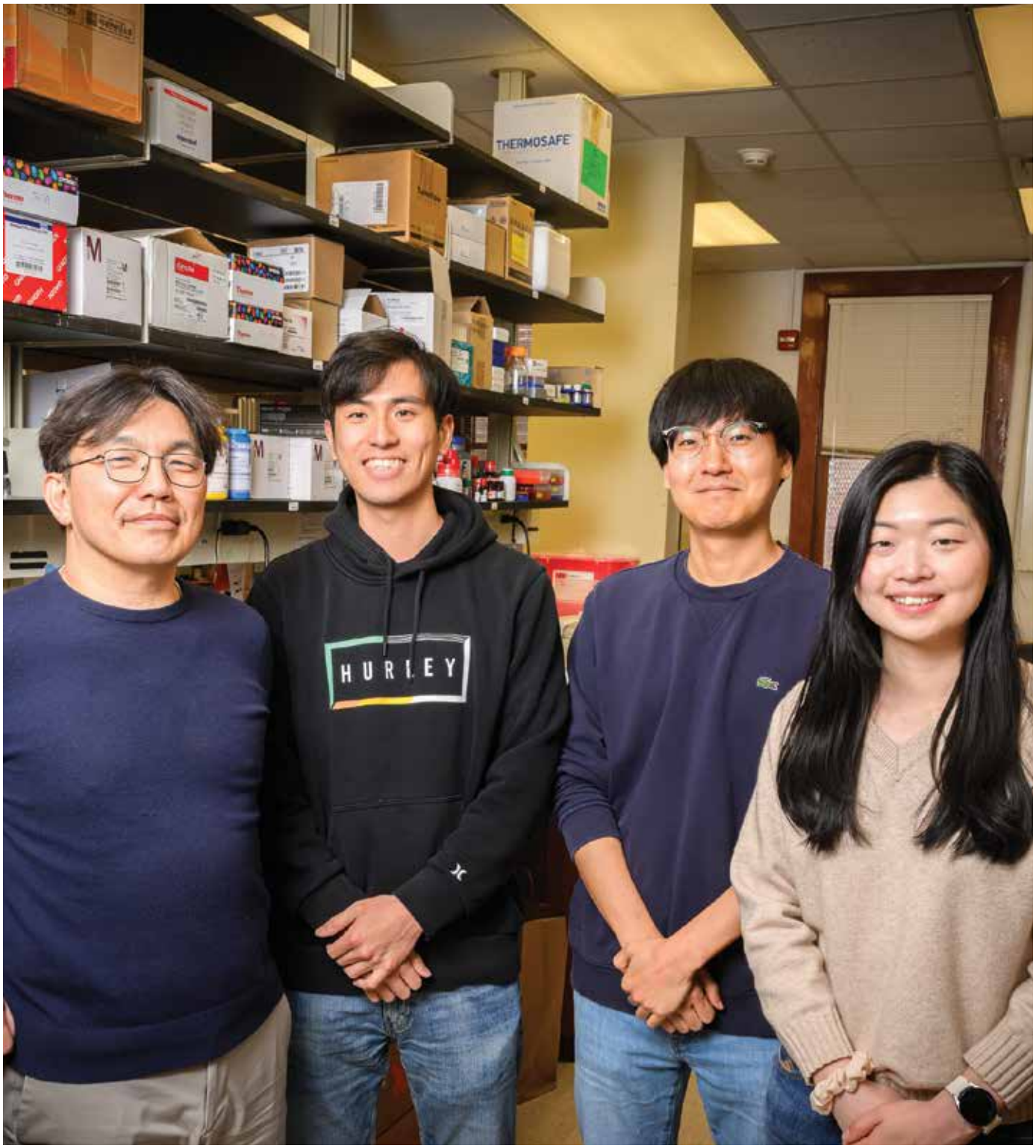
"We analyzed the cargo carried in the vesicles, and we found that there was a greater diversity of microRNA associated with impact on neurodevelopment," said Huang. "These findings highlight the importance of neuron innervation."

Next, the researchers plan to look further into mechanisms at the junction where the neurons meet the muscle cells. They seek to determine how nerve impulses stimulate the muscle and whether they affect the production of the brain-boosting factors, or just mediate their release—an important distinction for possible treatments for those who have lost nerves or muscle.

"It's our individual organs talking to each other: The brain tells the nerves to stimulate the muscle, and the muscle releases back molecules beneficial for brain function," Kong said.

"It underscores the importance of exercise. Exercise creates a more robust interface between motor neurons and muscle. So we could look at the benefits of exercise focused on fostering that connection more than simply increasing the volume or strength of the muscle."

The NSF, the NIH, the Alzheimer's Disease Association, and the Chan Zuckerberg Biohub Chicago supported this work.



The researchers found that muscle with nerves released more of the brain-boosting factors than muscle without nerves. Pictured, from left: Joon Kong and students Kai Yu Huang, Yujin An and Sehong Kang. / *Fred Zwicky*

IGB researchers awe Congress leaders with iBioFAB

The Computing Research Association, in collaboration with the Institute of Electrical and Electronics Engineers and Carnegie Mellon University, hosted Members of Congress and the public at the Robotics Showcase and Demo Day in Washington D.C. in April. The event, titled "Robotics for a Better Tomorrow", followed the Senate's year-long focus on breakthroughs in artificial intelligence.

The University of Illinois Urbana-Champaign participated by holding a live demonstration of the Illinois Biological Foundry for Advanced Biomanufacturing. Housed in IGB, iBioFAB aims to accelerate the biological engineering process by integrating AI and machine learning with laboratory automation.

"The integration of AI and robots with synthetic biology has the potential to drastically change our current paradigm of characterizing and engineering biological systems," said Huimin Zhao (BSD theme leader/CABBI/CGD/MMG), a Steven L. Miller Chair of Chemical and Biomolecular Engineering.

"We developed a web application, and at the click of a button, the attendees were able to watch a live view of iBioFAB executing the workflow," said Stephan Lane (CABBI), the Manager of iBioFAB.

Both Lane and Zhao explained to the Congress members that many researchers may not have access to expensive equipment, but iBioFAB helps in reducing that inequality by allowing people to conduct experiments remotely.

"They were able to run reactions, grab plates and send them to other instruments, prepare cell cultures, take measurements, and run enzyme assays during the demonstration," Lane said. "We were able to provide a really unique perspective on robotics as the only participants that were working on biotechnology."

Stephan Lane, left, and Huimin Zhao at the Robotics Showcase and Demo Day. / *Brian Mosley*

Machine learning used to classify fossils of extinct pollen

While previous attempts to utilize neural networks in classifying extinct organisms within phylogenetic trees have struggled, a new study published in *PNAS Nexus* heralds a significant breakthrough. The team includes Surangi Punyasena (CAIM), an associate professor of plant biology at the University of Illinois Urbana-Champaign; Shu Kong, an assistant professor of science and technology at the University of Macau; and Marc-Élie Adaimé, a graduate student in Punyasena's lab and first author on the study.

To accurately position organisms within a phylogenetic framework, neural networks must be trained not only to discern defining traits of various organism classes but also to recognize phylogenetic synapomorphies—derived features shared between organisms due to their common ancestry.

The team chose to apply their model to the classification of pollen and spores—a ubiquitous and ancient entity found throughout the fossil record. To validate the model's efficacy, the researchers tested it on micrograph specimens of extinct pollen from Panama, Peru, and Columbia. Impressively, the neural network model mirrored the placements made by the paleoecologists for nearly all specimens, underscoring its capacity to leverage morphological features learned during training to accurately position extinct species within a phylogenetic context.

"This work demonstrates that the amount of evolutionary information captured in pollen morphology had been previously underestimated. The history of a plant species is captured in its shape and form. Machine learning allows us to discover these novel phylogenetic traits," Punyasena said.

The study was funded by the National Center for Supercomputing Applications and Illinois.

Marc-Élie Adaimé (left) and Surangi Punyasena. / *Isaac Mitchell*

Sparing the gut microbiome

New antibiotic kills pathogenic bacteria, spares healthy gut microbes

Researchers have developed a new antibiotic that reduced or eliminated drug-resistant bacterial infections in mouse models of acute pneumonia and sepsis while sparing healthy microbes in the mouse gut. The drug, called lolamicin, was effective against more than 130 multidrug-resistant bacterial strains in cell culture.

The findings were detailed in the journal *Nature*.

"People are starting to realize that the antibiotics we've all been taking—that are fighting infection and, in some instances, saving our lives—also are having these deleterious effects on us,"

said Paul Hergenrother (ACPP leader/MMG), a professor of chemistry, who led the study with former doctoral student Kristen Muñoz.

Numerous studies have found that antibiotic-related disturbances to the gut microbiome increase vulnerability to further infections and are associated with gastrointestinal, kidney, liver, and other problems.

"Most clinically approved antibiotics only kill gram-positive bacteria or kill both gram-positive and gram-negative bacteria," Muñoz said.

Gram-positive and gram-negative bacteria differ in the composition of their cell walls. The few drugs available to fight gram-negative infections also kill other potentially beneficial gram-negative bacteria.

To tackle the many problems associated with indiscriminately targeting gram-negative bacteria, the team focused on a suite of drugs developed by the pharmaceutical company AstraZeneca. These drugs inhibit the Lol system, a lipoprotein-transport system that is exclusive to gram-negative bacteria and genetically different in pathogenic and beneficial microbes.

In a series of experiments, Muñoz designed structural variations of the Lol inhibitors and evaluated their potential to fight gram-negative and gram-positive bacteria in cell culture. One of the new compounds, lolamicin, selectively targeted some gram-negative pathogens and had no detectable effect on gram-positive bacteria in cell culture.

When given orally to mice with drug-resistant septicemia or pneumonia, lolamicin rescued 100% of the mice with septicemia and 70% of the mice with pneumonia, the team reported.

Extensive work was done to determine the effect of lolamicin on the gut microbiome. "The mouse microbiome is a good tool for modeling human infections because human and mouse gut microbiomes are very similar," Muñoz said.

Treatment with standard antibiotics amoxicillin and clindamycin caused dramatic shifts in the overall structure of bacterial populations in the mouse gut, diminishing the abundance of several beneficial microbial groups, the team found.

"In contrast, lolamicin did not cause any drastic changes in taxonomic composition over the course of the three-day treatment or the following 28-day recovery," the researchers wrote.

More research is needed to extend the findings, Hergenrother said. Lolamicin must be tested against more bacterial strains and detailed toxicology studies must be conducted.

The NIH supported this research.

The study team included, back row, from left, graduate student Rebecca Ulrich; chemistry professor Paul Hergenrother; Chris Fields, of the Roy J. Carver Biotechnology Center, research scientist Po-Chao Wen, graduate student Matt Sinclair; and, front row, from left, senior scientist Hyang Yeon Lee; Jessica Holmes, of the Roy J. Carver Biotechnology Center; and biochemistry professor Emad Tajkhorshid. (Study lead author Kristen Muñoz not pictured). / *Michelle Hassel*

RIPE team models connection between enzyme activity and yields for the first time

A team from the University of Illinois Urbana-Champaign has developed a modeling framework connecting enzyme activity related to photosynthesis to yield. This is the first time a model has tied the dynamic photosynthetic pathways directly to crop growth.

This work is part of Realizing Increased Photosynthetic Efficiency, an international research project. RIPE's research in this area received support from the Bill & Melinda Gates Foundation, Foundation for Food & Agriculture Research, U.K. Foreign, Commonwealth & Development Office, and Bill & Melinda Gates Agricultural Innovations.

In a study, published in *in silico Plants*, the researchers showed how their model will positively impact the ability of scientists to accurately simulate crop growth. "Plants don't exist in a stable environment. We can use this work to study the sensitivity of enzymes under different environmental conditions," said Megan Matthews (EIRH/GEGC), principal investigator for the RIPE Project and assistant professor in civil and environmental engineering at Illinois.

The model's ability to understand which enzymes can be limiting and connect this to expected yield comes from representing photosynthesis as a detailed series of dynamic enzyme reactions, rather than a simplified representation of a few reactions at steady-state.

"Scaling up from the metabolite level to the field level represents a pivotal advancement towards achieving a more accurate simulation of photosynthesis and crop growth," said Yufeng He, a postdoctoral researcher in the Matthews Group. "Furthermore, future applications will assist in improving crop management strategies, fostering sustainable agriculture practices, and bolstering food security amidst global challenges."

The work represents the first time that a model has been able to tie dynamic photosynthetic pathways to crop growth. / *Claire Benjamin*

Rising antimicrobial resistance in certain *Salmonella* serovars

Salmonella infections are a major public health issue in the United States, causing over 1.3 million illnesses annually. Emerging antimicrobial resistance in *Salmonella* isolates found in retail chicken meat is a growing concern; the trends of which were recently explored by a group of researchers from the University of Illinois Urbana-Champaign.

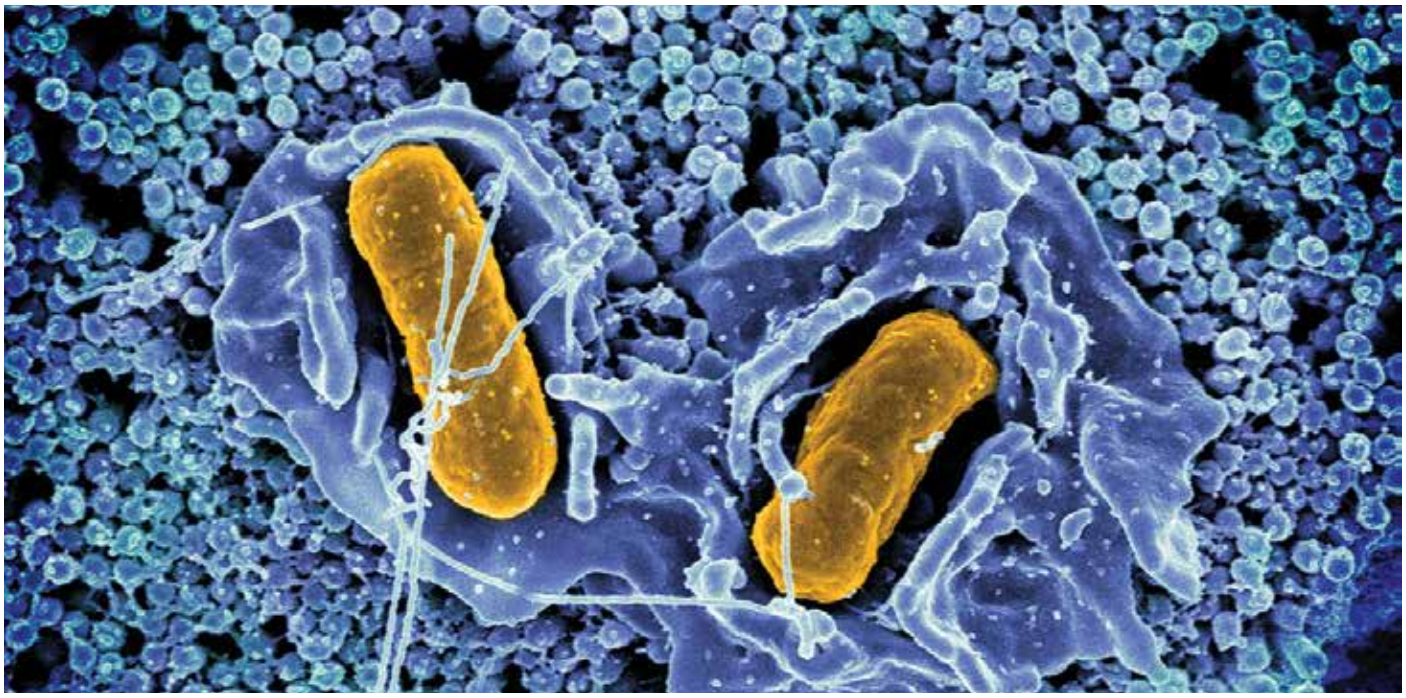
"The problem in detection is that some *Salmonella* serovars don't infect poultry. Also, in many cases, the infected chickens appear healthy while still harboring *Salmonella*, and then humans consume the meat and get infected," said Csaba Varga (IGOH), an assistant professor of epidemiology.

To monitor *Salmonella's* presence and antimicrobial resistance in retail chicken meat, the National Antimicrobial Resistance Monitoring System for Enteric Bacteria has been sampling chickens since 2002. In his recent study, Varga and his team utilized this extensive dataset to explore trends in the prevalence of the most common serovars of *Salmonella* and their antimicrobial resistance patterns over recent years.

Approximately 3,000 samples (7.7%) tested positive for *Salmonella*. The four most common serovars identified were *S. kentucky, S. typhimurium, S. infantis,* and *S. enteritidis*. Additionally, they varied in their spatial distribution across the United States, with high-proportion clusters of *S. typhimurium* more commonly detected along the East Coast, and *S. kentucky* along the West Coast and southern states.

The team plans to further investigate how management practices affect the development of antimicrobial resistance, and explore what can be done to reduce *Salmonella* prevalence and resistance to antimicrobials.

The study was published in *Food Control.*



Scanning electron micrograph of *Salmonella typhimurium* invading a human epithelial cell. */ National Institute of Allergy and Infectious Diseases*

Stress impacts cancer

Study links neighborhood violence and lung cancer progression

Scientists have identified a potential driver of aggressive lung cancer tumors in patients who live in areas with high levels of violent crime. The findings were detailed in the journal *Cancer Research Communications*.

The study was designed to address the higher incidence of lung cancer in Black men than in white men, said food science and human nutrition professor Zeynep Madak-Erdogan (CGD/EIRH/GSP), who led the research with University of Illinois Chicago School of Public Health health policy and administration professor Sage Kim. This disparity persists even though, on average, Black men smoke less and start smoking later in life than white men, Kim said.

The analysis focused on glucocorticoids, a group of steroid hormones like cortisol. These hormones bind to receptors that regulate the activity of other genes. Glucocorticoids and their receptors are involved in a variety of key functions, including metabolism, inflammation, and immune function, Madak-Erdogan said. The researchers first assessed patterns of gene expression in lung cancer tumors and in cancer-free lung tissue from patients who lived in various Chicago zip codes—some with higher or lower levels of violent crime. The team also determined where the glucocorticoid receptors were binding on DNA in those tissues.

Both analyses revealed that GR binding and gene-expression patterns were different in healthy versus tumor tissues, and that the patterns also differed by a patient's zip code. Overall, GR binding was highest in people who lived in high-violence areas. But within the tumor tissues, those living in high-crime zip codes had lower GR binding. They also had lower levels of GR-regulated genes in the tumor tissues.

The analyses also revealed that, within tumors, the GRs were activating genes for enzymes that degrade cortisol. This accounted for the lower cortisol levels—thus lower GR binding—in the tumors than in normal lung tissue. The lower cortisol levels were likely influencing the overall behavior of the receptors in the lung cancer tumors, Madak-Erdogan said.

"While we didn't prove a direct relationship in this study, our findings suggest that glucocorticoids and glucocorticoid receptors are a main driver of adverse tumor outcomes in patients living with chronically high levels of environmental stress."

Prior to the new study, scientists suspected that stress hormones played a role in cancer or other health disparities, Madak-Erdogan said. "I think this study really crystallizes the idea that it's not just that individuals in these areas are more stressed. It's also that their stress responses are dysregulated. There is a direct effect of these hormones on normal cellular physiology."

The NIH supported this research.

Zeynep Madak-Erdogan and her colleagues found that stress responses vary between lung cancer patients living in high-violence or low-violence zip codes. These differences likely lead to worse lung cancer outcomes in patients living in violent neighborhoods, the researchers found. / *Jonathan King*

New planning grant powers up pioneering glioblastoma research

A $25,000 grant from the Cancer Center at Illinois is catalyzing an interdisciplinary exploration of the relationship between neural networks and cancer cells in the brain. Led by Sara Pedron-Haba (RBTE), a research assistant professor of chemical and biomolecular engineering, the team is studying glioblastoma at the nexus of neuroscience and oncology.

Building upon previous glioblastoma research collaborations, Pedron-Haba wanted to step into the frontiers of understanding how neurons and cancer cells interact, prompting the application for a CCIL Planning Grant.

"I was interested in looking into the tumor microenvironment to see how neurons in the nervous system affect the development of tumors. It's an incipient area of research. Our team will use our experience in neuroscience and oncology to better understand how neurons communicate with tumors," said Pedron-Haba.

The planning grant was the first step for Pedron-Haba's team, enabling follow-up work to generate a proof of concept, establish models, and publish data that would empower the team to pursue larger grants in the future. One such funding stream was the Elsa U. Pardee Foundation which provided the team a grant of $173,665 for their research proposal.

"With our team's sophisticated imaging instrumentation, expertise in neuroscience, artificial intelligence, and radiotherapy, and access to cancer models in companion animals, our team will investigate how cancer cells interact with the healthy brain to improve treatments for patients with brain cancer," said Pedron-Haba.

University of Illinois Urbana-Champaign research team, from left, Kim Selting, Sara Pedron-Haba, and Catherine Best-Popescu, are recipients of grants from the Cancer Center at Illinois and the Elsa U. Pardee Foundation. / *Jonathan King*

PFAS found in nearly all fish tested from four northern Illinois rivers

Scientists tested fish species from Illinois rivers for contamination with per- or polyfluoroalkyl substances, synthetic chemicals found in numerous industrial and commercial products and known to be harmful to human health. The findings are reported in *Science of the Total Environment*.

The qualities that make PFAS desirable for industrial uses—their durability and stability under stresses such as high heat or exposure to water—also make them problematic in the environment and hazardous to human and animal health, said Joseph Irudayaraj (CGD/EIRH), a professor of bioengineering at the University of Illinois Urbana-Champaign.

The researchers focused on fish in the Pecatonica River, Rock River, Sugar River and Yellow Creek from 2021-22. The team collected dozens of samples from nine species of fish. The fish represented different levels of the food chain, from those that feed only on plants, like bluegill, to those eating other fish, such as channel catfish and northern pike.

Back in the lab, the scientists analyzed fish tissues for 17 PFAS chemicals. They found PFAS-contaminated fish in every river they tested and in every one of their 15 sampling sites. Fish from the Rock River had the highest concentrations of PFAS in their tissues. Contamination levels were highest in channel catfish, at the top of the food chain, and lowest in the plant eaters.

"Further studies are warranted to comprehensively evaluate the occurrence and sources of PFAS throughout the state of Illinois," the researchers wrote. "Such information is crucial to better understand the distribution and potential risks of these compounds to the environment."

Channel catfish had the highest accumulation of PFAS in their tissues, the researchers found. / *Eric Engbretson/USFWS*

Talking tomatoes

How tomato communication is influenced by enemies and friends

Plants produce a range of chemicals known as volatile organic compounds that influence their interactions with the world around them. They use VOCs for a variety of reasons: to help prepare their own defenses, to warn each other of threats, to recruit beneficial soil microbes that can help plants grow, and to alert insect predators that there is a pest chewing on that plant's leaves.

Studying the factors that influence VOC emissions, therefore, is key to understanding plant health. In the past, other studies have looked at how soil microbes like arbuscular mycorrhizal fungi or caterpillars or the variety of tomato plant can influence VOCs. In a new study, researchers at the University of Illinois Urbana-Champaign investigated the collective influence of all these factors on plant chemistry using four tomato varieties—two heirlooms and two hybrids. The hybrids used were Mountain Fresh and Valley Girl, and the organic heirlooms were Amish Paste and Cherokee Purple.

The researchers compared the responses of untreated plants to those that had been exposed to AMF, caterpillars, or both. The AMF and the caterpillars, separately, decreased the volatile emissions in all four varieties of tomato plants. Their effect when present together was minimal compared to the effects when either one was present.

Although it is unclear why the beneficial fungal associations decreased the VOCs, it is concerning that the plants were not as responsive to the caterpillars. Furthermore, the hybrid tomatoes emitted lower quantities of volatiles compared to the heirloom tomatoes. "Heirloom tomatoes—the big, juicy tomatoes we all love—are bred for flavor. Meanwhile, hybrids are grown for large scale conventional production, which comes at a cost to the plant," said Esther Ngumbi (CIS/MMG), an assistant professor of integrative biology.

"Our work suggests that we are compromising plant defenses through our breeding processes."

The plants were also evaluated based on their growth both above the ground and in the soil. The researchers found that plants that had associations with the fungi had higher leaf biomass and more complex root structures.

"AMF form partnerships in over 80% of the land plants, setting up a trade where the fungi extract nutrients from the soil in exchange for carbon from plants," said Erinn Dady, a graduate student in the Ngumbi lab. "We found that, especially in Cherokee Purple, AMF may confer additional benefits, including enhanced growth and greater emission of VOCs."

Surprisingly, the plants that were treated with caterpillars had greater plant growth. "These plants had more biomass in both their roots and above the ground, which seems counterintuitive because they've actively been eaten." Dady said.

The researchers are interested in further investigating the growth response to caterpillars. "There's a lot going on behind the scenes that we don't yet understand. People tend to think that plants are not intelligent, but our studies have shown that they are actively responding to the environment around them using chemistry," Dady said. The study was published in the *Journal of Chemical Ecology*

The work was funded by Illinois.

Esther Ngumbi, left, and Erinn Dady studied the effect of arbuscular mycorrhizal fungi, caterpillars, and the variety of tomato plants on plant chemistry. */ Fred Zwicky*

Study brings scientists a step closer to successfully growing plants in space

New, highly stretchable sensors can monitor and transmit plant growth information without human intervention, reported University of Illinois Urbana-Champaign researchers in the journal *Device*.

The polymer sensors are resilient to humidity and temperature, can stretch over 400% while remaining attached to a plant as it grows, and send a wireless signal to a remote monitoring location, said chemical and biomolecular engineering professor Ying Diao, who led the study with plant biology professor Andrew Leakey (CABBI leader/GEGC).

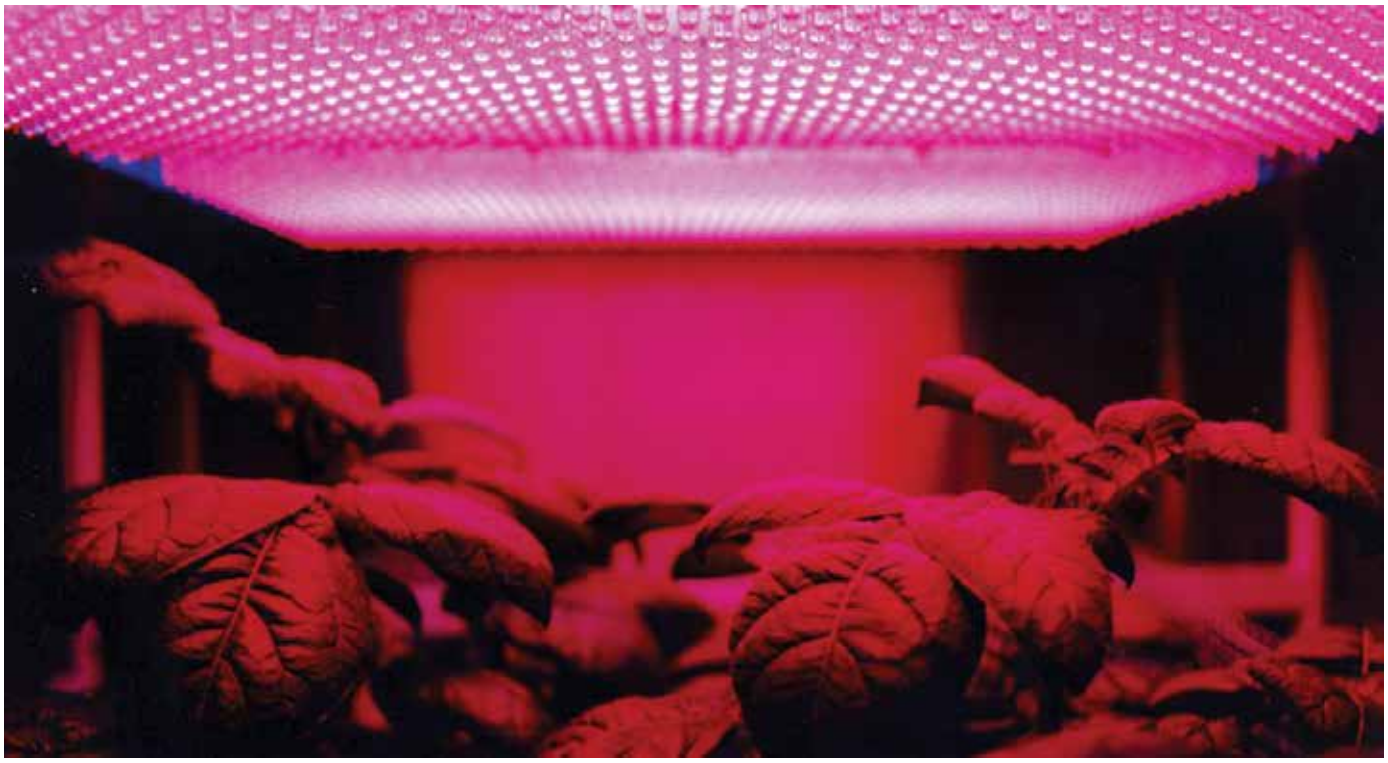
The study detailed some of the early results of a NASA grant awarded to Diao to investigate how wearable printed electronics will be used to make farming possible in space.

Diao's team landed on a 'Stretchable-Polymer-Electronics-based Autonomous Remote Strain Sensor,' or SPEARS2, a very thin film device that helps restrain the crystal growth during assembly and printing.

"It is an exciting technical advance in our ability to perform precise, noninvasive measurements of plant growth in real-time. I look forward to seeing how it can complement the latest tools for interrogating genomic and cellular processes," Leakey said.

"We know that plants are experiencing a lot of stress during climate adaptation, and I think soft electronics can play a bigger role in advancing our understanding so we can ensure that plants are healthy, happy and sustainable in the future–whether that is in space, on other planets or right here on Earth," Diao said.

The study was supported by NASA and the Beckman Institute for Advanced Science and Technology.



Research uses polymer-based stretchable electrodes to remotely monitor plant growth, bringing scientists a step closer to growing plants in space to feed astronauts during long missions. / *NASA Marshall Space Flight Center*

Woese Research Scholars announced for 2024

Sarah Kim and Vanessa Quan were selected for the Carl R. Woese Undergraduate Research Scholar Program this summer. With the support of IGB, they will carry out research projects that have broad implications for society over a ten-week period in the summer.

Kim is currently a rising sophomore in neuroscience and will be continuing her work in the lab of Paul Bonthuis (GNDP), an assistant professor of comparative biosciences. Kim will be studying the effects of stress on individuals and their brains. Specifically, she will be looking at chronic social defeat stress in mice.

"My work has the potential to uncover the biological basis of post-traumatic stress disorder and major depressive disorder," Kim said. "I am excited to make major contributions as a co-author on future papers, which will give me an advantage when I apply for graduate programs in neuroscience."

Quan is a rising sophomore who is interested in materials science and engineering. She will be working in the lab of Gregory Underhill (RBTE), an associate professor of bioengineering. One of the lab's interests is liver stem cell differentiation to better understand their behavior in Alagille Syndrome, a life-threatening liver genetic disorder.

"This work was done in mouse embryonic liver cells, and I want to extend the studies into human cells," Quan said. "It's enriching to see how the classes I take outside of my lab are connected to what I'm working on, and I look forward to sharing my discoveries so I can help drive the progress of the field."

Sarah Kim, left, and Vanessa Quan have been selected for the Carl R. Woese Undergraduate Research Scholar Program. / *Photos provided by Kim and Quan*

Tap dancing frogs

Why do Dyeing poison frogs tap dance?

Despite being widely documented, the underlying role of toe tapping behavior in various amphibians is poorly understood. In the present study, researchers studied this behavior in dyeing poison frogs. Their study was published in *Ethology*.

"I used the slow-motion camera on my iPhone to take minute-long videos of the frogs tapping. Afterwards, I went back to each video and counted the number of taps on each foot to get the 'taps per minute'," said Thomas Parrish, a former undergraduate student in the Fischer lab (GNDP), and the first author on the paper.

The researchers first confirmed that the frogs tapped their toes more in the presence of prey by adding half a teaspoon of fruit flies to the terrariums.

"We wondered whether it had a function in prey capture or if it was just an excitatory response like how dogs wag their tails," said Eva Fischer, an assistant professor of integrative biology.

The researchers used different surfaces to see whether the tapping behavior changed when the frogs could see the prey but not feed on it. They placed the fruit flies in small, clear Petri dishes in the frogs' home and measured the rate of toe tapping. They found that the frogs had an average of 50 taps/minute when they couldn't access the flies compared to 166 taps/minute when they fed on free-moving flies.

"These results suggested that since they kept trying to eat in both cases, the tapping was not just out of excitement," Fisher said.

The researchers wondered, then, whether the toe taps were a form of vibrational signaling where the frogs used it as a way to startle or distract the prey before they fed. They used four different surfaces to test this question: soil, leaf surfaces, gel, and glass. They found that while the tap rate differed depending on the surface, there was no difference in the total number of feeding attempts or success.

The researchers are interested in studying the underlying biomechanical aspects of the muscles. "It would be cool to look at the anatomy and see how the muscles work," Fischer said. "Ultimately, we could ask whether all frogs can tap their toes if they have the right muscles or whether there's something special about the anatomy of poison frogs."

The study was funded by Illinois, the Dr. Kirk and Mrs. Shannon Moberg Scholarship, Robert H. Davis Undergraduate Research Prize, and the NSF.

The role of toe tapping behavior in poison frogs is poorly understood. */Sarah Westrick*

GRANTS

CHRISTOPHER BROOKE
NICHOLAS CHING HAI WU
Emory University (NIH)
NIAID Centers of Excellence for Influenza Research and Response (CEIRR)

SHARON DONOVAN
KELLY FREEMAN BOST
NAIMAN KHAN
YUAN-XIANG PAN
SANDRA RODRIGUEZ ZAS
MARGARITA TERAN-GARCIA
NIH
Elucidating Gene-Environment-Behavior Interactions to Uncover Causal Mechanisms for Obesity in Early Life

ANDREW SMITH
WAWRZYNIEC DOBRUCKI
ERIK NELSON
NIH
Translational Combinations of Nanocarriers and Blockers for Metastatic Breast Cancer

HUIMIN ZHAO
DOUGLAS MITCHELL
WILFRED VAN DER DONK
NIH
A Next-Generation Scalable Platform to Discover Antimicrobials of Ribosomal Origin

SIHAI DAVE ZHAO
PAUL BONTHUIS
HOWARD GRITTON
YURII VLASOV
NIH
CRCNS Research Proposal: Multimodal Network Interactions Underlying Internal State Dynamics of Resiliency

ANDREW LEAKEY
MATTHEW HUDSON
DIWAKAR SHUKLA
HUIMIN ZHAO
NSF
Global Centers: Alliance for Socially-acceptable & Actionable Plants

DEBORAH LECKBAND
SUSAN LEGGETT
NSF
Forcing organization in multicellular assemblies

HUIMIN ZHAO
GEIR DULLERUD
SARAH STERMAN
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HUIMIN ZHAO
CARL GUNTER
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STEPHEN LONG
MEGAN MATTHEWS
Carbon Technology Research Foundation
Designing and Developing Plants to Draw Down More CO_2 and Store it in the Soil (DDPCS)

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JENNIFER DAVIS
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The Wayfarer Foundation
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ILAN SHOMORONY
MAXIM RAGINSKY
AbbVie, Inc.
Advanced Computational Approaches in Drug Discovery Design and Development

DOUGLAS MITCHELL
Ono Pharmaceutical Co Ltd
Directed Evolution of Macrocyclic Pyritides

JULIA POLLACK
CORINNE CAMPBELL
City of Urbana (Illinois)
Urbana Arts Grant - Art Lab: Creating a Conversation Between Art & Science

JASON RIDLON
ISAAC CANN
JOSEPH IRUDAYARAJ
Johns Hopkins University (Prostate Cancer Foundation)
Targeting Gut Bacterial Androgen Production to Reverse Therapeutic Resistance in Metastatic Prostate Cancer

AMY WAGONER JOHNSON
Carle Foundation Hospital
Shared Employee Agreement – Sarkar

BRIAN CUNNINGHAM
YING FANG
USDA
Portable, Rapid, Sensitive, and Inexpensive Point-Of-Use Biosensor Technology and Assays for On-Farm Detection of ASFV Infection

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USDA
Congress on Gastrointestinal Function 2024

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Chancellor's Staff Excellence Award

ALISON BELL
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Associate, Center for Advanced Study
Guggenheim Fellow, John Simon Guggenheim Memorial Foundation
Member, American Academy of Arts and Sciences

RASHID BASHIR
Grainger Distinguished Professor of Bioengineering; Dean, Grainger College of Engineering (CGD/M-CELS)
Member, American Academy of Arts and Sciences

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Fellow, American Association for the Advancement of Science

ANDREW LEAKEY
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Michael Aiken Chair

ZEYNEP MADAK-ERDOGAN
Associate Professor, Food Science and Human Nutrition (CGD/EIRH/GSP)
Michael B. Kastan Award for Research Excellence, American Association for Cancer Research
University Scholar

RIPAN MALHI
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Associate, Center for Advanced Study

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Ivan Racheff Professor in Environmental Engineering

HELEN NGUYEN
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Fulbright Scholar
Fulbright Specialist

BRENT ROBERTS
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Gutgsell Endowed Professor

TAHER SAIF
Edward William and Jane Marr Gutgsell Professor of Mechanical Science and Engineering (M-CELS/RBTE)
National Academy of Engineering

JACOB SHERKOW
Professor of Law (GSP)
University Scholar

STEPHEN SLIGAR
Professor Emeritus of Biochemistry (ACPP)
National Academy of Sciences

TOMMIE STURGEON
CNRG Senior Research Programmer
Cohort, IT Leadership Workshop

SUSAN THOMAS
Deputy Program Manager (IGOH)
Chancellor's Staff Excellence Award

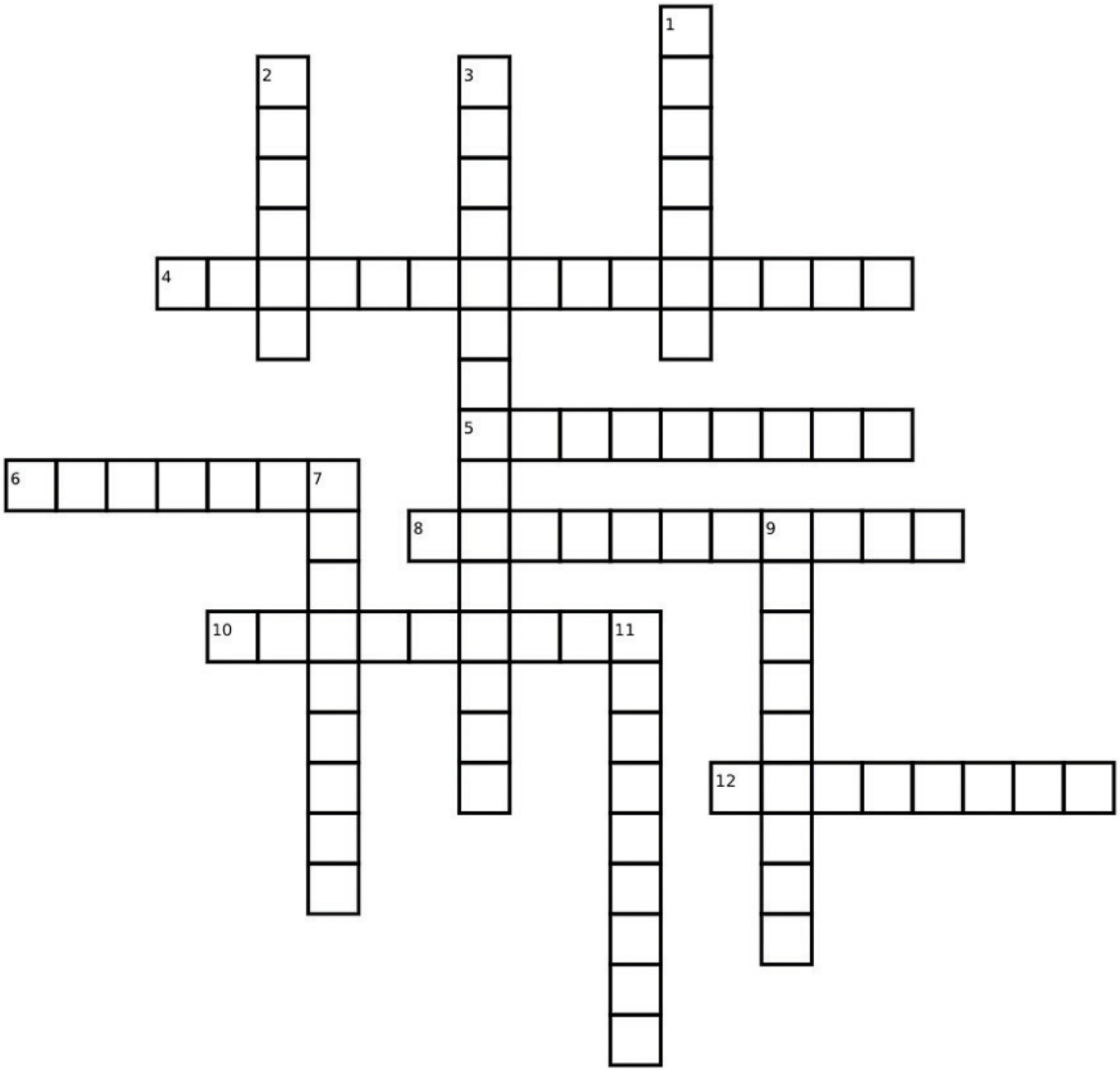
Volunteer
WITH THE IGB!

The IGB is looking to add more names to our list of volunteers! We have a plethora of fun events happening throughout the year and need your help!

- → Flexible dates and times
- → Choose the events you want to help with!
- → Open to all career stages
- → Earn an outreach certificate and a t-shirt

Biomarker: The Crossword

Have you read this year's Biomarker cover to cover? Find out by solving this puzzle!



Down

1. The university that the Robinson lab members teamed up with to study GxE interactions
2. Established a new endowment to support the M-CELS theme
3. Group of steroid hormones adversely linked to lung tumors
7. Neurotransmitter used to stimulate muscle into releasing more irisin
9. Kind of conductance involved in $C0_2$
11. New antibiotic found to selectively target gram-negative pathogens

Across

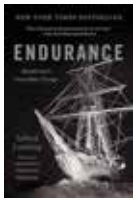
4. Technique judges used to separate DNA during an IGB workshop
5. RNA molecules capable of catalyzing biochemical reactions
6. Activity poison dart frogs engage in with their toes when prey are near
8. Part of the brain that nanoparticles accumulate in for those with Alzheimer's
10. Type of DNA used in genetic genealogy
12. The type of purple heirloom tomato that showed enhanced growth and VOC emission with its fungal partners

Fireside Reads

Books to pass the time when a snowstorm hits

The Disappearing Spoon: And Other True Tales of Madness, Love, and the History of the World from the Periodic Table of the Elements
by Sam Kean
A treasure trove of adventure, betrayal, and obsession, the book carries fascinating tales of how each element has played a unique part in human history.

If on a Winter's Night a Traveller
by Italo Calvino
Considered a challenging read, the reader is a central character who is trying to finish the novel while the author weaves stories that abruptly end or get interrupted.



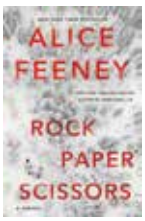
Endurance: Shackleton's Incredible Voyage
by Alfred Lansing
Based on a true story about Ernest Shackleton's expedition to Antarctica, the book highlights the team's incredible resilience and courage in the face of extreme conditions.

War
by Bob Woodward
A perfect read for learning the stakes of the 2024 US presidential election, the book interweaves the challenges the world faces with the US political climate.

A Woman in the Polar Night
by Christiane Ritter
A memoir that follows one woman's year of defying society's expectations to find peace and freedom by living in a remote hut in the Arctic.

There is No Antimemetics Division
by qntm
A modern cosmic horror, this book engages the reader's anxiety through an intense crescendo of short stories that contributes to a larger whole.

The Song of the Cell: An Exploration of Medicine and the New Human
by Siddhartha Mukherjee
Drawing from the author's experience as a researcher and doctor, the book tells the story of how scientists discovered cells, understood their inner workings, and are now using them to help society.



Rock Paper Scissors
by Alice Feeney
Split into different perspectives, the psychological thriller follows an unhappy couple as they spend a weekend in an old chapel, completely cut off from civilization.

The Monster of Elendhaven
by Jennifer Giesbrecht
A gripping tale of revenge, the book has parallel, twisting narratives that leave the reader sympathizing with the most horrible people imaginable.

Moon of the Crusted Snow
by Waubgeshig Rice
A post-apocalyptic thriller, the book follows a group of community members after they are cut off from the rest of the world amidst a societal collapse.

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

Stay connected to news, events, and program information at the Carl R. Woese Institute for Genomic Biology. By joining our mailing list, you'll receive our e-newsletter, publications, and details about seminars, workshops, and symposia at the IGB. Visit igb.illinois.edu/subscribe

For more information

TRACY PARISH
Director of External Relations and Strategic Partnerships
217-265-0880
tparish@illinois.edu

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.

EIDOLON OF ORPHEUS

Art of Science Volume 14

Scientist Collaborator Miranda O'Dell, using the Nanozoomer Slide Scanner, funded by IGB Core Facilities Group.

All scientists stand at the edge of a precipice; behind them is the accumulated knowledge of their peers and preceptors and in front of them lies a fog of questions. As they cast out the torch of scientific inquiry, the fog either dissipates to reveal clear answers or thickens, leaving more questions. As Walt Whitman said in his poem "Eidolons":

> Beyond thy lectures learn'd professor,
> Beyond thy telescope or spectroscope observer keen, beyond all mathematics,
> Beyond the doctor's surgery, anatomy, beyond the chemist with his chemistry,
> The entities of entities, eidolons.

The colorful layers of the image were created from oil pastel drawings and serve as a background to the mold *Penicillium*, which is central to the production of delicious cheeses, industrial enzymes, and, famously, the antibiotic penicillin. Usually, you might see this fungus as an offensive, dark piece of velvet cloth growing on rotten fruits. If you zoom in using a microscope, however, a different picture emerges; a branching tree whose individual units indelibly changed the landscape of medicine.