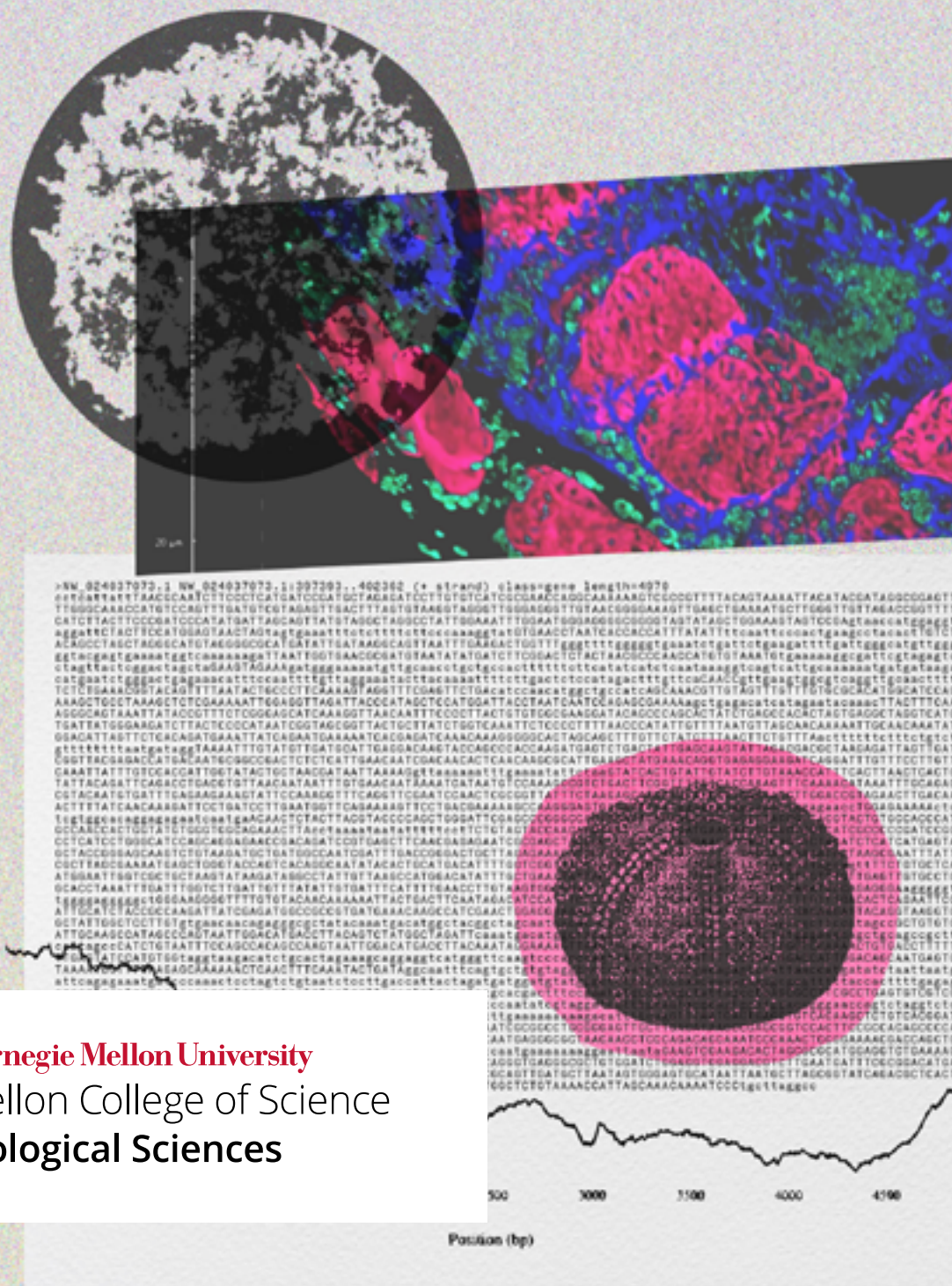
SPRING 2024

THE PROMOTER



Carnegie Mellon University
Mellon College of Science
Biological Sciences

THE PROMOTER

Department of Biological Sciences

The Promoter is published yearly by the Department of Biological Sciences at Carnegie Mellon University for its students, alumni and friends to inform them about the department and serve as a channel of communication for our community. Readers with comments or questions are urged to send them to vhinman@andrew.cmu.edu. The department is headed by Veronica Hinman.

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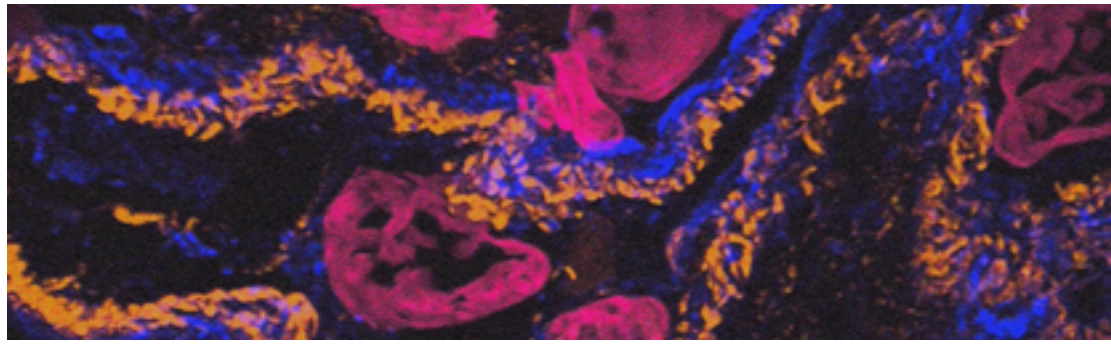


Letter from the Department Head

I'm thrilled to share the latest issue of the Promoter with you! As we navigate an ever-more-connected interdisciplinary approach to research, the Department of Biological Sciences thrives on the close partnerships we've forged with other parts of the university. Our faculty and students are at the heart of exciting interdisciplinary work.

Take Alison Barth, for instance. Recently honored as an AAAS Fellow, she's a neuroscientist diving deep into brain algorithms that drive learning, and she is applying that knowledge of circuit principles to design robust and efficient engineered systems.

Data is the currency of today. The explosion of information, collected at lightning speed, fuels our enthusiasm. In this issue, our feature delves into the community that is building and using innovative tools to shape neuroscience, microscopy and genetics.

To help students understand that data in deeper ways, we created the Quantitative Biology and Bioinformatics program, and our inaugural class of graduates are on their way to becoming trailblazers and future scientific leaders.

Speaking of our students, check out some of their amazing stories in this issue. Our students inspire me every day with the work that they do in the classroom, labs and outside of their academic endeavors.

Join me in celebrating the future of science and the Department of Biological Sciences. If you find yourself on campus or in Pittsburgh, swing by — we'd love to catch up!

Veronica Hinman, Ph.D.

Dr. Frederick A. Schwertz Distinguished Professor of Life Sciences
Professor & Head, Department of Biological Sciences

Faculty Notes

Barth Elected 2023 AAAS Fellows

Alison Barth, who holds The Maxwell H. and Gloria C. Connan Professorship in the Life Sciences, was one of five Carnegie Mellon University faculty members elected as 2023 fellows of the American Association for the Advancement of Science (AAAS).

Barth has been recognized for distinguished contributions to the field of cellular and systems neuroscience, particularly in linking molecular mechanisms of synaptic plasticity to behavioral learning.

Barth, who joined Carnegie Mellon in 2002, has appointments in the Department of Biomedical Engineering and the Carnegie Mellon Neuroscience Institute.

A pioneer in developing molecular methods to understand brain-scale neural circuit plasticity and function, Barth's recent work has focused on understanding brain algorithms that enable learning and using these circuit principles to design robust and efficient engineered systems.

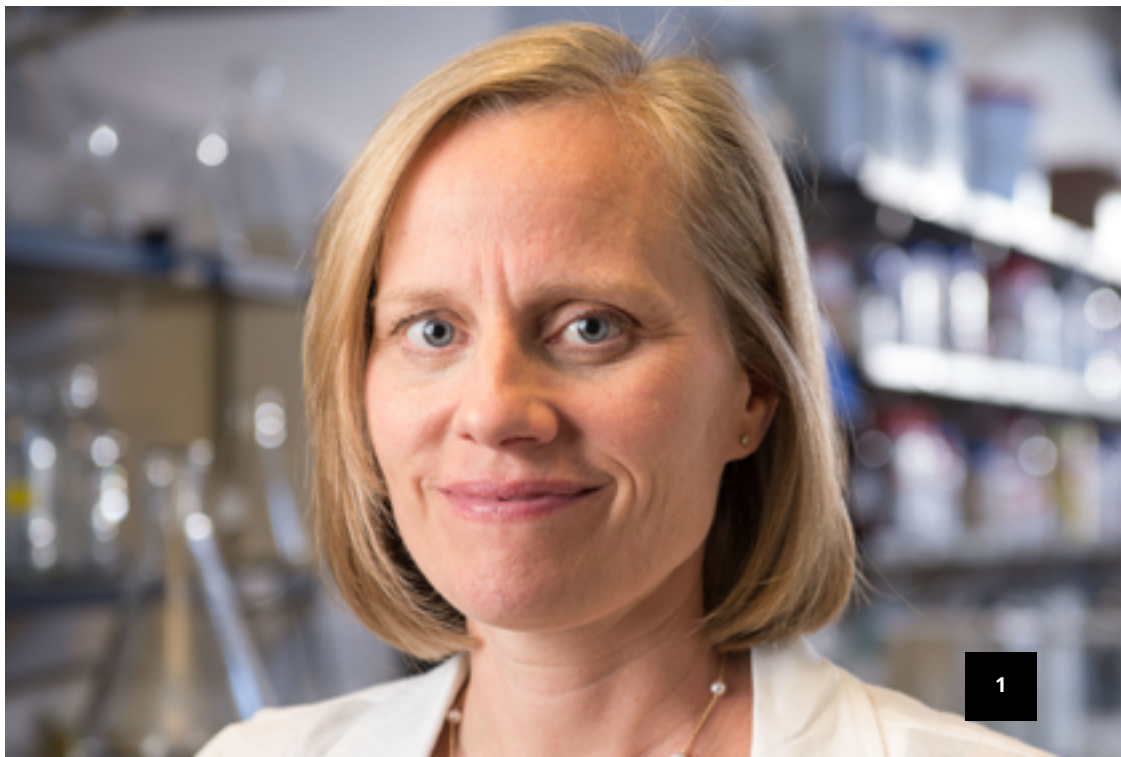
She has received numerous awards, including the McKnight Foundation's Memory and Cognitive Disorders Award, the Humboldt Foundation's Bessel Research Award and a Sloan Foundation Fellowship.

Barth earned her Ph.D. from the University of California, Berkeley, and completed a postdoctoral fellowship at Stanford University.

This year, 502 scientists, engineers and innovators were elected AAAS fellows and recognized for their distinguished achievements by the world's largest scientific society. Along with Barth, Carnegie Mellon University faculty members who were elected this year include Linda Argote, The Thomas Lord Professor of Organizational Behavior and Theory; Philip LeDuc, professor of mechanical engineering; Matthew Mason, professor emeritus; and Prasad Tetali, The Alexander M. Knaster Professor and head of the Department of Mathematical Sciences.

A tradition dating back to 1874, election as an AAAS Fellow is a lifetime honor. The newly elected AAAS Fellows will be honored for their achievements at a celebration in Washington D.C.

■ *Heidi Opdyke*



Biologists Determine Bacteria Sense Damage to Relatives

Carnegie Mellon University biologists have discovered that *Vibrio cholerae*, the bacteria behind the cholera disease, can sense when its relatives die. Bacterial cell death is often accompanied by lysis, where the cell explodes, releasing internal cellular components. The researchers found that a small molecule released during cell lysis is detected by living *V. cholerae*, which drives the survivors to clump together and form large communities, known as biofilms, to protect themselves.

"Our basic finding was that populations of bacteria can alter their collective behaviors when they sense the deaths of their relatives," said Jojo Prentice, a research associate in the Department of Biological Sciences. "The most interesting aspect of this work is that it provides a mechanistic connection between bacterial lifestyles and the threats they face in the wild — two features of their biology that were well known to independently shape their evolution."

Prentice and Drew Bridges, assistant professor of biological sciences, identified the cell death signal, norspermidine, as well as the receptor, called MbaA, found on *V. cholerae* cells, this is responsible for sensing the signaling process. When the MbaA receptor detects extracellular norspermidine, the death signal, it drives *V. cholerae* cells to form biofilms, which protect cells from pervasive environmental threats.

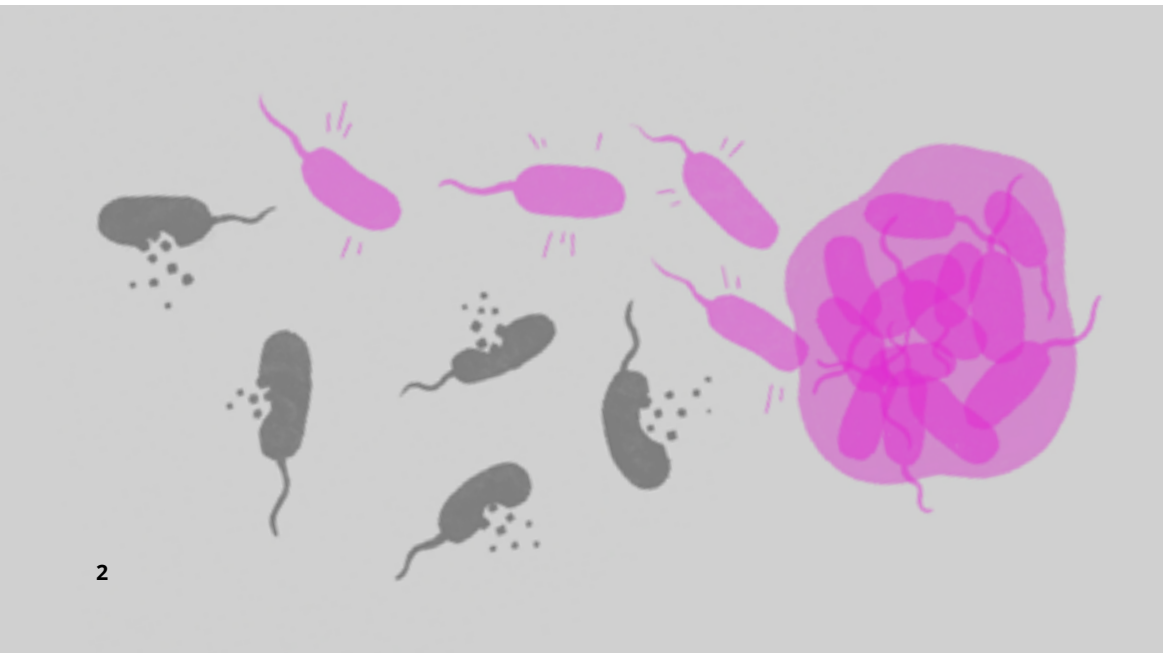
This pathway works for *V. cholerae* and other bacteria in the *Vibrio* genus, such as *V. vulnificus*, bacteria that can lead to necrosis and death. Bacteria in the *Vibrio* genus will form a biofilm if any other bacteria in the same genus are damaged.

"This is such a simple mechanism that could be fundamental," Bridges said. "We want to explore what other bacteria also do this. In addition, we really want to know what else is regulated by these receptors other than just biofilm formation. Are there any other sorts of bacterial immunity factors that are regulated by this cell lysis?"

Bridges plans on investigating similar cellular mechanisms in his future directions, and his lab recently received funding from the Curci Foundation and the Kaufman Foundation to expand their work and the number of researchers working on it.

Prentice and Bridges were joined by Robert van de Weerd on "Cell-Lysis Sensing Drives Biofilm Formation in *Vibrio cholerae,*" published in Nature Communications. Their work was funded by the National Institutes of Health and the Damon Runyon Cancer Research Foundation Dale F. Frey Award for Breakthrough Scientists.

■ *Heidi Opdyke*



New Faculty

ELIZABETH RANSEY

Elizabeth Ransey joined the Department of Biological Sciences in November 2023. Her research explores the structure and function of gap junctions, which are cell signaling channels implicated in numerous diseases.

In addition to conducting research, Ransey will teach courses in biochemistry.

Ransey was a graduate student at Carnegie Mellon from 2010 to 2013, receiving a Graduate Research Fellowship from the National Science Foundation (NSF) and a research dissertation fellowship from the United Negro College Fund (UNCF) - Merck Science Initiative Graduate Research Fellowship. She developed an interest in X-ray crystallography and completed her Ph.D. at Harvard University. Previously she was a postdoctoral researcher at Duke University.

BRETT WISNIEWSKI

Brett Wisniewski joined the Department of Biological Sciences in fall of 2023. He assists with teaching multiple classes, including Modern Biology and Cell and Development.

He hopes to develop microscopy and microbiology course as well as a science writing course tailored to students with primary majors in the Mellon College of Science.

Wisniewski became more involved in education as a Ph.D. student at Northwestern University, where he investigated the mechanics of mitochondria, organelles which provide energy for cells, in yeast cells. He mentored undergraduate students and taught multiple courses for both biology majors and non-majors.

Hinman Awarded International Kowalevsky Medal

Veronica Hinman's research into starfish, urchins and other echinoderms is unlocking secrets to evolutionary and developmental biology.

Hinman, head of the Department of Biological Sciences and the Dr. Frederick A. Schwertz Distinguished Professor of Life Sciences, was announced as the winner of the international Kowalevsky Medal, which is given annually by the Saint Petersburg Society of Naturalists for extraordinary achievements in evolutionary developmental biology and comparative zoology. The award is named after Alexander O. Kowalevsky, an influential 19th century biologist who worked at the intersection of evolution and embryology.

"It's a tremendous honor," Hinman said. "The people who have received the medal before me have been among my heroes in the EvoDevo field, so it is an enormous honor to be listed among them."

A member of Carnegie Mellon's Department of Biological Sciences since 2006, Hinman researches the evolution of developmental mechanisms, focusing on gene regulatory networks (GRNs), the complex pathways that control the expression of the genes, which are present at the beginning of most organisms' lives. How these genes are expressed results in the vast diversity of life that is present on Earth today.

Starfish and humans, along with other vertebrates, share a number of similarities in their early development, genome organization and gene content. Hinman oversees Echinobase, a web-based resource that provides access to genomic, expression and functional data from research related to starfish, sea cucumbers, sea urchins and other types of echinoderms. The National Institutes of Health NICHD P41 grant that funds Echinobase has recently been renewed for another five years. Hinman said Echinobase and other species model organism databases are crucial to scientific research.

NIH ECHINOBASE FUNDING

Echinobase is a repository that provides detailed information on known genomic information about a group of marine animals known echinoderms to researchers across the globe. Common echinoderms include sea urchins, sea cucumbers and starfish.

Veronica Hinman, along with Charles Ettensohn, professor of biological sciences at Carnegie Mellon, and Peter Vize, professor of biological sciences at the University of Calgary, created the latest version of Echinobase in 2020. The team received funding from the National Institutes of Health (NIH) to create the database, and in 2023, they received a $4 million grant to maintain the resource through 2028.

"Echinobase takes many types of disparate genomics datasets and brings them together into a single, easily searchable format. Researchers can rapidly find information about a gene of interest, for example, and then immediately find other information such as expression, function, genomic locus and information about this gene in multiple other species," she said. "These data provide a rich context to their work, allowing them to quickly gather diverse information and place their findings in the bigger context of other research."

Work on echinoderms could provide a pathway for future research on neuronal regeneration in humans. For example, in recent work, Hinman's lab discovered a mechanism that underlies the regeneration of neurons in starfish and showed for the first time that starfish can regenerate their nervous system.

"In development, the starfish uses orthologous genes to its vertebrate sister species. These findings may allow for the future understanding of how embryonic neurogenesis could be induced from other adult cell types in humans," Hinman said. "In humans, full recovery from traumatic brain injury, whether it be from an accident or an illness, is difficult and often impossible. If we could regenerate the brain cells that are no longer functioning, we could help to improve recovery from these devastating injuries."

Hinman earned a bachelor's degree in mechanical engineering in 1989, a bachelor's degree in zoology in 1994 and a doctoral degree in zoology in 2000 from the University of Queensland in Australia. After completing a post-doctoral fellowship at the California Institute of Technology in 2006, she joined the Biological Sciences faculty. She also is a member of Carnegie Mellon's Department of Computational Biology and the Center for Nucleic Acids Science and Technology.

■ *Heidi Opdyke*

Research Roundup

Researchers Zoom in on New Ways To View Biomolecules in Pathogens

A new set of protocols will allow doctors to expand the way they look at pathogens.

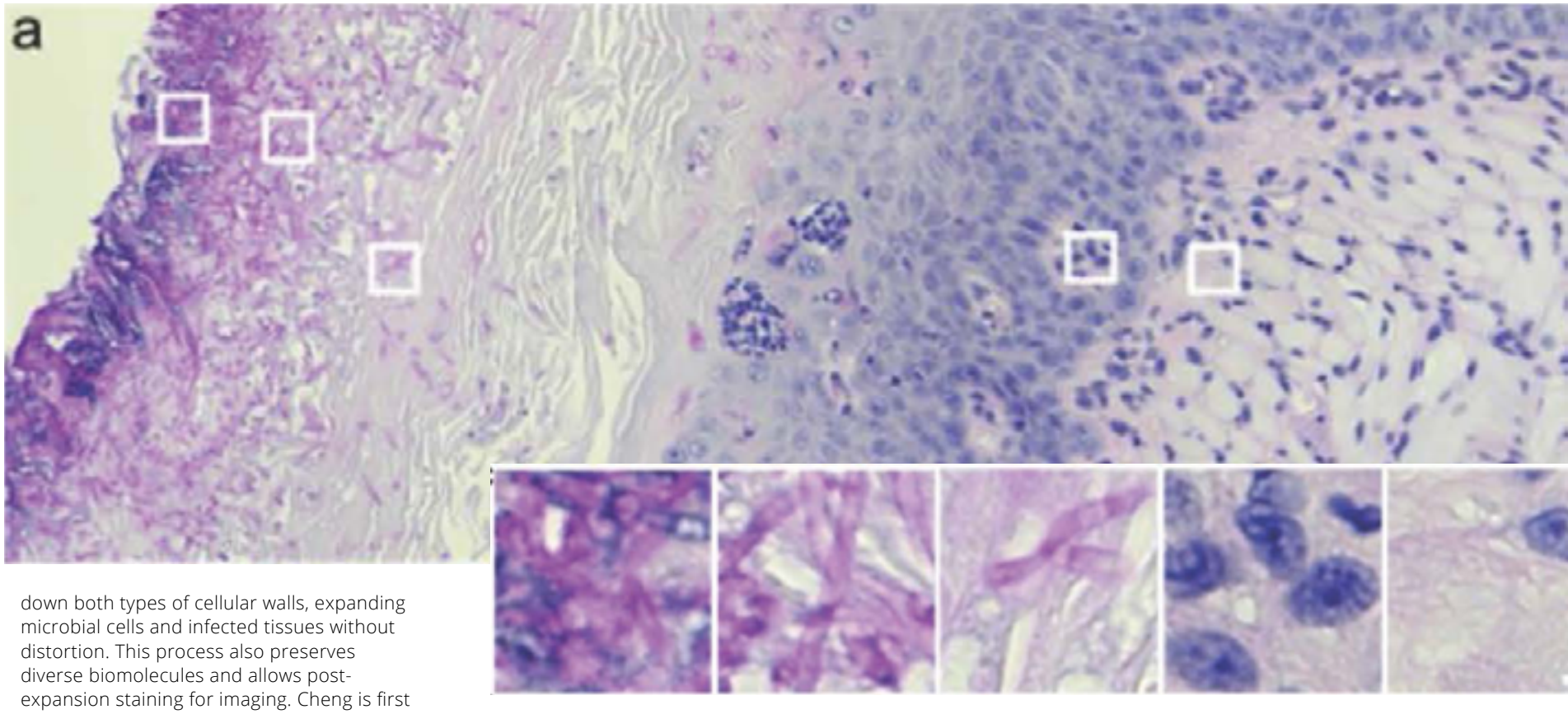
The principle of physically expanding biological study samples is known as expansion microscopy. The technique uses a hydrogel to homogenously expand cells and decrowd biomolecules, providing researchers with a way to visualize fine details in biological samples using standardized microscopes instead of expensive, specialized tools. Led by Eberly Family Career Development Associate Professor of Biological Sciences Leon Zhao, the Zhao Biophotonics Lab is a leader in advancing expansion microscopy for biomedical applications.

MicroMagnify, the latest protocol published by the Zhao Lab, takes their work a step forward. The protocol expands complex microbial cells and infected tissues without distortion, allowing enhanced high-plex fluorescence imaging capabilities.

Super-resolution optical imaging tools are crucial in microbiology to understand the complex structures and behavior of microorganisms such as bacteria, fungi and viruses.

"Visualizing infected tissues and pathogens has always been challenging due to the minuscule size of bacterial cells, often 1 micron or less," Zhao explained. "The development of a cost-effective, nanoscale imaging technique to visualize pathogens within host tissue is crucial for both research and clinical applications."

Traditional expansion methods struggle to break down the thick, rigid cell walls of bacterial pathogens like *Staphylococcus aureus* and the similar envelopes of fungal pathogens that protect cell shapes. However, doctoral student Zhangyu "Sharey" Cheng discovered that a mix of heat denaturation and enzyme cocktails effectively breaks down both types of cellular walls, expanding microbial cells and infected tissues without distortion. This process also preserves diverse biomolecules and allows post-expansion staining for imaging. Cheng is first author on a paper outlining the process in Advanced Science.



Researchers often will use fluorescent proteins to track molecules and cells during imaging, but current protocols limit instrumentation to at most five targets in one sitting. With MicroMagnify, Zhao said that they demonstrated how one sample could be used to image 10-12 targets within a pathogen-infected mammalian cell.

"MicroMagnify preserves biomolecules and proteins in the gel, enabling a cycle of imaging, labeling and washing with different reagents each round. Theoretically, this allows the study of hundreds of targets," Zhao added.

To better understand the complex three-dimension images generated by MicroMagnify, the Zhao Lab and Benaroya Research Institute (BRI) at Virginia Mason collaborated on ExMicroVR, an immersive virtual reality environment. With a low-cost VR headset, GPU-accelerated computer and internet access, scientists can meet virtually to explore biological data.

Caroline Stefani, research assistant member at BRI, helped pioneer the use of virtual reality as a 3D visualization tool for fluorescence images and prepared samples for the Zhao Lab. Stefani and Tom Skillman, BRI's former director of research technology, met Zhao through Grand Challenges, an initiative of the Bill & Melinda Gates Foundation.

"In this space, they can see the cell image and interact with simple avatars of each other," said Skillman, who founded Immersive Science, a VR company. "They can manipulate the cell image, point, talk, locate regions of interest and engage in discussions about the cell's response to an invading pathogen."

Next, Cheng is using MicroMagnify to study the microbiomes in the gut. "Microbiomes are incredibly complex and their interactions with host organs can significantly affect disease progress, such as tumors," Cheng said. "With MicroMagnify methods, we can resolve the composition and signaling of these microbiomes and explore how their interactions with host organs affect disease progression, such as cancer. This will enable us to profile the microbiomes and their signaling proteins with nanoscale precision and identify specific populations that may contribute to disease progression or, conversely, help prevent it."

The work was funded in part through Grand Challenges, an initiative of the Bill & Melinda Gates Foundation, DSF Charitable Foundation, Charles E. Kaufman Foundation and the National Institutes of Health Director's New Innovator Award.

■ *Heidi Opdyke*

RESEARCH FEATURE:

Quantitative Biology

by Kirsten Heuring

All biology starts with data.

"In biology, there is so much data to be had," said Veronica Hinman, head of Carnegie Mellon University's Department of Biological Sciences and the Dr. Frederick A. Schwertz Distinguished Professor of Life Sciences. "Having new tools to understand this data is of profound importance."

The Department of Biological Sciences is bringing big data and new technology to the forefront by putting an emphasis on quantitative biology.

"What we really want to do is uncover mechanisms of biology that are important for humanity, whether it be health, the environment or basic processes of biology," Hinman said. "Experimentation is the core of what we do, but there are new tools and technologies that allow you to get masses of data, and you have new statistical and AI tools to make sense of that data. At Carnegie Mellon, we're well poised to take advantage of that."

The Department of Biological Sciences has fostered a community that uses quantitative biology as part of research. Quantitative biology uses big data and new tools, like artificial intelligence (AI) and machine learning, to answer research questions.

"We've targeted hiring people who would be generating a lot of data and who would be interested in using new quantitative biology approaches. We've got a lot of faculty that are smart and savvy," Hinman said.

New Tools, New Solutions

Professors are using big data to create new tools, that — in turn — are used to acquire more big data. Technology is providing a self-perpetual model for scientific advancements.

"There are new tools that allow you to get masses of data. The problem is trying to find patterns and trying to distill what that data is telling you," Hinman said. Biological Sciences faculty are up to the task.

Eric Yttri, Eberly Family Associate Professor of Biological Sciences, developed a machine learning program known as A-SOiD with Ph.D. alumnus Alex Hsu and University of Bonn researchers. A-SOiD allows researchers to upload data, such as video of a human waving, and train the program to recognize identifiable patterns.

The difference between A-SOiD and other machine learning models is its guided learning. Most machine learning programs are black boxes, Yttri said, where researchers input data and the program reports results. But, researchers do not know exactly how or why the program comes to the final results.

A-SOiD allows researchers to show the program what it did wrong and re-learn from its mistakes. With proper data and training, A-SOiD can tell the difference between a healthy person's wave and the tremors of a patient with Parkinson's disease.

"This technique works great at learning classifications of animal behaviors," Yttri said. "We're going to be using it to address neuroscience questions."

Yttri said he plans to use A-SOiD in combination with other techniques to make connections between neural mechanisms and spontaneous behaviors. This new tool will allow Yttri and other researchers to understand nuances of human and animal behavior.

Yongxin (Leon) Zhao, Eberly Family Associate Professor of Biological Sciences, is building tools to pull big data from microscopic material.

Zhao's expansion microscopy technique known as Magnify is a set of protocols that use hydrogel to expand cells while keeping the cell's organelles, proteins and nucleic acids intact.

AI tools are enhancing his work further. Using Magnify, he expanded both cancerous and healthy cells and imaged them. Zhao and collaborators are using the images to train an AI tool to identify which cancerous cells could potentially respond to specific treatments.

"Magnify showed some features that allows AI to actually predict whether cancer patients can respond to chemotherapy, which is something that pathologists do not currently have the capability to do," Zhao said. "If it's successful, pathologists will have that capability, and oncologists will be able to optimize their plans."

Microscopic Components, Big Data

Many researchers in the Department of Biological Sciences are gathering large quantities of data from RNA and cellular mechanisms.

Joel McManus, associate professor of biological sciences, investigates gene expression, particularly how messenger RNA (mRNA) is used to synthesize proteins, a process called translation. He uses RNA sequencing and ribosome profiling to determine how efficiently mRNA from different genes is translated into proteins. Since ribosomes bind to mRNA, ribosome profiling allows researchers to see the locations of ribosomes on mRNA, the amount of mRNA expressed and the number of ribosomes bound to each mRNA.

The McManus lab has also developed two massively parallel reporter assays to comb through tens of thousands of mRNA sequences to uncover how many ribosomes they can load and how much protein is synthesized.

"We generate a lot of data," McManus said.

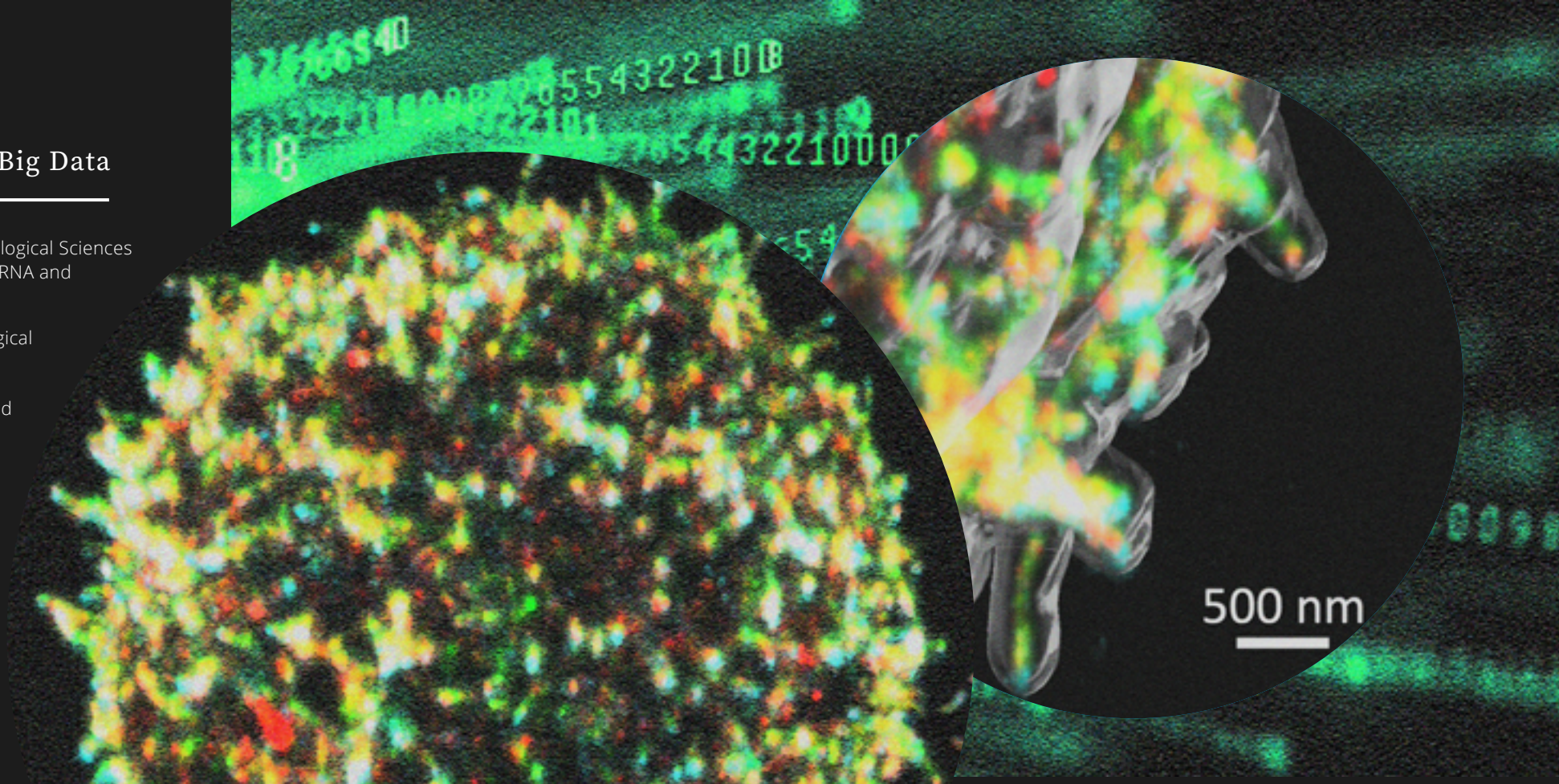
With the help of former Ph.D. student Christina Akirtava and lab research scientist Gemma May, the lab used machine learning to develop models that explain how the features of these sequences affect ribosome loading in yeast. Now, the lab is applying the same approach to investigate translation of human genes, with a broad goal of cracking the code for mRNA translation.

"When we compare mammalian genomes to the human genome, there are regions where everyone has the same sequence," McManus said. "These regions are very likely to have important functions."

En Cai, assistant professor of biological sciences, investigates T-cell activation. T-cells are a type of white blood cell that detects and destroys cells that carry pathogens in the body.

Cai uses a combination of expansion microscopy and high-resolution imaging to create 3D images that show how T-cells respond at different points of activation, both before and after being exposed to pathogens. She has built a large data set that includes various markers of the different phases of T-cell activation. The next step is to collaborate with researchers in the Ray and Stephanie Lane Department of Computational Biology to design a machine-learning-based image analysis platform that can precisely identify the cell's signaling stages based on these markers.

"There are a lot of features that we can already see, but they're difficult to quantify," Cai said. "What we're trying to do first is get to the quantification of features reliably. We want to be able to use an image to see what kind of cell we're seeing and in what state."



Next-Gen Researchers

Cai and other faculty members aim to have students in the Department of Biological Sciences ready for a future with big data, machine learning and AI.

Cai teaches a graduate course on statistical and computational techniques that includes introducing students to the programming language Python.

"Students run into a lot of different types of data, for example, sequencing data, protein structure data, and imaging data. I want them to become confident that they know how to work with biological data and quantify it, so they can use it in their own research," Cai said.

For the final project, students are encouraged to apply the tools they've learned in the course to analyze raw data collected from real experiments. When she first taught the course in 2022, she had approximately 40 students; it has since expanded to more than 60 students.

Hinman said that the department will continue to emphasize the importance of quantitative biology tools, methods and data collection techniques. She said as the department expands, students, faculty and staff will continue to break new ground.

"I hope we maintain our focus on making important findings, doing rigorous, careful science that's going to stand the test of time," Hinman said. "We want to make the sort of findings that will make people 20 years from now say, 'that changed our way of thinking about something, and it's held true.'"

Student & Postdoc Stories

Mia Carrarini Researches Medical Solutions

Growing up in Apollo, Pennsylvania, Mia Carrarini watched her father, an optometrist, work with patients. The experience made her interested in pursuing medicine.

"I learned a lot from my dad," said Carrarini, a recent graduate with majors in biological sciences and psychology and a minor in biomedical engineering. "I've seen him interact with patients, and if I can have 1% of his skill and his kindness, I know I'm going to be a really successful physician."

Carrarini came to Carnegie Mellon with medicine in mind. She joined the Health Professions Program (HPP) her first year. Through HPP and its director, Jason D'Antonio, assistant teaching professor of biological sciences, she connected with Donald DeFranco, professor of pharmacology and neuroscience at the University of Pittsburgh School of Medicine.

In the DeFranco lab, Carrarini investigated potential pharmacological solutions for premature babies who are likely to be affected by bronchopulmonary dysplasia, a chronic lung disease that damages the tissue.

Current bronchopulmonary dysplasia treatments can include the corticosteroid dexamethasone; though this treatment could help the lungs, it can have significant negative side effects, particularly on brain development in premature babies. However, by testing current drugs, she investigated the efficacy of a potential new option to promote lung maturation in premature infants while limiting negative side effects.

"The drug that we've found is actually an asthma medication that's already approved for use in young children," Carrarini said. "In animal models, we're not seeing negative effects on the brain, but we are seeing the same anti-inflammatory, protective effects in the lungs."

■ *Kirsten Heuring*

Biological Sciences Students Honored as Top Academic Athletes

The Student-Athlete Academic Achievement Celebration honored 35 of the highest-achieving juniors and seniors across all colleges and athletic teams, including two students from the Department of Biological Sciences.

Rising senior Emma Kulbida and recent graduate Maya McAuley both compete in swimming and diving. They both shared how competing has enhanced their Carnegie Mellon experiences.

"The team is such a great network of love and support and allows us all to achieve success at a higher level," Kulbida said. "The friendships that I have made and the community that I have found make me eternally grateful for getting to be a part of CMU swimming and diving."

"I've found that a lot more of the skills I've gained from my sport translate to academics than I would have thought," McAuley said. "The organization and efficiency I need to have to get everything done has really helped me with my research, where I am leading projects and need to figure out how to feasibly fit in multiple experiments and troubleshoot when things don't go as planned."

■ *Kirsten Heuring*

Lianna Huang Teaches New Tricks, Orchestrates Opportunities

Recent biological sciences graduate Lianna Huang flipped from teaching to research to music and handsprings, all in one day.

"Doing different things in my four years at CMU was very important to me," Huang said. "People are very surprised that I'm involved in so many things and can balance them, but since I love everything that I do, it's always worth the extra effort."

Huang was a member of the Carnegie Mellon Tricking Club from 2022 through 2024, becoming vice president during her senior year. The club blends gymnastics, martial arts, breakdancing, parkour and other forms of movement.

"Joining Tricking Club was like finding a home for me at CMU because I could incorporate all of those skills that I learned and also learn new skills from other people who have different athletic backgrounds," Huang said. "I really enjoy it, and I think the diversity of everybody there has really enriched my experience."

Her other longtime activity was performing with the All University Orchestra as a violist.

Huang performs almost as many feats in the lab as she did with the Tricking Club and orchestra. She works with Shou-Jiang Gao, professor of integrative systems biology at the University of Pittsburgh, in his lab that is part of the UPMC Hillman Cancer Center. She investigates B-cells, immune cells that produce antibodies, and how they are affected by Kaposi's sarcoma-associated herpesvirus, a virus that can lead to cancer.

Huang said some of her favorite experiences involved teaching as part of Student College (StuCo) or as a teaching assistant (TA). She served as a TA for Experimental Techniques in Molecular Biology and Experimental Cell and Development, and she taught a StuCo course on tea culture.

Huang plans to pursue a career in medicine. During her gap year after graduation, she will be continuing her research at UPMC Hillman Cancer Center. Huang said she is excited to make the leap from Carnegie Mellon to laboratory research and then eventually to medical school.

"I want to use medicine to take care of others," Huang said. "You can make such a great impact on the people around you."

■ *Kirsten Heuring*

Guatemala Trip Serves Communities, Inspires Students

Maddy Burke stood in an elementary school classroom in rural Guatemala, assisting a doctor with two patients, a mother and daughter. The mother said that her daughter hadn't eaten properly in two years, and the mother was suffering from abdominal pain.

"The only thing the doctor could do was prescribe vitamins for the girl. Vitamins weren't really going to help her, but it was the best he could do," said Burke, a recent biological sciences graduate. "And for the mother, the doctor realized she had cholecystitis, which is an inflammation of the gallbladder. So, she needed to go to the hospital to get her gallbladder removed, but the nearest hospital was an hour away, and the mother might not have the money or means to travel there. I really saw the differences between what they had compared to the medicine we have in the United States."

Burke and Grace Tang, a rising senior in biological sciences, traveled to Guatemala during spring break with the Global Medical Brigades (GMB), an organization that connects students from the United States and Europe with doctors in under-resourced countries. Students spend a week assisting doctors with patient intake and surveying the community to see what resources they need.

Like Burke, Tang saw the barriers to healthcare that the patients faced firsthand.

"In this community, they do a lot of weaving, and it's very evident in their clothes that it's all done by hand. It's super beautiful," Tang said. "A woman came in and had the tensest back because she had been weaving her whole life. There was no chiropractor available near the village, so we just provided some medicine to make her muscles less tense all the time."

Burke and Tang both said their experiences with GMB have influenced their plans for their futures. Burke plans to attend medical school in fall 2025, and she hopes to specialize in radiology.

"GMB affirmed that I want to go into the medical field," Burke said. "It gave me even more of an appreciation for how service can tie into medicine. As a doctor, I would want to be able to take trips like these with different groups and help provide medical care in places like these."

Tang said she plans to pursue a Ph.D. after she finishes her undergraduate education. She said that she hopes to go to graduate school, and learning how to communicate with people from a wide variety of backgrounds through GMB will help her with her goal.

"GMB helped me learn about the world, which is really important no matter where you want to go in the future," Tang said.

■ *Kirsten Heuring*

Bio Lab Olympics Make Sport of Science

Anna Cappella was ready for the Bio Lab Olympics. The junior biology major had spent the last two semesters perfecting her laboratory skills in the Experimental Techniques in Molecular Biology course and the Cell and Development course. As she made her way through the events — the Parafilm Pull, Conical Tube Bowling, the PCR Pipette Challenge — Cappella's confidence began to falter.

"We were using the same skills but in a new way, so I thought I would be good at it," she said. Narrator: She was not good at it. But it didn't matter to Cappella. "We learned a lot this year, and now we get to vibe. It's a nice break."

The Bio Lab Olympics, the brainchild of Carrie Doonan, director of undergraduate laboratories, and her team, takes place at the end of the spring semester when students are feeling the pressure of preparing for finals and finishing up projects. But on this day in late April, the undergraduate labs were buzzing with an infectious joy as first-year students and juniors and seniors had a little fun with their classmates, teaching assistants and instructors.

There was a lot of laughter — and smack talk — as students raced to see who could eject pipette tips the farthest, put on gloves over wet hands the fastest or pipette colored liquid into wells of a PCR plate to spell out 'PCR' the quickest.

"I thought I had a good strategy, but then I misspelled PCR," said a laughing Andrew Voor, a senior neuroscience major.

But it wasn't all about speed. Students guessed how many pipette tips, plates and test tubes the undergraduate labs use in a year. Teaching Lab Manager Mariah Murphy raided the stock room for old equipment and glassware, and students had to identify each item and what it was used for. Students sent a roll of tape barreling toward 10 50 mL conical tubes set up in a bowling pin formation.

"There are so many different types of activities, so no one feels intimidated. You don't have to do them all — you can just pick and choose what you want," said Assistant Teaching Professor Emily Drill.

Devon Gaichas, a first-year student in the introductory lab course Frontiers, Analysis and Discovery in Biological Sciences (FADS), spent the past year getting up to speed with bench work and experiment design after coming from a high school that didn't offer lab courses. Participating in the Bio Lab Olympics was an unexpected change of pace.

"We would never get away with doing this kind of stuff in the lab," Gaichas joked.

For Doonan, that's part of the appeal.

"We really wanted to show them the fun of lab," she said. "The overarching goal is stress relief, because that week they really need it."

But even more important is building community, Doonan said.

"I think they go hand in hand because if you feel a part of a community, you think, 'I'm not alone in this. I have other people who are going through this, too.'"

The stations were run by Biological Sciences faculty and staff, including Brian Corletti, Cytalia Crosby, Lynley Doonan, Ken Hovis, Amber LaPeruta, Kaelin McKelvey and Brett Wisniewski. Teaching assistants, who designed T-shirts for classes to wear, were also on hand for the days' events.

Ken Hovis, assistant dean for educational initiatives and associate teaching professor, was eager to help with the event this year.

"I usually only get to interact with students in the classroom setting, but here students were laughing, having fun and yelling with excitement," Hovis said. "And when I saw those students get awarded medals at the end of the event, it was pure joy and happiness on their faces. I had a great time! It was such a great environment."

The afternoon's activities culminated in an awards ceremony with students walking away with gold, silver or bronze medals in each event. Everyone also received participation medals, Olympic stickers designed by Associate Teaching Professor Natalie McGuier, and "Olympic-sized" treat bags full of nutritious snacks to get them through finals.

"The most heartwarming thing for me is to see the students grow, to feel confident and comfortable enough to go around to the events with another friend that they met in lab and just do something silly," Doonan said. "It's such a great event, and it's all thanks to this fantastic staff and these wonderful students. It's such a great community."

■ *Amy Pavlak Laird*

Claire Phoneprasert Wins the Gilman Award

Whether serving as a member of the Carnegie Mellon University Emergency Medical Services (CMU EMS) or helping as a teaching assistant in an undergraduate biological sciences lab, Claire Phoneprasert wants to help others.

"Both of these experiences really taught me that I wanted to help people," said Phoneprasert, a recent neurobiology graduate. "I really felt like part of the community."

Phoneprasert joined CMU EMS in August 2022 as she considered a career in medicine. She said she used it as a test to see if medicine would be a good fit.

Phoneprasert said that some of her most meaningful experiences were as a teaching assistant and a supplemental instructor for a range of courses covering biology and psychology. She started serving as a teaching assistant in her junior year, and she continued until graduation.

"The Department of Biological Sciences is amazing, and they do a really great job of making sure everyone in class feels supported," Phoneprasert said. "I had a really great experience in my bio labs, and it felt really gratifying to come back and make an impact as a TA."

For her efforts, Phoneprasert earned the 2024 Mellon College of Science Gilman Award. This award is given to a graduating MCS student who has demonstrated exceptional commitment as a scholar, professional, citizen and person.

Phoneprasert plans to spend the next year applying for medical school, which she aims to attend in fall 2025. She wants to bring the same positive, kind attitude she used in the classroom and as an EMT to her future patients.

■ *Kirsten Heuring*

Annie Meyer Receives Glen de Vries Fellowship

Annie Meyer wants her research to help biology develop and evolve.

"All animals start off exactly the same, but it's development that establishes the diversity we see," said Meyer, a Ph.D. student in the Department of Biological Sciences. "We have all these different concepts to try to understand how animals diverge, but it's really much more of a mess than we think."

Meyer investigates how multicellular organisms develop and how cells transition and differentiate using sea urchins and starfish.

Both echinoderms, sea urchins and starfish have overlapping genes and highly similar life cycles. However, sea urchins have two different types of cells that starfish do not, such as pigment cells that have immune functions. Meyer analyzes the genetics of these cells to see how they compare to cells in starfish.

"I found that even though pigment cells are novel to sea urchins, there are two populations of starfish cells that look similar," Meyer said. "One is immune, which makes sense, but the other one looks a lot like neurons. They express a lot of the same genes."

Based on her research, Meyer believes that the differences in cells are based on which genes are activated and which genes are not. Depending on which genes are activated, cells make different proteins, which have varying effects on cell function.

Veronica Hinman, Dr. Frederick A. Schwertz Distinguished Professor of Life Sciences, said Meyer's work has advanced research in her lab and has the potential to advance the field of developmental evolutionary biology.

"Annie has used a comparative single cell sequencing to examine the relationships between cell types and consequently frame inferences about how cell types evolve," Hinman said. "It's a very hot area of research as people are beginning to examine old assumptions about what constitutes a cell type and how they evolved in light of new data from single cell sequencing. Annie's work has been at the forefront of these new ideas."

Because of her work in and outside the lab, Meyer received the Glen de Vries Fellowship. The fellowship, which was created by Mellon College of Science alumnus Glen de Vries, recognizes outstanding research and potential in Ph.D. students studying biological sciences.

■ *Kirsten Heuring*

Mueller Brown Studies How Pneumococcal Bacteria Communicate

Karina Mueller Brown's work sometimes follows her home. The recent Ph.D. graduate in biological sciences studies *Streptococcus pneumoniae*, a pathogen that lives in the nasal passages of nearly half of all children, including — most likely — Mueller Brown's young daughter.

"There are occasions when I'm helping my daughter wipe her runny nose and wondering what the bacteria are up to in there. That's how geeky and nerdy I am," she jokes.

Mueller Brown is the 2023 recipient of the Bhakta and Sushama Rath Graduate Award, which supports a Ph.D. student in a STEM field whose research benefits U.S. industry or societal needs.

S. pneumoniae, commonly called pneumococcus, causes more than a million annual deaths worldwide, especially in young children and the elderly. The bacterium is on the Centers for Disease Control and Prevention's list of serious threats.

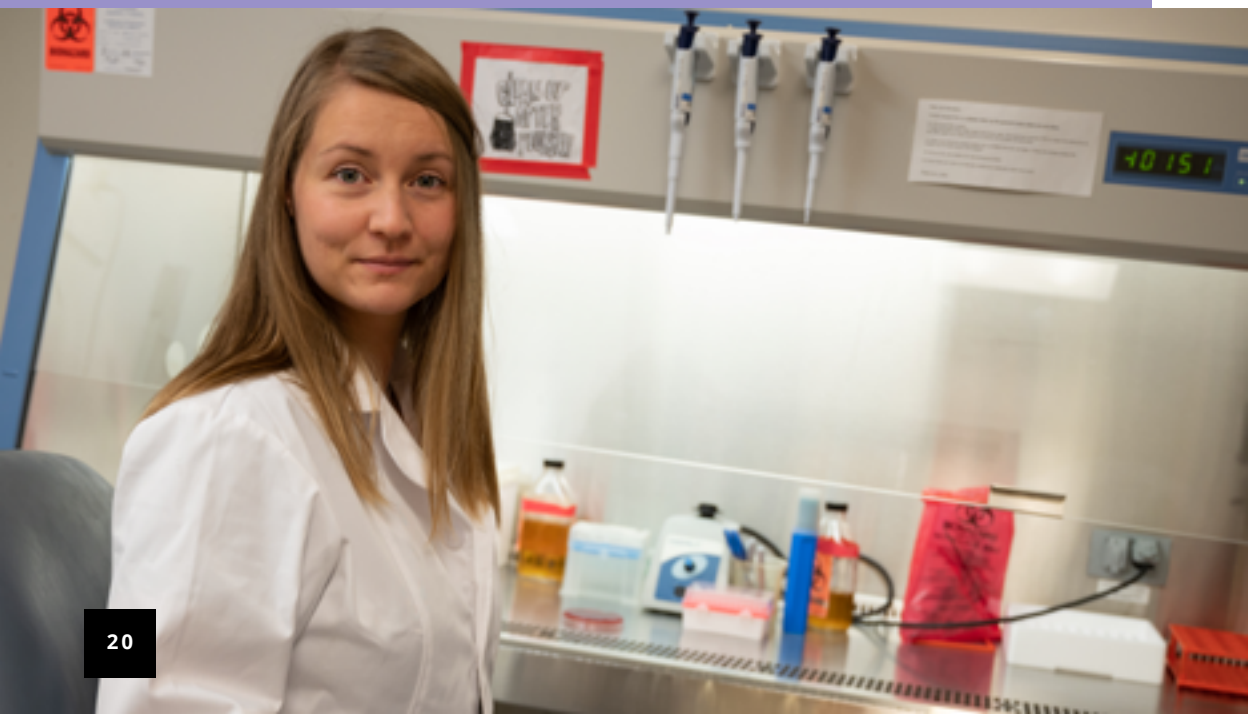
While it can present as a major pathogen, pneumococcus doesn't always cause disease. A community of pneumococcus can colonize the nose and throat without causing any further symptoms, but if these bacteria migrate to other tissues, they can cause dangerous illnesses. Mueller Brown wants to know why and how they turn pathogenic.

Pneumococcus exists in complex bacterial communities, where each individual bacterium produces and receives signals to sense the host environment and communicate with its neighbors.

The bacteria use many different systems for communication, each of which involve different signaling molecules. Each system has a distinct function related to staying asymptomatic or turning pathogenic. Scientists have characterized each system, and now Mueller Brown has uncovered a link indicating that the systems likely have to coordinate in a certain manner to cause disease.

"The interesting part is that this coordination is only detected when it has a host. You do not see it when you grow the bacteria in a culture, but if you grow them with a cell culture line of lung cells, that's when we can actually see this pathway being turned on and off," she explained. "The host is actually what triggers this mechanism."

■ *Amy Pavlak Laird*



Ashni Arun Pivots Engineering Background to a Biotech Future

Ashni Arun's dad and brother are her biggest support system.

"I am who I am because of my dad," said Arun, an alumnus who graduated from Carnegie Mellon University's Master's of Science program in Biotechnology and Pharmaceutical Engineering (MS-BTPE). "He still pushes me to be the best that I can be. I also have a lot of friends from back home in India who are a part of who I am."

Arun comes from a family of engineers, including her dad and her uncle. Arun said that for a lot of international students, being away from home is a struggle.

"There are a lot of differences between how I grew up and the culture here. Talking about these differences to my support system helps me," she said.

The MS-BTPE program is joint effort between the Mellon College of Science's Department of Biological Sciences and the College of Engineering's Department of Chemical Engineering designed to prepare students for new jobs in growing areas within biotechnology. Arun said the program's community is close.

"My cohort is pretty tight knit," she said.

The MS-BTPE program admits both engineering and biology students who work side-by-side in their coursework as they will in industry. Arun said she likes the structure of the program and its balance of required and elective courses.

Arun, who received her undergraduate degree in chemical engineering from Manipal Institute of Technology in India, spent her first semester focused on a deep dive into modern biology with other classmates who have engineering backgrounds. In parallel, those with a biology background trained on chemical engineering principles.

"I found it a challenge, a good challenge, to learn a lot of the biology, especially the lab work. It's not like I had done this before, and we were doing it at the master's level," Arun said. "I really liked what I was doing."

She added, "After the first semester, I think everyone has an equal understanding of all the subjects."

Last summer, she conducted research she started during the spring semester in the lab of Luisa Hiller, the Eberly Family Career Development Associate Professor of Biological Sciences. Arun purified extracellular vesicles (EVs) from bacteria and grew the bacteria on different media. The end goal of the research, which includes other collaborating labs, is to use the EVs as vaccines.

Arun said she realized the need for a scale up of drug production as she witnessed the need for vaccines during the height of the COVID-19 pandemic. As someone with a longtime interest in biology, she worked on drug delivery systems and tissue engineering with one of her undergraduate professors.

"Pharmaceutical engineering seemed very apt for me," she said.

■ *Lauren Smith*

M.S. in Quantitative Biology and Bioinformatics Creates New Opportunities

Amogh Ananda Rao wanted to make a lasting difference through research, but as a medical school graduate, he didn't feel he had the skills he needed to properly conduct the research that he felt would help him potentially change the field of medicine. To develop those skills, he registered for the first cohort in Carnegie Mellon University's M.S. in Quantitative Biology and Bioinformatics (MS-QBB) program.

"I realized CMU is where I need to be because I had a biology background, but I needed to learn programming and machine learning," said Ananda Rao, who graduated from the MS-QBB in December 2023. "CMU is No. 1 in computer science and artificial intelligence, so that is how I ended up here."

The program offers students with biology backgrounds opportunities to learn computational skills applicable to future careers in bioinformatics and quantitative biological sciences. The program, run through the Mellon College of Science's Department of Biological Sciences, allows students to choose a 2-semester or 3-semester option.

D.J. Braiser, associate teaching professor and assistant department head for graduate affairs of biological sciences, advises MS-QBB students. He said so far, all the students have chosen the 3-semester schedule.

"In that time, we provide students with a little bit of extra in-depth training in some of the skills that they're developing as well as giving them a little bit more flexibility in terms of elective options," Braiser said. "It also provides students with the opportunity to do an internship or research over the summer."

Ananda Rao conducted summer research that tied his medical school training with his newly acquired skills in quantitative biology and bioinformatics. He worked with Rema Padman, the Trustees Professor of Management Science and Healthcare Informatics in CMU's Heinz College of Information and Public Policy, to create a program that can suggest commonly missed medications based on which prescriptions a physician inputs into the program.

"The most common prescribing error that physicians make in the U.S. is missing a medication, so it's a very important problem to address," Ananda Rao said. "I built a recommendation system as to which ones are the most probable missing medications from a patient's prescription similar to how YouTube learns our tastes and videos and music and Netflix generally recommends these movies that you're likely to be interested in."

Ananda Rao has continued his work with Padman since graduation. He plans to pursue a Ph.D. so he can further develop tools that will improve diagnosis and prescribing of medications.

Tina Ryu, a current MS-QBB student, also has taken advantage of the research opportunities the program provides. She works with Zheng Kuang, assistant professor of biological sciences, investigating how the circadian rhythm is affected by gut microbiota, the ecosystem of beneficial bacteria that lives in the intestines. She focuses on three gene regulators in the intestine.

"The circadian rhythm is really important for immune function and metabolism," Ryu said. "Understanding the mechanisms behind the microbiota and the circadian rhythm can help us understand how we can treat diseases that are related to immunity and metabolism."

Before starting the MS-QBB, Ryu completed a postbaccalaureate fellowship at the National Institutes of Health, investigating compounds to support drug discovery research for medicines. She said she believes that the MS-QBB will allow her to pursue a career in computational research.

"I saw that the QBB program was specifically made for people who didn't have a strong background in computation but were interested in doing bioinformatics. I thought it would be perfect for me to develop computational skills while also doing biological work and research," Ryu said.

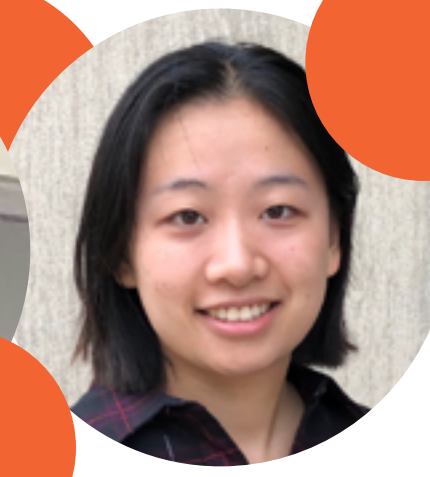
Brasier said that he is happy to see the success of the first two classes of students, and he looks forward to the future of the program.

"What sets this program apart is that it provides students with this collaborative opportunity to ask and answer questions independently or in groups," Brasier said. "Students are given a lot of flexibility and a collaborative group experience that is driven by scientific questions and go beyond the core skills that are in data analysis."

■ *Kirsten Heuring*





Four Ph.D. Students, Two Fellows Awarded Biological Sciences Departmental Grants

The Department of Biological Sciences has selected four graduate students and two postdoctoral fellows to receive awards funded through endowments from Margaret Carver and Semon Stupakoff. Four $5,000 awards provide funding for research enrichment and diversity, equity and inclusion initiatives, and three $1,000 awards are presented to candidates who have published outstanding papers in the last year.

Postdoctoral fellow Biplab KC received a Margaret Carver Research Enrichment Award. KC, a member of the Zhang lab, is involved in designing artificial condensate using a new generation photosensitive chemical dimerizer to understand Alternative Lengthening of Telomeres (ALT) phenotype in cancerous cells. He plans to use the award to buy additional reagents and equipment to expand his techniques. He will use the remaining funds to attend a workshop on quantitative imaging.

Ph.D. student Shaw Camphire received a Stupakoff Graduate Student Research Enrichment Grant. Camphire, a member of the Hiller lab, is working to understand the potential impact that a bacterial cell-cell communication system encoded in multiple species in the human upper respiratory tract has on human health. The award will be used to purchase an array of synthetic SHP144 peptides and to acquire microscope time to characterize biofilm phenotypes.

Ph.D student Elizabeth Ouanemalay received a Margaret Carver Grant for Enhancing Diversity, Equitability and Inclusion. A member of the Hinman lab, Ouanemalay will use the award to develop an annual symposium addressing diversity in the biological sciences. Along with the symposium, she plans to create a mentorship program and an online resource.

Ph.D. students Annie Meyer, a member of the Hinman lab, and Zhangyu (Sharey) Cheng, a member of the Zhao lab, each received a Stupakoff Outstanding Research Paper Grant.

Meyer is the first author “New hypotheses of cell type diversity and novelty from orthology-driven comparative single cell and nuclei transcriptomics in echinoderms,” published July 20, 2023, in eLife. For the publication, she developed several new methodologies and protocols, including the first protocol for single nucleus RNA sequencing in echinoderms and a novel analytic pipeline to integrate cell type atlases across species.

Cheng is the first author on “MicroMagnify: A Multiplexed Expansion Microscopy Method for Pathogens and Infected Tissues,” which was published October 2023 in Advanced Science. Her work aims to broaden the scope of Magnify, the lab’s previously published method known for its high expansion factor and universal molecule retention capability, by applying it to pathogens and infected tissues.

Postdoctoral researcher Meng Xu received the Margaret Carver Outstanding Research Paper Grant. His paper, “TERRA-LSD1 phase separation promotes R-loop formation for telomere maintenance in ALT cancer cells,” was published on March 9, 2024 in Nature Communications. Xu, a former member of the Zhang lab and now at the National Institutes of Health, worked on TERRA, a type of RNA found in cancer cells. The award will be used to support research in the Zhang Lab.

■ *Heidi Opdyke*

WILD WORK AT CARNIVAL

The Biological Sciences Student Advisory Council (BioSAC) Dog House at Carnegie Mellon University’s Annual Spring Carnival celebrated the 2024 year’s theme of “Arcade: Let the Games Begin,” with a design based on the game Animal Jam. The massively multiplayer online game teaches players zoology facts.

Samskrathi Sharma Receives AIChE Fellowship

Samskrathi Sharma is energized about her research into the circadian rhythm.

As part of her research, she studies how bacteria in the intestines affect the body's natural sleep-wake cycle. The gut microbiota influence not only the circadian rhythm but also a range of bodily functions including digestion.

Sharma, a Ph.D. student in the Department of Biological Sciences, said she's drawn to looking at how organisms interact with their environments.

"In the Kuang lab, we look at phenotypes," she said. "We look at metabolism and immunity, but we go down in the details of how it works. It's the perfect mix of application and basic biology."

Sharma focuses on how the gut microbiota's role in the circadian rhythm regulates metabolism through the genes Nr1d1 and Nr1d2, which create proteins that inhibit other circadian mechanisms. They have also been implicated in metabolization of fats and carbohydrates in the gut.

"We found that when you knock it out, their circadian rhythms are disrupted in the intestine, and the male mice gain more weight when they are on a high fat diet," Sharma said. "If they are eating a normal chow diet, they don't show any differences."

Sharma also found that once the microbiota is removed in the mice with inactivated genes, they do not have the same side effects. Her research indicates that the gut microbiota affects fat metabolization by communicating with Nr1d1 and Nr1d2.

Sharma shared her research at the Sixth International Conference on Microbiome Engineering in December 2023. There, she received an American Institute of Chemical Engineers (AIChE) Fellowship sponsored by the U.S. Department of Energy, the U.S. Army Research Labs and the National Science Foundation.

"It was a great experience," Sharma said. "I met people who could be potential collaborators, and I got a lot of helpful input and feedback about my work."

■ *Kirsten Heuring*

Alumni News

Arsema Thomas Acts with Others in Mind

Dearest readers, you've no doubt heard about Arsema Thomas (MCS 2016) and their breakout role as Lady Agatha Danbury in 2022's "Queen Charlotte: A Bridgerton Story."

A prequel to the blockbuster Netflix series, the show tells a late-1700s royal love story — and the beginnings of a 50-year friendship between the title character and a person of society.

"Lady Danbury is to me what a backbone looks like," said Thomas, who only started to pursue their dream of an acting career in 2018 after earning their master's degree of public health at Yale University and completing the college's prestigious Summer Drama Program after graduation. "She does not falter to anyone and has such a strong sense of self. They're two steps ahead of everyone because of the way the world worked, and still works, for women."

Conversations on gender and race are central to the show's storyline, and the same discussions drive Thomas' priorities off-screen, too.

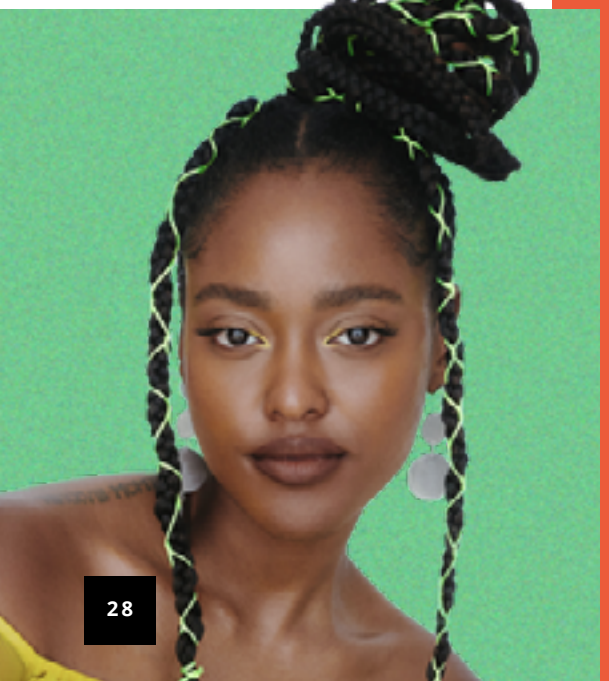
The child of two diplomats who "grew up everywhere," Thomas spent many years in sub-Saharan African nations. That led to an awareness and interest in global and Pan-Africanism affairs.

A plan to impact health care on the continent brought Thomas to Carnegie Mellon where they earned their bachelor's degree in biological sciences and participated in CMU in Haiti, Habitat for Humanity and Minority Association for Pre-Health Students (MAPS).

During their graduate studies, they founded the now-shuttered Mosaic, an online networking tool for refugees to connect their skill sets with needs in their area, and Enki, an SMS-based app that helps women in rural Kenya to monitor their menstrual cycles and subscribe to a discreet delivery of female condoms to combat the spread of HIV and AIDS. The company is currently working through the FDA and patent processes to create its own condoms.

"The foundation of everything I do is figuring out how to make unfair things more fair and create stability for more people," Thomas said.

■ *Amanda S.F. Hartle*



A FORMATIVE AND COLORFUL EXPERIENCE

"CMU felt like this massive playground where I was able to kind of dip my finger into whatever colors I wanted and see what came out in the end," Thomas said. "I learned what freedom was and gained the confidence to try whatever I wanted out in the world. It's one of the biggest things that I could have ever been given."

Connect with Arsema

@arsemathomas

Photo Credit: Samuel Paul

The Business of Life Sciences

Carnegie Mellon University alumna Pamela Bush remembers borrowing winter clothes for a trip from her home state of Florida to interview for the biology Ph.D. program in the Department of Biological Sciences.

"I came for an interview, and I almost froze," said Bush, who graduated with her doctorate in 2002 and her MBA in 2009. "But I absolutely loved the school. My goal, when I came to Carnegie Mellon, was I wanted to work in oncology. I wanted to find a cure for cancer."

Bush has built a career pursuing that goal with executive and consultant roles in life sciences business development. Most recently she was the chief business officer of Predictive Oncology, a life sciences company that uses artificial intelligence to develop personalized cancer therapies. She led strategic, operational and financial planning initiatives.

In her first year as a doctoral student, a class on the molecular biology of animal and plant cells and one on advanced genetics convinced Bush she was on the right track. Both courses required deep analysis of published studies.

"These were classes that included a lot of journal reading," she said. "We were learning how to critically think about the data that was being presented and the conclusions that were being drawn. They were teaching us how to be critical-thinking scientists."

One of the coolest things about the biology program, she said, was finding professors who encouraged students to seek careers outside of academia. Bush knew she wanted to work in business. During her Ph.D. program, she took classes without credit at the Tepper School of Business.

After graduation, she joined the Pittsburgh Life Sciences Greenhouse, a regional accelerator for health tech startups backed by the Commonwealth and area universities.

After five years, she returned to Carnegie Mellon to earn an MBA at the Tepper School. There she found the same focus on data and critical thinking that she had in her Ph.D. program.

Bush's first job after the Tepper School was in finance at Eli Lilly and Company. She went on to executive and consultant roles at pharmaceutical and bio/life sciences research firms.

As a double Carnegie Mellon alumna, Bush fields queries from science students who want to move into industry, like she did. She said she would like to do more to potentially help these students.

"Everybody should be a scientist. I don't know why everybody's not a scientist," Bush said. "I absolutely love it. It is the coolest thing to work in science at the intersection with business."

■ *Sally Parker*

OBITUARY: ALAN WAGGONER

Alan Waggoner, emeritus professor of biological sciences at Carnegie Mellon University, died peacefully at home surrounded by family on Tuesday, May 21, 2024. He was 82 years old.

Waggoner, the former Maxwell H. and Gloria C. Connan Professor in the Life Sciences, helped transform the fields of biomedical research and cell biology through his development of fluorescent probes that have allowed scientists to delve into the mysteries hidden inside cells. A brilliant scientist, Waggoner invented cyanine-based dyes called CyDyes, which are used to detect macromolecules like proteins and nucleic acids in cells and tissues. His dyes have greatly contributed to our understanding of how gene and cellular functions are regulated.

Born in Los Angeles in 1942, he graduated from the University of Colorado in 1965 and earned his Ph.D. in chemistry in 1969 at the University of Oregon. After completing postdoctoral work at Yale University, Waggoner taught at Amherst College where he served as chairman of the Department of Chemistry until 1982 when he joined the Carnegie Mellon faculty.

He left Carnegie Mellon in 1992 to become vice chairman of Biological Detection Systems, Inc., a Pittsburgh start-up company that sold microscope imaging systems and fluorescent labeling reagents developed at the university. In 1994, the start-up was bought by Amersham PLC and Waggoner joined Amersham as principal scientist and head of fluorescence.

In 1999, Waggoner returned to Carnegie Mellon as the director of the Molecular Biosensor and Imaging Center (MBIC). Under his leadership, MBIC became world renowned for its expertise in biochemistry, genetics, dye chemistry, and imaging.

When he retired from teaching in 2018, Waggoner continued to teach OSHER courses on the beginning of the universe and the origins of life. He also created Sharp Edge Labs, a spin-off company he started with the late Biological Sciences and Chemistry Professor Marcel Bruchez and Chemistry alumnus Scott Sneddon. The company uses biosensors developed at MBIC to identify new drugs to treat diseases caused by defects in protein trafficking.

Waggoner is the holder of 27 patents and the recipient of numerous awards in recognition of his fundamental contributions to the development of fluorescent-based detection systems for biology and biotechnology, which have advanced research worldwide. In 2010, Waggoner received the International Society for the Advancement of Flow Cytometry's distinguished service award for his significant contributions to both the advancement of flow cytometry and to the society.

Waggoner is survived by his wife of 58 years, Karen, and by children Shemariah Little (Waggoner) and Eben Waggoner, grandchildren Melina and Marc Little, and sisters Diana Davies and Teri Nebeker, and his beloved cats, Junior and Minnie.

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