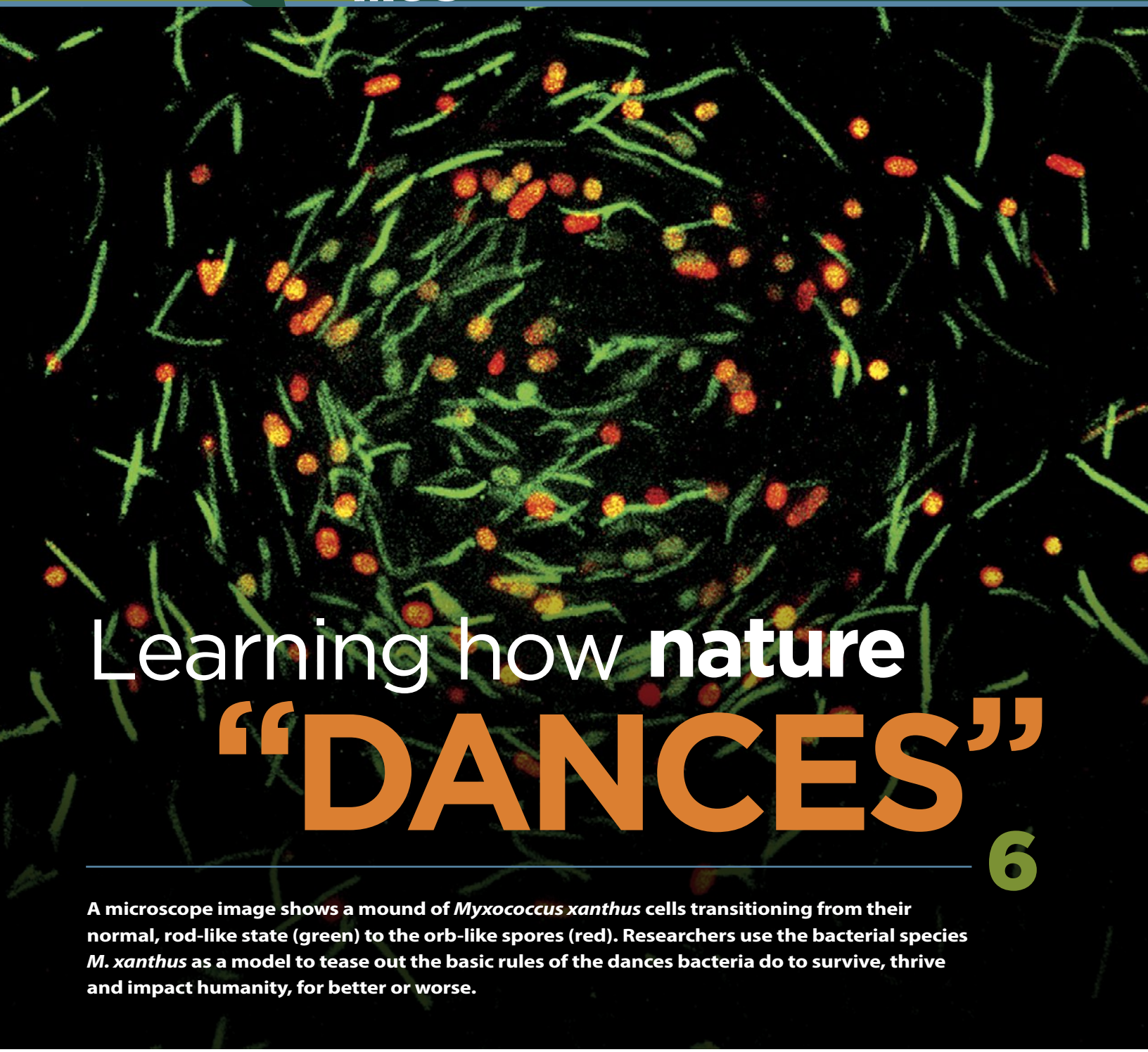
DEPARTMENT OF
Biochemistry & Molecular Biology
SUMMER 2022
MSU College of **Natural Science** | *Newsletter for Alumni and Friends*



Learning how **nature** "DANCES"

6

A microscope image shows a mound of *Myxococcus xanthus* cells transitioning from their normal, rod-like state (green) to the orb-like spores (red). Researchers use the bacterial species *M. xanthus* as a model to tease out the basic rules of the dances bacteria do to survive, thrive and impact humanity, for better or worse.

INSIDE

From the Department Chair. . .

Another challenging year is behind us, and while the pandemic is not yet over, there is optimism and a feeling that science and sensible policy will permit us to reach a new normal soon. Nothing, however, will bring back those we lost to COVID-19, and my thoughts are with them. Last year, we also lost to cancer our dear colleague, friend and collaborator Danny Schnell, chair of the Department of Plant Biology. Danny, you are very much missed!

This is my last message as chair of the Department of Biochemistry and Molecular Biology (BMB), as my five-year appointment ends in August, and I have decided not to continue for another term. I have enjoyed (almost) every minute of my interactions with the awesome BMB faculty, staff, postdocs and students, but my research program needs me back; having two full-time jobs is unsustainable. I very much look forward to continuing to make contributions to the department as a faculty member. Professor Tim Zacharewski will serve as interim chair until the ongoing external search for a new chair is completed.

> "Despite all the challenges imposed by the pandemic, BMB had another awesome year."

Despite all the challenges imposed by the pandemic, BMB had another awesome year. Many recognitions and awards were bestowed on my colleagues. Of particular note, Dean DellaPenna was elected a member of the prestigious National Academy of Sciences; and two BMB faculty members—Rob Last and Kennie Merz—were named MSU University Distinguished Professors (see page 5). BMB also welcomed Tommy Vo, who started in the fall of 2021 as an assistant professor. His research on the control of gene expression by RNAs and chromatin very nicely enhances existing BMB efforts in these areas. And Evelyn Grace joined us in mid-2021 as an academic advisor. You can read more about our new faculty and staff on page 4.

The many accomplishments of BMB faculty members in research and service have significantly increased the ranking of the department among its peers, a trend that I expect to see continue. These successes are possible because of the excellent support provided by our department staff, and I want to take this opportunity once again to thank them for their teamwork and extraordinary commitment to supporting our faculty and students.

Significant opportunities and challenges lie in front of us. We developed a new biochemistry laboratory course (BMB 370) to ensure that our majors get exposed earlier in their careers to hands-on experiences (see page 9). This course will first be taught fall 2022, and we anticipate that it will better prepare our students for industry internships, which should become part of the BMB/biotechnology major.

The number of majors in the department has significantly increased over the past two years. It is awesome to see this boosted interest in biochemistry and molecular biology, but without increased support, it will be a challenge to accommodate them in our classes, particularly the labs. We continue to count on our alumni, donors and friends to give back and help build the next generation of scientific leaders.

Thank you, as always, for your support. Enjoy the newsletter!

Erich Grotewold, Chair
Department of Biochemistry and Molecular Biology
grotewol@msu.edu

ALUMNI CLASS NOTES

Anita Klein, Ph.D., biochemistry, '81, retired in May 2020 after a 35-year career at the University of New Hampshire—initially a member and then briefly chair of the Department of Biochemistry and Molecular Biology. She spent two years on loan to the NSF as a program director for the Plant Genome Program (2005-2007). The last nine years of her career was divided between Faculty Fellow for the New Hampshire Agricultural Experiment Station and as a faculty member in the Department of Biological Sciences.

Rebecca Dutch, biochemistry and microbiology, '86, became the vice dean for research for the University of Kentucky College of Medicine in July 2021. This spring, she received two honors—a Southeastern Conference (SEC) Faculty Achievement Award, given to one faculty member from each SEC university annually; and election as a fellow of the American Academy of Microbiology.

Steve Proper, Ph.D., biochemistry and molecular biology, '13, completed training in the Advanced Allergy and Immunology Research Training Fellowship at Cincinnati Children's Hospital (where he is a practicing allergist/immunologist) and will be starting in August at Western Michigan University Homer Stryker M.D. School of Medicine in Kalamazoo, Mich., as an assistant professor in the Department of Pediatric and Adolescent Medicine.

Diana Dawood, biochemistry and molecular biology, '21, completed a contracting period at Pfizer Global Supply in Kalamazoo, Mich., as an analyst in the human health drug product department. She was then hired by Pfizer as a full-time colleague as a technician for aseptic plant support in the microbiology department.

Emily Veith, biochemistry and molecular biology, '21, will attend Kent State University College of Podiatric Medicine on an academic scholarship this fall.

BMB cultivates new talent with postdoc funding support

Research funding and the complementary expertise of mentors to afford synergistic gains in postdoctoral training are essential to future scientific leadership and success.

For that reason, BMB chair Erich Grotewold established the Trainee Early Career Award for Mentoring in Unexplored Problems, or TEAM-UP—a postdoctoral training program that offers innovative ways to initiate collaborations between data-driven research projects within the department that are not currently funded.

Grotewold said that these funds can serve as an important stepping stone to additional funding, citing the recent success of inaugural TEAM-UP research associate Stephanie Hickey.

"Stephanie was one of our first TEAM-UP postdocs, and her recent receipt of a Brain and Behavior Research Foundation Young Investigator Award would not have been possible without this fellowship," Grotewold said. "With TEAM-UP funds running out in the next year or two, we hope that funds such as the recently established Suelter post-doctoral fellowship provide the needed monies to continue this critical support."

Clarence Suelter

Now retired, Clarence Suelter was one of the first faculty members hired to join MSU's new Department of Biochemistry in 1961. To celebrate Suelter's academic achievements, department colleague Shelagh Ferguson-Miller, along with her husband, established the Clarence Suelter Endowed Post-Doctoral Fellowship.

"Offering a named postdoctoral fellowship is a very effective way to attract excellent post-doctoral scholars to MSU, which is key to furthering high-quality research in the department and increasing the stature of Michigan State and its faculty," Ferguson-Miller said.

This spring, María Santos Merino, a postdoctoral researcher in the lab of BMB's Danny Ducat, was the first to be awarded a Suelter postdoctoral fellowship, which she will use to visit the University of Turku in Finland to learn a new technique—membrane inlet mass spectrometry (MIMS).

To donate to the Suelter fellowship, use the envelope in this newsletter or visit NatSci.msu.edu/bmb-2022. To learn more about ways to support BMB, contact Karen Wenk, NatSci associate director of development, at wenk@msu.edu; 517-353-5962.

Retirement

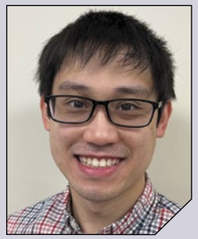
Wang

John Wang, professor, retired in December 2021, having served MSU for 44 years—since 1977. He received his Ph.D. in biochemistry from The Rockefeller University in New York, where he was a postdoctoral researcher and assistant professor before coming to MSU in 1977. He was widely recognized for his research on carbohydrate binding proteins and pre-mRNA splicing and galactins. Google Scholar credits more than 100 articles with excellent citation numbers to his name.

New Faculty/Staff

Grace

Evelyn Grace joined the department as an academic advisor in August 2021 (75 percent BMB; 25 percent plant biology). She advises undergraduate students on course selection, major and university requirements. Grace received her master's degree in higher education and student affairs from Ohio State University.



Vo

Tommy Vo became an assistant professor in January 2022, having worked as a postdoctoral fellow at the National Cancer Institute from 2016 to 2021. His research focuses on understanding the molecular mechanisms and tools that control gene activities, such as chromatin modifications, transcription regulation and RNA processing to determine how to help alleviate human disease and disorders.

Weise

Sean Weise became an instructor in January 2022, tasked with developing and co-teaching a new introductory course for biochemistry majors, which focuses on professional development and laboratory skills. Previously, he worked as a research assistant professor for BMB University Distinguished Professor Thomas Sharkey in the MSU-DOE Plant Research Laboratory.

Williams

Leslie Williams joined the department in March 2022 as an office coordinator. She manages the weekly external speaker seminar series, supports faculty searches, serves as department event planner and manages the chair's calendar.

Contact Us

The Department of Biochemistry and Molecular Biology newsletter is published annually by the College of Natural Science for alumni and friends of the department.

Send correspondence to:
MSU College of Natural Science
Advancement Office
288 Farm Lane, Room 5
East Lansing, MI 48824

(517) 432-4561 | natsci4u@msu.edu

Contributing writers: Erich Grotewold, Marguerite Halverson, Jeff Mason, Val Osowski and Laura Seeley.

Photographs, figures courtesy of: Lee Kroos Lab (cover, page 6); Department of Biochemistry and Molecular Biology (pages, 2, 3, 4); Harley Seeley (pages 5, 9, 11); Willis Wood family (page 7); Min-Hao Kuo (page 8, top); NCI/USC Norris Comprehensive Cancer Center/Min Yu (page 8, second image); Ben Orlando (page 8, third image); Emily Brown, Wikimedia Commons (page 8, bottom image; PNAS (page 10, top image); Kara Headley (page 10, bottom); Amy Ralston Lab (page 12).

CONNECT WITH NATSCI

Faculty Honors

Christoph Benning and **Gregg Howe** were among nine MSU faculty members recognized in the 2021 Highly Cited Researchers list, which honors researchers who "demonstrated significant and broad influence reflected in their publication of multiple highly cited papers over the last decade" from 21 different fields of study.

Bjoern Hamberger was named a J. K. Billman, Jr., M.D. Endowed Professor, a five-year award, effective June 1, 2022, in recognition of his distinguished research on the discovery of plant pathways for bioactive diterenoids in medicinal plant species, with significant contributions to teaching and service.

Susanne Hoffman-Benning received the MSU Award for Outstanding Service to Education Abroad from MSU International Studies and Programs for contributions that help fulfill the university's mission to advance knowledge and transform lives across the globe.

A. Daniel Jones was named a 2021 AAAS Fellow for his distinguished contributions to biological applications of analytical chemistry, particularly the use of mass spectrometry to study biochemistry, plant and microbial ecology.

Robert L. Last and **Kenneth Merz** were among 11 MSU faculty members named University Distinguished Professors in 2021 by the MSU Board of Trustees in honor of their achievements in research, teaching and mentoring, and community engagement.

Kristin Parent was selected by the American Society for Microbiology (ASM) for its Distinguished Lecturer Roster. ASM designates lecturers through an annual competitive nomination process, selecting only the most celebrated researchers as participants. Parent conducts pioneering research using electron cryo-microscopy and 3D image reconstruction methods to better understand the underlying mechanisms that control virus infection and decipher the process of virus assembly.

Rob Quinn was awarded a Metabolomics Association of North America (MANA) Early Career Rising Star Award in recognition of outstanding academic achievement. Quinn gave an oral presentation titled, "Table talk: dinnertime conversations between us and our microbiome," at the MANA 2021 this past October.

DellaPenna

Dean DellaPenna was elected to the National Academy of Sciences (NAS), one of the country's highest scientific honors—and one of just 120 members elected in 2021. NAS recognized DellaPenna for his excellent research in plant science, particularly plant biochemistry and genetics as they relate to human health and nutrition. He investigates plant metabolism and the molecules plants make, such as vitamin E and provitamin A, which are essential not just for plants but also for human and animal diets.

Postdoc/Graduate Student Honors

Jacob Bibik, graduate student, won the Best Poster and Presentation Award, Student Category, at the 2021 Phytochemical Society of North America conference for his work, "Terpenoid bioproduction in plants using compartmentalization via lipid droplet scaffolds and engineered plastid pathways."

Stephanie Hickey, postdoc, received a two-year Brain and Behavior Research Foundation Young Investigator Award for her project, "Predicting gene relationships across time and space to identify age- and brain-region-specific treatments for schizophrenia."

Rachel Kerwin, postdoc, was one of 16 new assistant features editors selected by *Plant Physiology* to serve on its editorial board for two years beginning in 2021.

Maria Santos-Merino, postdoc, received the Best Oral Presentation award at the 30th Annual Western Photosynthesis Meeting for her paper, "Testing the capacity of heterologous metabolic sinks to replace photoprotective mechanisms in cyanobacteria."

Aiko Turmo, graduate student, received a travel award from the American Society for Biochemistry and Molecular Biology (ASBMB) to attend the ASBMB 2022 conference. She will present her poster, "Characterization of the nickel-inserting cyclometallase LarC from *Moorella thermoacetica* and identification of a CMPylated reaction intermediate" and give a talk—"Metal Mania."

Learning how nature "dances"

Long ago in Earth's history, individual cells began to communicate and coordinate with one another. Thanks to this and a few billion years of evolution, humans can now gather in lecture halls to share ideas about how to study this communication and its wide-ranging implications.

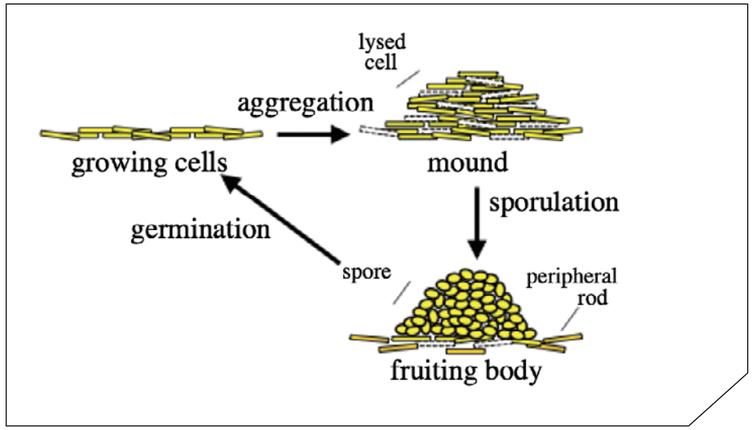
That's how Michigan State University scientists Lee Kroos and Yann Dufour came together to probe microbial processes that influence our world in myriad ways—during a departmental seminar series.

Their research takes a deep look at how single cells work together to choreograph collective behavior. In particular, the team used a bacterial species known as *Myxococcus xanthus* as a model to tease out the basic rules of the "dances" bacteria do to survive, thrive and impact humanity, for better or worse.

"You need to know the rules underlying the behavior," said Dufour, an assistant professor in the Department of Microbiology and Molecular Genetics (MMG). "With every added detail we can see in the dance, we're getting a bit closer to describing these elements that we really want to understand."

DISCOVERY

"With every added detail we can see in the dance, we're getting a bit closer to describing these elements."



Myxococcus xanthus life cycle. Starvation causes cells to stop growing and aggregate, forming a mound. Some cells lyse. Peripheral rods stay outside of the fruiting body. Other rods become spores, which can germinate and grow when food is available.

"Microbial communities called microbiomes impact the life of all organisms," said Kroos, a professor in the Department of Biochemistry and Molecular Biology and MMG. "Limited understanding of how cells interact with each other in microbiomes impedes our ability to intervene for the benefit of society."

With studies such as this one, scientists make progress toward being able to manipulate these microbiomes to help society—by preventing microbial films that foul up medical devices and water treatment systems, or by encouraging microbial coordination in ways that remediate pollution, gobble up greenhouse gases and promote crop growth.

"Microbes are on the inside and outside of every living thing, so there are lots of practical applications of this work," Kroos said. "But we have a lot of fundamental knowledge we still need to gain."

The researchers teamed up with MSU's Center for Advanced Microscopy to get the most detailed images to date of the dance of the hungry *M. xanthus.*

When food is scarce, these bacteria start a well-documented, but not fully understood, ritual. Roughly 100,000 cells congregate in what's known as a mound. The rod-shaped bacteria then start squishing themselves into hardy orbs called spores that can survive in a dormant state until food becomes available again.

But this doesn't happen willy-nilly. It's a coordinated, collective effort. The bacteria use signals to dictate when it's time to mound up and when to activate the genes used to make spores.

The team found that—where cells were in the mound—how close together they were and how they were oriented all play a role.

"It's really pretty amazing that there's this substructure at the cellular level within the mound," Kroos said. "I can't say why they do that, but it's pretty cool that they do."

Although Kroos and Dufour don't have all the answers yet, they do have new microscopy and data analysis techniques to continue watching and learning from the dance.

Willis A. Wood endowment to inspire future generations of BMB students, faculty

Willis A. Wood

Willis Wood poses with his children at his 95th birthday celebration.

Willis A. Wood will forever remain an icon in the BMB department that he so loved.

The former MSU professor and department chairperson, affectionally known as Woody to his students and friends, joined the faculty in 1958 as professor of agricultural chemistry. He led a research lab at MSU for 24 years, focusing on the enzymology and protein chemistry of metabolic enzymes.

Upon his death last year at the age of 99, a former student, along with Wood's three children, created the Willis A. Wood Research Innovation Award in Biochemistry "to reward, enhance, and accelerate innovation and instrumentation in biochemistry."

"We established this award to preserve the memory of my father's inventions and discoveries, and to inspire new innovations by students and faculty," said Suzanne Spencer-Wood (professor of anthropology, Oakland University), one of Wood's daughters.

Wood was known for discovering the first left-handed enzyme, co-inventing the Gilford spectrophotometer and domesticating the morel mushroom with his colleague Professor Tolbert.

INSPIRATION

"We established this award to preserve the memory of my father's inventions and discoveries, and to inspire new innovations by students and faculty."

"My father loved his lab and conducting research with his students, who called themselves the Wood Institute in honor of his inspiring mentorship of his students," Spencer-Wood added. The Wood Institute was populated by a mix of undergraduate students, graduate students, post docs, lab technicians and visiting established scientists.

"I always thought the name—the Wood Institute—was a great tribute to dad and how he made the students feel like they all belonged," said Charlotte Lott (retired professor of economics, Chatham University), another of Wood's daughters.

"My father was a strong believer in education. I think his interest and support is why all three of his children ended up getting Ph.D.s," Lott added.

"When I was in high school, my mother signed me up for an MSU computer programming class for high school students; and that made a huge difference in my life. After taking that class at MSU, I would go on to do bioinformatics and computer work throughout my career," said Wood's son, William Wood (retired director of bioinformatics at Genentech). The summer after his senior year in high school, he also worked in his father's lab.

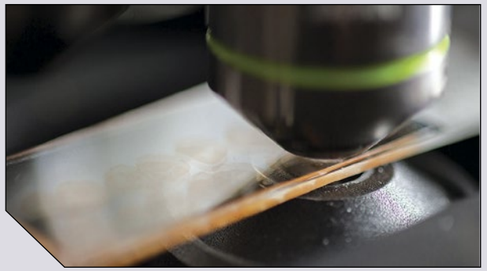
Willis Wood was also active in the formation of the Biochemistry Department in the early 1960s and in the funding and design of the Biochemistry Building, which was completed in 1964. While advancing the forefront of biological research was Wood's primary goal, much of this work was a success due to his innovations in instrumentation and methodology.

Therefore, recipients of this new award will be selected on the basis of their particularly innovative discoveries, with a preference given to methods and instrumentation. Undergraduate students, graduate students, post docs and department faculty members are all eligible.

During Wood's tenure at MSU, the Wood Institute was well known for having the lights on from very early in the morning (the agricultural college students started work at 6:00 a.m.) to after midnight (as the more urban-based students came into the lab in the afternoon and worked late into the night).

Now, this Willis A. Wood Research Innovation endowment will ensure that the lights remain on in BMB labs well into the midnights of tomorrow.

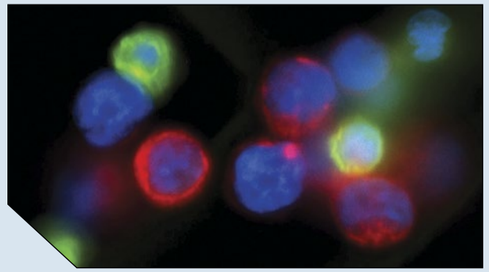
Key Grants



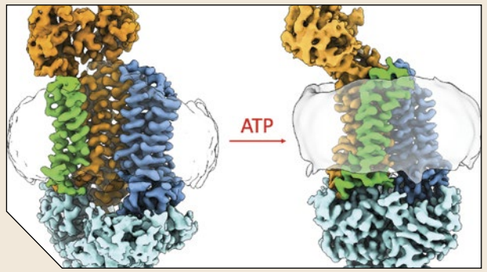
A major goal of the Kuo lab is to discover the first therapeutic compound for Alzheimer's disease.

Min-Hao Kuo, professor, received a three-year, $1.34 million National Institutes of Health (NIH) RF1 grant to study the molecular details of Alzheimer's disease and related dementia. Specifically, this project will investigate how brain cells are damaged or killed by hyperphosphorylated tau protein, which is a key pathogenic factor for neurodegeneration, and how hyperphosphorylated tau itself is regulated by native and synthetic molecules. Understanding the action and control of hyperphosphorylated tau may ultimately lead to the development of efficacious treatment of this devastating disease.

Sophia Lunt, associate professor, received a five-year, $2.02 million NIH National Cancer Institute R01 grant to further her studies on the role of metabolism in supporting cancer metastasis. The overall objective of this grant is to clarify the mechanisms by which serine and sialic acid biosynthesis pathways enable cancer spreading to other parts of the body. These studies could lead to new biomarkers for metastatic risk and development of novel therapeutic strategies for aggressive triple negative breast cancer.



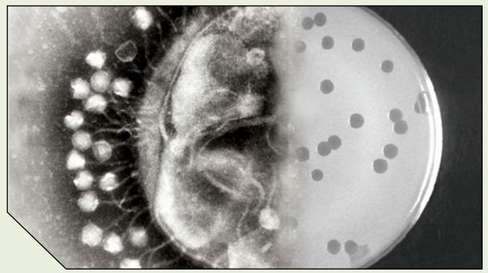
A micrograph showing cancer cells (red) found circulating in the blood of a breast cancer patient.



Atomic structure of protein implicated in antibiotic resistance and its conformation when given ATP.

Ben Orlando, assistant professor, received a five-year, $1.24 million NIH R35 Maximizing Investigator's Research Award (MIRA) grant to study the molecular machines that allow Gram-positive bacteria to resist some of our most powerful clinical medications. A key to controlling and preventing pathogenic outbreaks is to understand how bacteria evade attack by antimicrobial compounds. In his research, Orlando will combine structural and functional analyses to understand how membrane protein complexes called "Bce modules" sense and provide resistance to antimicrobial peptides in Gram-positive bacteria.

Kristin Parent, a J.K. Billman, Jr., M.D. Endowed Research Professor, received a $1.5 million NIH MIRA grant that will support her ongoing research exploring the structural and biochemical mechanics behind bacteriophage infection. This award will allow her to expand her research to several hundred phage-host pairs and delve more deeply into how bacteriophage bind to a cell's surface, transfer their genetic material across the cell membrane and use the bacteria's own genetic equipment to replicate hundreds more phages.



Bacteriophage—shown here attached to a bacterial cell wall (left) and in a petri dish (right)—use cell surface proteins to connect to, infect and reproduce inside some of the world's deadliest gut bacteria.

BMB adds lab course to train next generation of scientists

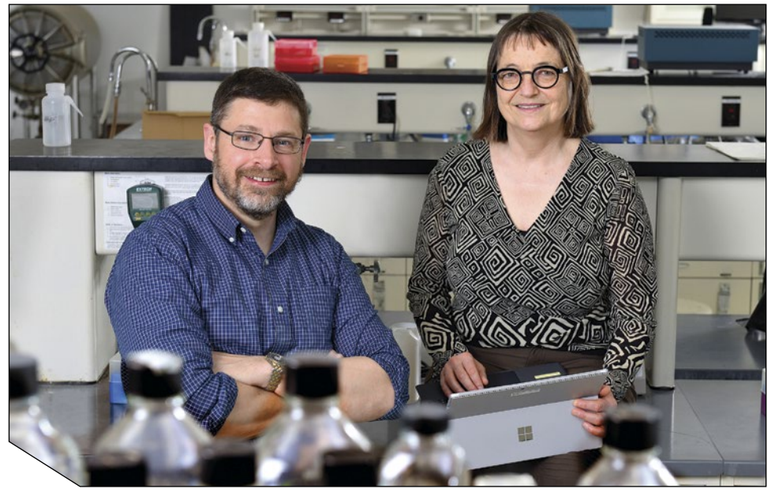
Despite the challenges posed by the COVID-19 pandemic and its impact on the higher ed community over the past two-plus years, the number of students majoring in biochemistry has increased significantly during this time. In 2019, the Department of Biochemistry and Molecular Biology (BMB) had 293 undergraduate students; to date, there are 501, and this number is expected to increase by the start of the 2022 fall semester.

To amplify training efforts for this next generation of scientists, BMB has created a new 300-level introductory biochemistry lab course—BMB 370—to be offered this fall. The course, which was the idea of BMB professor and chair Erich Grotewold, will be taught by Associate Professor Claire Vieille and BMB instructor Sean Weise.

The goal of the course is to ready students to join labs or participate in industry internships.

"This is a great opportunity for our undergraduates to learn the basics of lab work and be better prepared to succeed once they work in research labs," Vieille said. "Currently, students take introductory biology courses as first-year students and do not take a biochemistry lab course until their senior year. This course will give them an opportunity to be more successful in a lab and will also give them tools that transfer to other disciplines."

"One of the biggest challenges that students report are the analytical skills necessary to complete course work or conduct lab experiments." Weise said. "We are putting a lot of time and effort in the development of this course to guiding students though the math needed in biochemistry and reinforcing it with plenty of opportunities for practice. I am really excited about this course!"



Sean Weise (left) and Claire Vieille are looking forward to teaching the new course, which will be offered this fall.

SUCCESS

"This is a great opportunity for our undergraduates to learn the basics of lab work and be better prepared to succeed . . ."

Course lectures will introduce students to basic concepts and lab experiments. In the lab, students will conduct experiments, learn basic statistics, and develop skills to prepare graphs and handle common biochemistry lab calculations. Weekly recitations will guide their learning, and two practical exams will be given per semester to assess students' skill proficiency.

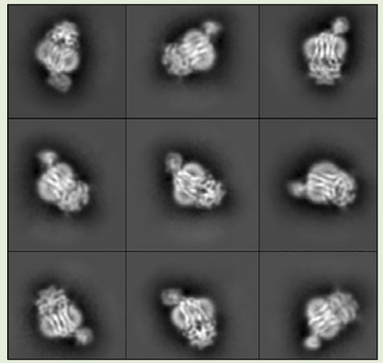
Allan TerBush, a BMB assistant professor who manages lab operations for the senior labs (BMB 470 and 471) said that creating this course—which will replace CEM 262 (Quantitative Analysis) in the program—provides the opportunity for labs, recitations and lectures to be more tailored to biochemistry, while still providing the technical rigor of data collection and analysis.

"Providing students with a lab earlier in their program will get them better prepared to jump in and hit the ground running by the time they reach the senior-level labs," he said.

BMB is partnering with the Neogen Corporation – a Lansing, Mich.-based company that offers a diverse suite of solutions for the food, beverage, animal protein and agriculture industries—who is providing funding support for the course. The money will be used to hire two students this summer to beta-test course experiments and train them in experiential learning approaches and processes.

"I'm thrilled about what BMB is doing to prepare the next generation of scientists," Vieille said.

Peering into the structure of antibiotic resistance



A sampling of the cryo-EM snapshots taken by researchers to show the protein in different orientations.

Ben Orlando is a structural biologist who studies some of nature's smallest machines to figure out how they work. He's currently focused on proteins that bacteria use to survive antibiotic treatments so he can help decommission these biological machines and fight potentially deadly infections.

"What our research does is help set the groundwork to understand how a variety of human pathogens can resist some of our most powerful medicines," Orlando said.

Orlando and his team are focused on a protein that contributes to antibiotic resistance by protecting certain bacteria from what are known as antimicrobial peptides. These molecules include the bacitracin found in Neosporin and other topical ointments, and vancomycin, which is used to treat a range of tough infections.

The researchers zoomed in on a protein that lives on the outer membrane of many Gram-positive bacteria, where it acts as a sentry to guard the cell from antibiotic attack.

Using the electron microscope in Michigan State's Cryo-EM Facility, the researchers took thousands of snapshots of the protein in different orientations. From those images, they built up the 3-D atomic structure of the biological machine and saw how it changed its conformation with help from ATP, or adenosine triphosphate, a molecule that fuels biochemical processes.

"This structure is quite unlike anything we've seen before," Orlando said. "If we can understand how these machines work, then maybe we can jam them up with new molecules or develop new antibiotics that evade resistance."

Real-world plants illuminate new photosynthesis biology

A key limitation to plant productivity occurs when excess energy from sunlight overwhelms the capacity of photosynthesis to process it, leading to photodamage. Plants protect themselves by dissipating this excess light, but at a cost of energy loss. Therefore, plants must balance photoprotection with efficiency.

To address this issue, David Kramer, MSU Hannah Distinguished Professor and his team developed a series of instruments connected to an open science data platform to explore photosynthetic responses in the field in detail.

Atsuko Kanazawa using a handheld MultispeQ device.

"The problem is that many of these processes are not seen under standard laboratory conditions, so we don't know what we are missing," said Atsuko Kanazawa, a research assistant professor in Kramer's lab. "How do we measure photosynthesis under real field conditions in enough detail to figure out what plants are doing?"

Working together, the researchers found that field plants indeed behaved in ways not seen in the lab. Collaborating with MSU statistics graduate student Abhjijnan Chattopadhyay and his advisor, Tapabrata Maiti, they discovered that plants in the field behaved in new and unexpected ways.

"These results lead us to reevaluate how photosynthesis is regulated at the biophysical and biochemical levels," Kramer said. "Under some conditions, photoprotection is so strong that it limits overall energy capture. But even under mild changes in weather, a completely different process of photoprotection—one likely to lead to photodamage—takes over. These findings will help better understand how plants will respond to climate change, and ultimately to the development of more robust and efficient crops."

BMB faculty strong contributors to education research

Over the past 20 years, education research has provided significant insights into how to improve teaching practices and student learning.

In addition to its outstanding basic science research contributions, the Department of Biochemistry and Molecular Biology (BMB) is a notable contributor to efforts that improve student learning and performance, including discipline-based education research, or DBER.

One key area involves how students connect ideas across introductory biology and chemistry courses. BMB faculty members Kevin Haudek, Kristin Parent and Jon Stoltzfus have collectively co-authored dozens of papers on how students learn biology and chemistry.

"The idea behind DBER is that we, as researchers are interested in how students learn to do science and learn the important content within a given discipline," Haudek said. "Once we discover how students learn those key ideas and engage with those practices, we can start asking questions about what kind of instruction supports that learning."

Haudek' s research centers on the assessment of student learning using written explanations to understand how students are learning key concepts in both biology and chemistry.

"Research suggests that using student writing provides a far richer picture of student thinking than simply using multiple choice or single answer questions," he said. "We find that students have mixed models—they generally hold scientific and non-scientific ideas simultaneously and use both to build their explanations. If we want to change that, instructors need to understand that students have these complex mixtures of ideas about scientific phenomenon."

Stoltzfus and Parent do DBER in addition to applying what they learn in their classrooms.

"To be a good biochemist, you need to be able to connect and integrate biology and chemistry," Stoltzfus explained. "Our upper-level biochemistry courses are built on the foundational knowledge that students learn in their introductory courses. The research I'm doing helps to better understand if and how students are connecting ideas across courses and can use them in meaningful ways, which then sets them up for the upper-level courses."

Earlier this year, Stoltzfus and his MSU colleagues published a paper in the *Journal of Chemical Education* that shares the detailed processes and approaches used in task development and how the subsequent student responses can be analyzed.

"We hope our findings will provide insight to instructors and researchers as they, too, develop such tasks to explore student reasoning," Stoltzfus said.

Parent has contributed to several DBER papers that looked at specific learning objectives for introductory biology; for example, students' use of chemistry core ideas to explain the structure and stability of DNA.

Kristin Parent works with a student on an in-class assignment in an introductory biology class.

Her role in these collaborative studies included the design and analysis of assessments as well as classroom implementation.

Parent is deeply gratified to see the transformative effect of this research on her classes.

"It's such a great feeling when a student has an 'Aha!' moment or says 'Oh! That makes sense, that's why you taught us that,'" Parent said. "The same holds true when I'm working with high school students. It's about having them see the representation that they can go to college or, if they don't want to do that, to see the value of why science is important for society. That's why it's crucial to provide these types of opportunities as early as possible."

MICHIGAN STATE UNIVERSITY | **Biochemistry & Molecular Biology**

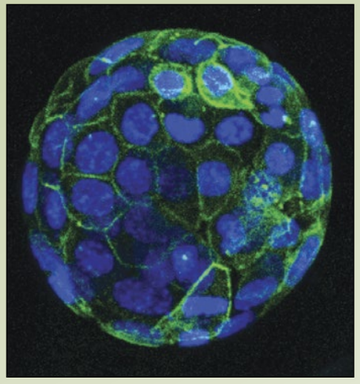
c/o College of Natural Science
288 Farm Lane, Room 103
East Lansing, MI 48824-1115

Nonprofit Org.
U.S. Postage
PAID
Lansing, MI
Permit No. 249

GO GREEN! Shining a light on early pregnancy mysteries

Michigan State University developmental biologist Amy Ralston is working to illuminate the mysteries of early pregnancy by studying embryonic cells that fluoresce—thanks to a new technique called GOGREEN.

The technique provides a new way to look at how cells change over time by combining old-school techniques and new-school technology to let researchers more quickly and efficiently study embryo development in the earliest stages of pregnancy.



MSU's new GOGREEN system offers a fast, efficient way to illuminate the biology of developing mouse embryos.

"This gives us a new way to look at how cells change over time, because we image these embryos as they're living," said Ralston, a James K. Billman, Jr., M.D. Endowed Professor in the Department of Biochemistry and Molecular Biology. "We're trying to understand what the generalizable principles of mammalian development are. What we learn could help understand how to make sure people have healthy pregnancies."

GOGREEN works by first breeding mice strains that have most of the genetic material needed to express fluorescent proteins. In a second step, researchers use a technique known as CRISPR to quickly add the remaining piece exactly where they want it.

"We showed that you can make specific proteins glow inside the embryo using the GOGREEN system," Ralston said. "And it's so efficient. We can get close to 100 percent of our embryos glowing green. Using the old-fashioned methods alone, it would maybe be one out of 100 or one in 1,000."

The fact that the proteins glow green certainly helped inspire the name for the new approach, but Ralston admitted there was a bigger motivator.

"We definitely named it for MSU because all of the work was done here," she said.

College of **Natural Science**

natsci.msu.edu

CONNECT WITH NATSCI