

Microbiology & Molecular Genetics

From the Department Chair...

The most exciting news in Microbiology and Molecular Genetics (MMG) as we begin the new year is that we have secured a new chairperson to lead the department! Professor Victor DiRita will be joining us on June 1, 2015, both as MMG chairperson and the Rudolph Hugh Endowed Chair in Microbial Pathogenesis.

Vic is currently a professor of microbiology and immunology at the University of Michigan in Ann Arbor. He is also an associate dean of graduate and postdoctoral studies in the medical school, and program director of the National Institutes of Health-funded Molecular Mechanisms in Microbial Pathogenesis Training Program there. We look forward to MMG's continued development under Vic's leadership. You can read more about his background on page 3.

Several faculty members have recently joined MMG. As previewed in the last newsletter, Matthew Schrenk (a geomicrobiologist with a primary appointment in geological sciences) arrived from East Carolina University in January 2014, and Ashley Shade (a microbial ecologist) and Yann Dufour (studying chemotaxis and phenotypic diversity) arrived from Yale University in July of this year. In August, we welcomed two jointly appointed faculty members—Lixin Zhang (a pathogen epidemiologist from the University of Michigan), who is primarily affiliated with the MSU Department of Epidemiology and Biostatistics; and Sarah Evans (a microbial ecologist from UC-Irvine), who is located at the Kellogg Biological Station and is affiliated with the MSU Department of Zoology. Two more faculty members joined us this month to kick off the new year. Cecilia Martinez-Gomez is a microbial physiologist from the University of Washington who will be studying methylophilic bacteria, and Margaret "Peggy" Petroff is a placental immunologist

who comes from the University of Kansas Medical Center. You can read more about these outstanding new additions on page 3.

"It has been a pleasure for me to serve as interim chair of the department during the past 1½ years..."

It's been a busy year for faculty promotions. Rob Britton, whose research focuses on therapeutic microbiology, was promoted to professor. Poorna Viswanathan was promoted to associate professor in recognition of her outstanding teaching and service roles associated with running our many instructional laboratories. Also, Christopher Waters, Zhiyong Xi, Claire Vieille and Shannon Manning were each promoted to associate professor, with the award of tenure. Chris studies microbial biofilms and other intriguing aspects of signaling in *Vibrio cholera*; Zhiyong investigates the intracellular bacterium *Wolbachia* as a means to control mosquito-transmitted diseases including malaria and dengue fever; Claire uses modern biotechnology methods to manipulate microorganisms in order to enhance yields of desired bioproducts such as succinic acid and simple sugars; and Shannon focuses her work on the epidemiology and evolution of enteric pathogens.

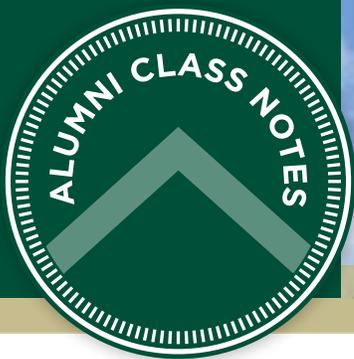
We welcome our new faculty and share the pleasure of those who were promoted, but

it is also appropriate to recognize those who have departed MMG. Our top faculty members are highly sought-after by other institutions and, despite our efforts to retain them here, we had two faculty members lured away this year—Rob Britton is now affiliated with Baylor Medical College, and Titus Brown is now a member of the University of California–Davis faculty, where he will continue to expand his interest in bioinformatics. In addition, Ron Patterson retired during the past year; his research interests are highlighted on page 3.

It has been a pleasure for me to serve as interim chair of the department during the past 1½ years, and I'm looking forward to handing over the reins and working with Vic when he starts this summer. I've enjoyed meeting with those of you who visited, chatting with those who called and responding to the many who wrote with questions or comments. It's great to know of your continued interest in MMG, and I encourage you to routinely visit our newly redesigned website, www.mmg.natsci.msu.edu, for up-to-date news. Please do continue to stay in touch and stop by if you are in the area. Finally, I'd like to remind you that MSU has initiated a capital campaign to which you can contribute directly to aid MMG. I encourage you to consider using this opportunity to enhance the department! ♡



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Robert Gewanter, microbiology, '53, retired in 1998 following a long career in the food industry. Among his employers were the Liebmann Brewery, producers of Rheingold Beer, and the National Biscuit Company, now known as Nabisco. Gewanter was active in fields of fermentation and research into yeast development.

Susan Hutchins Routson, M.S., microbiology, '69, served as founding director for Peer Information Center for Teens, Inc., in Richmond, Ind., from Jan. 1986 to May 2013.

Richard Gilpin, Ph.D., microbiology and public health, '70, is president of Richard W. Gilpin, Ph.D., Limited, a Maryland corporation founded in 1981 that includes the GTS Legionella Water Testing Laboratory in Gaithersburg, Md. He is director of the Control of Biohazards course that was started at Johns Hopkins University, Baltimore, Md., in 1979. He continues this biosafety training program throughout the U. S. and overseas.

Keith Singletary, microbiology, '72; M.S., microbiology, '77, was named Professor

Emeritus in the Department of Food Science and Human Nutrition at the University of Illinois at Urbana-Champaign following a research career in molecular carcinogenesis and cancer chemoprevention.

R. Wes Leid, microbiology and public health, '73, retired from academics on Dec. 31, 2007, after 40 years. He lives on a small farm just outside of Dayton, Wash.

Tim Greenamyre, M.D., Ph.D., microbiology, '77, was named the Love Family Professor of Neurology at the University of Pittsburgh in May 2014. He previously held the UPMC Chair in Movement Disorders. Greenamyre is director of the Pittsburgh Institute for Neurodegenerative Diseases and vice chair of neurology; he is also editor in chief of the scientific journal, *Neurobiology of Disease*, and the web-based clinical resource, *MedLink Neurology*.

Chris Pierson, M.D., Ph.D., microbiology, '93, is a neuropathologist at Nationwide Children's Hospital in Columbus, Ohio.

He was recently promoted to associate professor-clinical at The Ohio State University College of Medicine in Columbus.

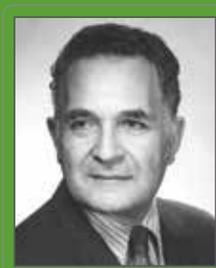
Donna (Molnar) Malaski, zoology and microbiology, '98; M.A., student affairs administration, '00, recently received her Ph.D. in educational leadership (with a higher education administration cognate) from Oakland University in Rochester, Mich.

Serina Mazzoni, human biology and genomics and molecular genetics, '08, recently completed her Ph.D. in human genetics at the University of Michigan in Ann Arbor.

Stephanie Kotsiris, genomics and molecular genetics, '11, will graduate in May 2015 from MSU's College of Osteopathic Medicine with aspirations of entering a family medicine residency.

Angela Detomaso, microbiology and genomics, and molecular genetics, '13, moved to Washington, D.C., and started working as a lab tech at a fertility clinic. She is applying for an internship at the National Institutes of Health to research HIV.

In Memoriam



Sadoff

Harold Lloyd Sadoff, Distinguished Professor Emeritus of microbiology and public health (now microbiology and molecular genetics), died June 5, 2014, at the age of 89 after a lengthy battle with Alzheimer's.

Sadoff earned his bachelor's degree in chemical engineering from the University of Minnesota, and worked several years as a research chemical engineer for the International Milling Company. He returned to academia at the University of Illinois, receiving his M.S. in bacteriology and his Ph.D. in bacteriology-biochemistry under the mentorship of Professor H. Orin Halvorson. He joined MSU's Department of

Microbiology and Public Health in 1955 as an assistant professor and became a full professor in 1965. During his career, he held two fellowship appointments through the National Institutes of Health (NIH) and was continuously funded by NIH until his retirement in 1987.

His early research focused on the study of bacterial endospore dormancy with emphasis on thermo-resistance of spore enzymes. He later focused on *Azotobacter* encystment.

Sadoff is survived by his wife, Gertrude, of almost 68 years and four children.

Retirements



Patterson

Professor **Ron Patterson** retired in 2014 after working for the department for 42 years. He joined the department in 1972 and developed a long-standing interest in the structure

of the cell's nucleus. Patterson was an authority on RNA splicing, a critical biochemical process in which non-coding sequences are removed from the initially synthesized polynucleotide transcript to form messenger RNA, which can then be translated into protein.



DiRita named new MMG chair

On June 1, 2015, Victor J. DiRita will become the chairperson of the Department of Microbiology and Molecular Genetics and also serve as the MSU Rudolph Hugh Endowed Chair in Microbial Pathogenesis—a shared department of the Colleges of Veterinary Medicine, Human Medicine, Osteopathic Medicine and Natural Science.

DiRita comes to MSU from the University of Michigan in Ann Arbor, where he is currently professor of microbiology and immunology, and associate dean of graduate and postdoctoral studies in the medical school. DiRita earned his bachelor's degree in microbiology and public health at MSU, his Ph.D. in biological



DiRita

sciences from Purdue University and carried out postdoctoral training at Harvard Medical School before joining the University of Michigan faculty in 1991.

“Coming to the Department of Microbiology and Molecular Genetics at MSU is a wonderful opportunity,” DiRita said. “Returning to the department where my research focus was sparked and fostered as an undergraduate in the lab of Robert Brubaker is very special. I look forward to joining the excellent community of scholars in the department and working with them to build strong cross-campus collaborations in research and education.”

DiRita will succeed Professor Robert Hausinger, who has served as interim chair since 2013.

New Faculty



Dufour



Evans



Shade



Zhang



Martinez-Gomez



Petroff

The Department of Microbiology and Molecular Genetics welcomed four new faculty members this past summer:

Yann Dufour joined the department as an assistant professor in July 2014. His research focuses on the collective behavior of bacterial communities. Dufour was a postdoctoral associate at Yale University in New Haven, Conn., prior to coming to MSU. He received his Ph.D. in microbiology from the University of Wisconsin-Madison.

Sarah Evans joined the department as an assistant professor with a joint appointment in the MSU Department of Zoology in August 2014. Evans works at the W.K. Kellogg Biological Station. Her research focuses on how microbial communities respond to environmental variability. Prior to coming to MSU, Evans had an NSF postdoctoral fellowship at the University of California, Irvine. She received her Ph.D. in ecology from Colorado State University in Fort Collins.

Ashley Shade joined the department as an assistant professor in July 2014. She investigates microbial communities, especially the ecological and evolutionary dynamics of microorganisms within their communities. Prior to coming to MSU, Shade was a postdoctoral scholar at Yale University in New Haven, Conn. She received her Ph.D. in microbiology from the University of Wisconsin-Madison.

Lixin Zhang joined the department as an assistant professor with a joint appointment in the MSU Department of Epidemiology and Biostatistics in August 2014. His general research interests are in infectious disease epidemiology, pathogen genomics and bioinformatics. Prior to joining the department, Zhang was a research assistant professor at the University of Michigan (U-M) School of Public Health in Ann Arbor. He received his Ph.D. in epidemiology from U-M.

Two faculty members joined the department this January:

N. Cecilia Martinez-Gomez is an assistant professor whose research goal is the understanding of regulatory mechanisms in key metabolic pathways of one-carbon metabolism to further engineer methylotrophic bacteria to produce value-added chemicals, such as biofuels and antibiotics. She was a postdoctoral research associate at the University of Washington in Seattle prior to coming to MSU. She received her Ph.D. in microbiology from the University of Wisconsin-Madison.

Margaret “Peggy” Petroff is an associate professor with a joint appointment in the MSU Department of Pathobiology and Diagnostic Investigation. Her research focuses on the cross-talk between the reproductive and immune systems, and specifically on the immunological functions of the placenta. Prior to coming to MSU, Petroff was an associate professor at the KU Medical Center at the University of Kansas. She received her Ph.D. in reproductive biology from The Ohio State University in Columbus.

Studying pathogens to better understand disease processes

Shannon Manning's research is carried out in a lab that studies a diversity of pathogens to better understand the disease process in both humans and animals.

"We are trying to determine which factors of pathogens enhance their ability to cause disease," said Manning, MMG associate professor.

Her lab has been studying Shiga toxin-producing *Escherichia coli*, a leading cause of diarrheal disease in the United States.

"Over the past five years, we've seen an increase in "non-O157" serotypes of *E. coli*—as opposed to the more familiar *E. coli* O157:H7," she said. "We've seen major outbreaks attributable to these pathogens, many of which have been linked to fresh produce or beef.

"Not only are we seeing increases in human infections attributable to different serotypes, we're also detecting them in cattle," Manning continued. "When we sampled 12 cattle herds in Michigan, only about 25 percent of the strains were *E. coli* O157. We are not sure what has contributed to this shift, and which subset of strain types are most capable of causing human disease."

"We are trying to determine which factors of pathogens enhance their ability to cause disease."

Another pathogen of interest in Manning's lab is Group B *Streptococcus* (GBS).

About 40 percent of men and women carry GBS in their genitourinary tracts with no ill effects. But it becomes a problem in pregnant women because it can be transferred from mother to baby during



Shannon Manning, MMG associate professor, poses with an enlarged version of *E. coli*, one of the bacterial pathogens that is studied in her lab.

delivery, or *in utero*, causing stillbirth or inducing premature birth.

"The baby can aspirate the organism during childbirth and it can cause respiratory infection within hours of delivery," Manning explained. "The organism can also cross the placenta and infect the baby prior to delivery, and cross the blood-brain barrier to cause meningitis and death. This is typically preventable if you can detect the organism ahead of time."

Although antibiotics are administered to pregnant women who test positive for GBS during mandatory screening at 35 to 37 weeks, this approach does not safeguard against stillbirth or premature birth prior to that screening. That's why developing alternative preventive methods is so important. Manning's team hopes to identify targets that could be significant for vaccine development.

"We found there are certain GBS strains that are better able to attach to the placenta and cross it," she said. "We are now trying to identify gene targets important for that process."

Their next step is to focus on macrophages, the first line of defense against foreign invaders.

"We're hypothesizing that some strains of GBS might be more persistent in women and may evade antibiotics because they are capable of surviving inside macrophages," Manning said. "We have recently found that some more virulent strains can survive up to 72 hours inside a macrophage. This would be just enough time to allow travel through the bloodstream of a newborn baby and cause infection of other organs.

Manning and her team are now trying to understand how these pathogens survive inside macrophages. This would allow them to identify new therapeutics that aim to block intracellular survival.

"Enhancing our understanding of the mechanisms that different pathogens use to facilitate transmission to humans, survive inside the human host and cause more severe disease will assist us in our effort to identify novel prevention strategies that can reduce the burden of some infectious diseases," Manning said. 🍀



Cell resiliency: An unexpected phenomenon

Cells are more resilient in taking care of their DNA than scientists had originally thought. Even when missing critical components, cells can adapt and make copies of their DNA in an alternative way.

“Our genetic information is stored in DNA, which has to be continuously monitored for damage and copied for growth,” said Kefei Yu, MMG associate professor. “If the cell is unable to make copies of its DNA or if it overlooks mistakes in its structure, it can lead to cell death or the production of cancerous cells.”

Studying mouse cells, Yu’s research team found that when cells lack the gadgets required to replicate DNA, they adapt and use other tools instead—a family of proteins called DNA ligases, which are needed for a variety of processes associated with DNA.

Belonging to this family of ligases is DNA ligase I, thought to be critical for making copies of DNA and hence essential for growth. However, the MSU researchers have shown that DNA ligase I is actually not needed in some cells.

“It might be that these ligases can substitute for each other when one of them is missing,” Yu said.



A team led by MMG Associate Professor Kefei Yu shows that cells are more resilient in taking care of their DNA than scientists originally thought.

The research team also found that these “handicapped” cells are able to fix induced damages in the DNA.

“Our next question is whether this

phenomenon is unique to this specific type of cell, or if it’s generally true to a variety of other cells, including those of humans,” Yu said. “We’re interested in finding out exactly how the cell is adapting.” 🌱

MMG professor plays key role in highly successful journal

Standards in Genomic Sciences (SIGS), an open-access publication established in July 2009 by the Genomic Standards Consortium (GSC)—through grants from MSU’s Office of the Vice President for Research and Graduate Studies and the U.S. Department of Energy—is now a leading journal in the field and available on the BioMed Central platform.

BioMed Central, publisher of 270 peer-reviewed, open-access journals, launched SIGS on their platform in December 2014.

GSC, an international community composed of representatives from a wide range of research institutions, was formed in 2005 to work toward improving the descriptions of the complete collection of genomes and metagenomes, as well as the



Garrity

mechanisms for data exchange and integration. The goal was to develop community standards for descriptive “omics” metadata. The consortium determined that

one way to accomplish this was through an open-access publication.

“The consortium established SIGS to encourage scientists in the genomics community to start talking to each other,” said George Garrity, MSU MMG professor and member of the consortium.

“SIGS provides highly standardized information, aiming to fill a void that had been developing over several years,” said Garrity, the journal’s current editor in chief.

SIGS has published more than 400 Short and Extended Genome Reports—highly structured articles designed to make comparison of genomes simple for both human and machine readers. The journal also includes meeting reports, standard operating procedures and white papers.

Readers are invited to explore all 20 of the launch articles on the new platform at www.standardsingenomics.com/; all articles from previous issues of the journal are available at PubMed Central at <http://www.ncbi.nlm.nih.gov/pmc/journals/1427/>.

Faculty Honors

Professor **Lee Kroos** was named a 2014 AAAS Fellow by the American Association for the Advancement of Science. Kroos was selected for his seminal contributions to the understanding of developmental regulation in bacteria *Bacillus subtilis* and *Myxococcus xanthus*, and distinguished mentoring and service to the scientific community.

Emeritus Professor **C. Adinarayana Reddy** received a Doctor of Science (Honoris Causa) from Tamil Nadu Agricultural University in India in August.

Associate Professor **Shannon Manning** was named an MSU Foundation Professor. Manning was selected for her outstanding work with various pathogens—including Shiga toxin-producing *Escherichia coli*, a leading cause of diarrheal disease in the United States, and Group B *Streptococcus*—in order to better understand the disease process in both humans and animals.

Three members of the department were recognized for their achievements during 2014 at the College of Natural Science's annual awards presentation in November.

They are: Professor **Edward (Ned) Walker**, NatSci Outstanding Faculty Award; Professor **Terence (Terry) Marsh**, NatSci Teaching Prize; and Administrative Assistant **Coreena Spitzley**, NatSci Outstanding Support Staff Award.

Associate Professor **Chris Waters** received the College of Osteopathic Medicine's Early Promise of Research Excellence in September. He was honored for his research with bacterial pathogens and the role chemical signaling plays in the initiation, maintenance and termination of infection.

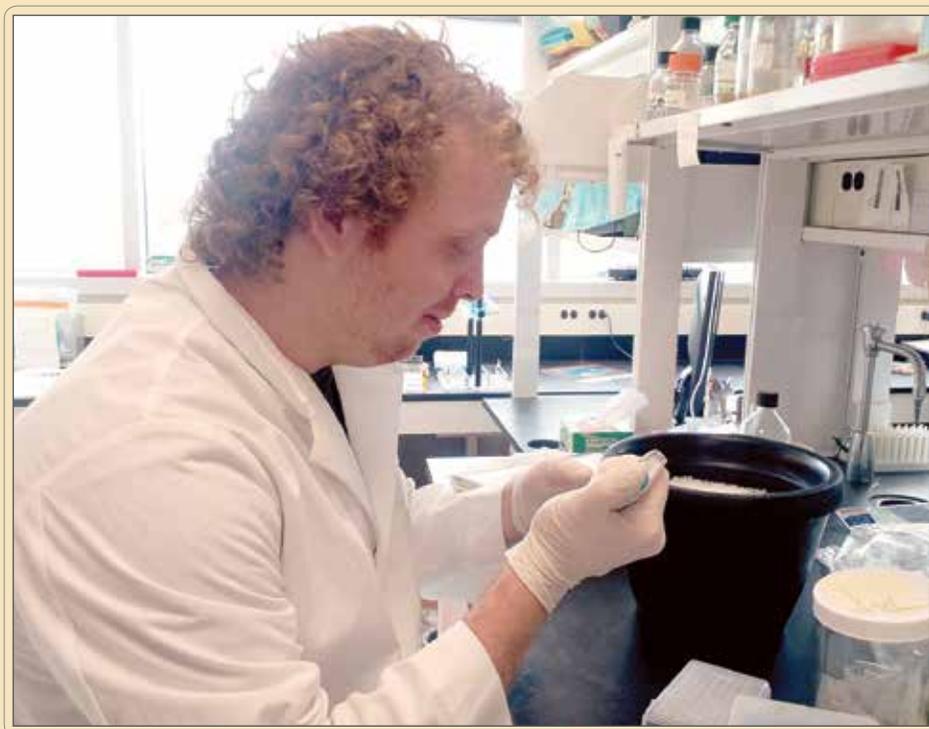
Student Honors

MMG student lands American Society of Microbiology Fellowship

Anthony Findley, a senior in genomics and molecular genetics, was the recipient of a 2013 Undergraduate Research Fellowship from the American Society of Microbiology (ASM). Each fellow received up to a \$4,000 stipend to conduct full-time summer research and present their research results at the 114th ASM General Meeting, which took place in Boston, Mass., in May 2014.

Findley used the fellowship to continue working as an undergraduate researcher in former associate professor Robert Britton's lab. He was involved in a number of projects aimed at developing genetic tools to manipulate *Lactobacillus reuteri*, a probiotic bacterium that has been shown to have a variety of beneficial effects, including decreasing bone loss in mouse models of osteoporosis. Findley's project that led to the fellowship related to this research.

"This fellowship allowed me to witness firsthand how collaborative science actually works," said Findley, who plans to attend graduate school when he graduates in May 2015. "The ASM's



Genomics and Molecular Genetics senior Anthony Findley adds DNA to *Lactobacillus reuteri* cells in preparation for recombining to knock-out a gene in his ASM-supported research project.

General Meeting is a great way to see how researchers draw on the expertise of their peers to drive their own research forward, and it allowed me to see

cutting-edge research in microbiology. It also provided a good opportunity to interact directly with other scientists during my poster presentation."



Enhanced microbes feast on nuclear waste

A microbe developed and patented by MMG Associate Professor Gemma Reguera has just been improved and is now capable of cleaning up nuclear waste.

The key to Reguera's research is her patented adaptive-engineered bacteria—*Geobacter sulfurreducens*.

Much of her work with *Geobacter* bacteria focuses on engineering their conductive pili or nanowires. In earlier research, she identified that these tiny conductive hair-like appendages did the yeoman's share of remediation. By increasing the strength of the pili nanowires, she improved their ability to clean up uranium and other toxic wastes.

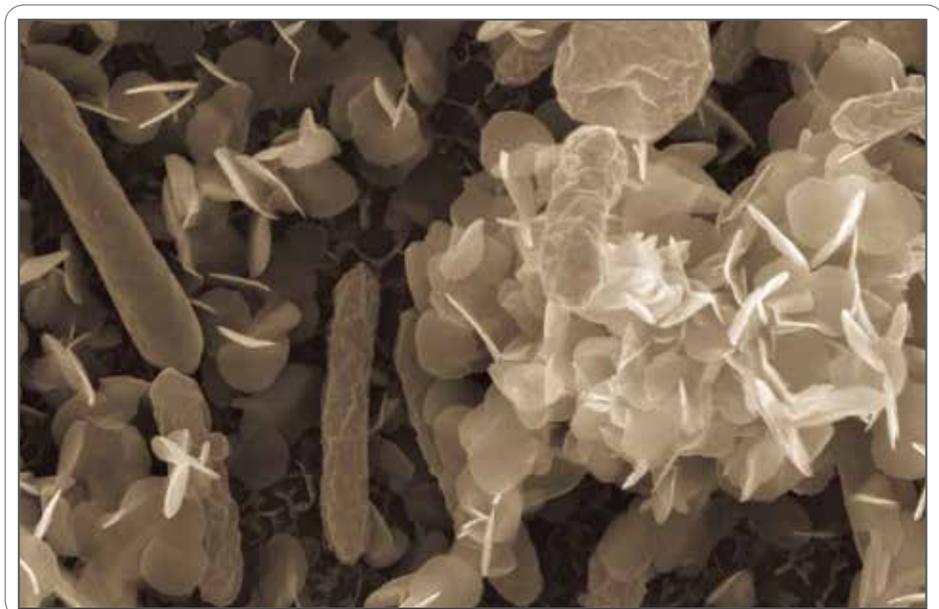
“The results surpassed our most optimistic predictions.”

The microbes also use the pili to stick to each other and grow a film on just about any surface, similar to the bacterial film that forms on teeth. The *Geobacter* biofilm, encased by a network of nanowires and slime, gives the bacteria a shield and increases their ability to neutralize even more uranium. The improvement also allows the bacteria to survive longer even when exposed to higher concentrations of the radioactive material.

“The results surpassed our most optimistic predictions,” Reguera said. “Even thin biofilms immobilized uranium like sponges. They reduced it to a mineral, all while not suffering any damage to themselves, for prolonged periods of time.”

Even when exposed to extremely high and toxic concentrations of uranium, levels that would destroy individual *Geobacter* cells, the biofilms didn't just survive, they thrived, she added.

This work builds on Reguera's earlier work, in which she developed a new fuel-cell concept that allows biodiesel



A microbe developed to clean up nuclear waste and patented by Gemma Reguera, MSU microbiologist, has just been improved.

plants to eliminate the creation of hazardous wastes while removing their dependence on fossil fuel from their production process.

The platform, which uses microbes to glean ethanol from glycerol and has the added benefit of cleaning up the wastewater, will allow producers to reincorporate the ethanol and the water into the fuel-making process.

Reguera's research team evolved *Geobacter* to withstand increasing amounts of toxic glycerol. The team then searched for partner bacteria that could ferment it into ethanol while generating byproducts that “fed” the *Geobacter*.

“It took some tweaking, but we eventually developed a robust bacterium to pair with *Geobacter*,” Reguera said. “We matched them up like dance partners, modifying each of them to work seamlessly together and eliminate all of the waste.”

Together, the bacteria's appetite for the toxic byproducts is inexhaustible.

“They feast like they're at a Las Vegas buffet!” Reguera added.

This promising process has caught the eye of economic developers, who are helping scale up the effort. Through a Michigan Translational Research and

Commercialization grant, Reguera and her team are developing prototypes that can handle larger volumes of waste.

Reguera's future research on the radioactive material front will focus on deciphering how the biofilm matrix that encases the cells shields them so effectively, and on improving its properties further. 

Contact Us

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MMG professor continues malaria-related work, co-leads new center

Edward A. (“Ned”) Walker, MMG professor, is a medical entomologist who has dedicated his life to understanding and eradicating malaria and other mosquito-borne illnesses.

His groundbreaking research with insecticide-treated bed nets in western Kenya led to the use of these nets as a powerful control tool that thwarts mosquitoes that cause malaria, a devastating disease that kills about 3,000 children daily in Africa.

However, in the past decade, mosquitoes have shown growing resistance to the pyrethroid insecticides used to treat the nets. So, Walker and other researchers are investigating how the insecticide works at a molecular level, which could help stem mosquitoes’ resistance to the insecticide. Also, new research from Walker’s lab shows that, even with resistance, bed nets remain effective if they do not develop holes from wear and tear.

In further recognition of his work and expertise, Walker was recently selected to co-lead MSU’s new Center for Health Impacts of Agriculture with Felicia Wu, John A. Hannah Distinguished Professor



MMG Professor Edward “Ned” Walker; internationally known for his work on malaria and other mosquito-borne illnesses, was recently selected to co-lead MSU’s Center for Health Impacts of Agriculture.

in the College of Agriculture and Natural Resources.

This first-of-its-kind center, which addresses the growing global effects of agriculture on human and animal health, links MSU’s renowned agricultural and food security research with its three colleges of medicine, as well as several other university units, including the College of Natural Science.

Issues that the center will address include the agricultural development and economic effects related to increased cases of malaria in Malawi, Africa; antimicrobial resistance in humans, animals and plants, and the implications on human health; and health risk assessment and nutrient regulation policies. 🌱