



## From the Department Chair...

Evolution is one of our major research themes in the Department of Microbiology and Molecular Genetics (MMG), but it also describes the progressive changes in personnel that allow for adaptation and growth of the department.

As a key example, after 10 years of outstanding leadership, Walter Esselman recently shifted from being department chair to becoming the associate dean for research in the College of Human Medicine. In that role, he will provide vision for the college while continuing to foster cross-college research synergies, develop collaborative projects and pursue support for global health projects. Meanwhile, I'm pleased to step into the role of interim chair, with the wonderful support of my colleagues. The department is in good shape financially thanks to strategic decisions made by Walt and Michigan State University (MSU). A chairperson search committee has been identified so that continued success of the department is assured. As summarized below, several other changes in personnel are worthy of mention.

Gemma Reguera and Kefei Yu were each promoted to associate professor with tenure (2012 and 2013, respectively). Gemma investigates electrically conductive bacterial pili (affectionately called nanowires) and their use in microbial fuel cells and for removing uranium from groundwater. Kefei studies the molecular mechanisms involved in immunoglobulin gene rearrangements (specifically, a process termed class switch recombination) that contribute to the tremendous diversity of these molecules as part of our immunological response.

We welcomed Zhiyong Xi into our department from his original position in the MSU Department of Entomology. Zhiyong characterizes the symbiotic interactions between the bacterium *Wolbachia* and the mosquito *Anopheles stephensi*. Of tremendous global health interest, he and his colleagues have established stable infections of the mosquito that are resistant to the malaria-causing parasite, *Plasmodium falciparum*. Zhiyong also hopes to use *Wolbachia* infection to control mosquito-borne infections of dengue virus. Read more about his research on page 7 of this newsletter.

The newest member of the department is Robert Abramovitch, who joined us in January. He studies *Mycobacterium tuberculosis*, including ways to combat this often-lethal pathogen. Rob's work is described more fully on page 4.

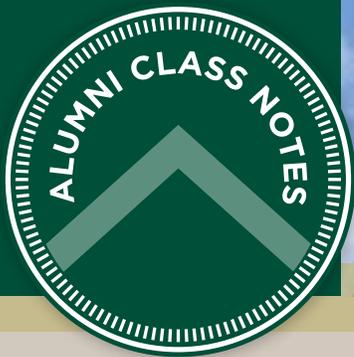
Three additional faculty members will be joining the department as assistant professors in 2014: Ashley Shade, Yann Dufour and Matthew Schrenk. Ashley and Yann are both currently at Yale University and will join us in July. Ashley is a microbial ecologist who uses high-throughput metagenomics and multivariate analysis to investigate microbial community responses to disturbances. Yann studies the role of phenotypic diversity in populations of chemotactic bacteria. Matt is currently an assistant professor at East Carolina University; he will join us in January as a joint faculty member with the Department of Geological Sciences. Matt examines the ecology and physiology of microbial communities in the subsurface biosphere. These individuals will lend great strengths to the department while conducting truly fascinating work.

As we welcome and are invigorated by the new faculty who are soon to arrive, I also want to recognize others who have moved on to new phases of their lives. Karen Friderici and C. A. Reddy recently retired from their highly productive careers. Tom Schmidt relocated to the University of Michigan to direct a Center for Microbial Systems Science, Todd Ciche is now in the agricultural traits discovery group at Monsanto and Jay Lennon moved from the Kellogg Biological Station to the University of Indiana. Finally, Angie Zell of the MMG office staff has moved on to a position at the college level and has been replaced by Katie Gallagher. Best wishes to all!

Finally, I want to acknowledge the vibrant group of postdoctoral researchers, graduate students and undergraduate students who have been associated with MMG over the years. They are responsible for doing the fantastic work for which the department is so widely recognized. I encourage all alumni and friends of MMG to stay in touch with the latest department happenings by visiting our website at [mmg.msu.edu](http://mmg.msu.edu). Please stop by for a visit when you are in the area, or feel free to contact me directly. ☺



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**Stuart Freeman**, microbiology, '66, retired in 2008 after practicing general internal medicine for 33 ½ years.

**Richard Gilpin**, Ph.D., microbiology and public health, '70, is president and CEO of R. Gilpin, Limited, a biosafety consulting corporation that includes the GTS Legionella Water Testing Laboratory, based in Gaithersburg, Md.

**John Mankovich**, microbiology, '79, is one of the co-inventors of the world's largest selling drug, Humira, from AbbVie.

**Laurie Welton**, microbiology, '81, D.O., '92, is a board certified infectious disease physician in Florida.

**Denise (Glenn) Angonese**, microbiology, '82; medical technology, '84, is starting her 29th year as a clinical microbiologist at Sparrow Hospital, Lansing, Mich.

**Brandon West**, microbiology, '82; J.D., '91, is celebrating 30 years of private practice in Walled Lake, Mich., as a Doctor of Podiatric Medicine. He is being honored this year for 25 years as an attending podiatrist at Botsford Hospital, Farmington Hills, Mich.

**David Westernberg**, microbiology and public health, '82, is chair of the American Society for Microbiology (ASM) Committee for K-12 Outreach.

**Lisa Beltz**, Ph.D., microbiology and public health, '88, published a textbook in 2011, *Emerging Infectious Diseases: A Guide to Diseases, Causative Agents and Surveillance*, and is preparing to write a second book that will outline additional emerging infections. She recently joined Malone University, Canton, Ohio, as an associate professor of natural sciences.

**Matthew Kane**, Ph.D., microbiology and public health, '90, National Science Foundation program director, is on a one-year sabbatical that began this August. He is being hosted by Matt Sullivan's laboratory at the University of Arizona in Tucson, where he will be working on the comparative genomics of the reductive acetyl-coA pathway.

**Katherine (Rubrich) Graham**, environmental biology/zoology, '00; M.S., industrial microbiology, '05, received a Pfizer Global Supply Mission Award nomination. She is currently a senior associate in Pfizer's Bio-therapeutics Pharmaceutical Sciences Division, and began a secondment with the company in August.

**James McKinlay**, M.S., industrial microbiology, '03; Ph.D., microbiology and molecular genetics, '06, is an assistant professor in the Department of Biology at Indiana University, Bloomington, Ind. In 2012, he received a five-year Early Faculty Development CAREER Award from the U.S. Department of Energy.

**Josh Buysse**, microbiology, '06, has been with Abbott Laboratories for 5 years and recently took a new job as microbiology supervisor at a new Abbott Laboratories nutrition plant in Tipp City, Ohio.

**David Stepien**, microbiology, '07; M.S., microbiology and molecular genetics, '08, completed his Ph.D. on the immunobiology of traumatic injury under Daniel Remick in the Department of Pathology at Boston University School of Medicine in May. He is now completing his clinical clerkships and will graduate in May 2015.

**Sheena (Tapo) Simmons**, physiology and microbiology, '08, graduated in May with a master's degree in public health from the Rollins School of Public Health at Emory University, Atlanta, Ga., and began an Oak Ridge Institute for Science and Education fellowship with the Centers for Disease Control and Prevention in September. She gave birth to her first child, Daniel, in Feb.

**Gregory Moyerbrailean**, microbiology, '10, started his Ph.D. program in molecular biology and genetics at Wayne State University, Detroit, Mich., in fall 2012.

**Gabrielle Benjamin**, microbiology, '12, was recently hired as the microbiologist and quality affairs manager at North Bay Bioscience, Traverse City, Mich., after completing a contract as a quality testing technician with Terumo Cardiovascular, Ann Arbor, Mich.

**Daniel Charlat**, genomics and molecular genetics, '12, attended the 6th Annual Future of Genomic Medicine Conference in La Jolla, Calif., in March.

**Dana Gradl**, microbiology and psychology, '12, is an Oak Ridge Institute for Science and Education Research Fellow with the Food and Drug Administration in Bedford Park, Ill. He is involved in several projects examining *Salmonella* survival and heat tolerance in low-moisture foods.

## In Memoriam

**Peter Hirsch (1928-2013)**

Peter Hirsch, a professor in the department from 1967 to 1970, had a major impact during his short tenure. Along with then-MMG professor James Staley, Hirsch started the microbial ecology program and was instrumental in hiring numerous faculty members, including University Distinguished Professor James Tiedje, who is now the director of the MSU Center for Microbial Ecology. Hirsch's enthusiasm, engaging personality and extraordinary understanding of microbial diversity were legendary. He died near Plön, Germany, on July 9, 2013.

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## Faculty Honors

Assistant professor **Robert Abramovitch** has been named a **Grand Challenges Explorations Winner** for his work in developing new treatments for tuberculosis. The initiative, funded by the Bill and Melina Gates Foundation, encourages individuals worldwide to explore innovative ideas for solving global health and development challenges.

**Christopher Adami**, professor of microbiology, and **Jerry Dodgson**, professor of microbiology and molecular genetics, were named fellows of the **American Association for the Advancement of Science (AAAS)**. Adami was honored as a AAAS fellow in 2012 for his research on living systems using computational and theoretical methods. He pioneered the application of methods from information theory to the study of evolution and helped design the Avida system, a scientific software platform that allows experimentation with actively evolving computer programs to help investigate evolutionary questions. Dodgson was recognized as a AAAS fellow in 2013 for his contributions to the elucidation of the structure and function of chicken genes and avian genomes and for service to the U.S. Department of Agriculture National Animal Genome Research Program. He and his research team currently are completing a clone-based physical and comparative map of the turkey genome.

## New Faculty



*Abramovitch*

**Robert B. Abramovitch** joined the department in January 2012 as an assistant professor. His research focuses on utilizing genetic, genomic and biochemical approaches to characterize new genes and proteins that enable pathogens to survive and reproduce within host cells. He works primarily with *Mycobacterium tuberculosis*, which causes tuberculosis, a leading cause of death in humans by an infectious disease. Before coming to MSU, Abramovitch was a postdoctoral fellow at the Cornell University College of Veterinary Medicine from 2006 to 2011. He received his doctorate in plant pathology from Cornell University and his bachelor's degree in microbiology from the University of British Columbia.



*Schrenk*

**Matt Schrenk** will join the department as an assistant professor in January 2014. He currently is an assistant professor of biology at East Carolina University in Greenville, N.C. Schrenk will have a joint appointment in the Department of Geological Sciences. His research focuses on microorganisms in the subsurface—how many there are and what they are doing. More specifically, he studies the activities of microorganisms in the deep subsurface biosphere using molecular biological approaches coupled with geochemical analysis. Schrenk became interested in this area of research as an undergraduate at the University of Wisconsin-Madison and pursued a doctoral degree in oceanography at the University of Washington.

## Retirements



*Friderici*

Professor **Karen H. Friderici** worked for the department for 14 years. Her research focused on the molecular pathology of genetic disease with a primary focus on human disease. Friderici's work involved the understanding of the normal function of organs or proteins by observing mutations. One thrust of her research was the identification and characterization of genes involved in the hearing process, especially genes

that mutate and cause deafness with no other symptoms. Friderici worked on collaborative projects with the department of pediatrics and human development to investigate the genetics of hearing by identifying families from Mid-Michigan with genetic hearing loss.



*Reddy*

Professor **C. Adinarayana Reddy** was a member of the department's faculty for 40 years. A long-term goal of his research centered on the efficient transformation of biomass into fuels, such as ethanol and chemicals, and various low molecular weight phenolic compounds. Using molecular biological, biochemical, and ecological approaches, Reddy researched lignin biodegradation by a group of filamentous fungi belonging to the group basidiomycetes. There has been

worldwide interest in this area of research because of its potential application to biopulping, degradation of toxic environmental pollutants such as dioxin, and biotransformations of lignocellulosic materials to feeds, fuels and chemicals.



# Leading the charge to find cures for tuberculosis

Robert Abramovitch hopes that his novel research approach will shed light on new treatments for tuberculosis (TB), a common and, in many cases, lethal, infectious disease caused by various strains of mycobacteria, usually *Mycobacterium tuberculosis*. The World Health Organization (WHO) estimates someone is infected with the organism that causes TB every second of every day. Although an infected person may not develop full-blown TB, the disease kills 1.5 million people every year.

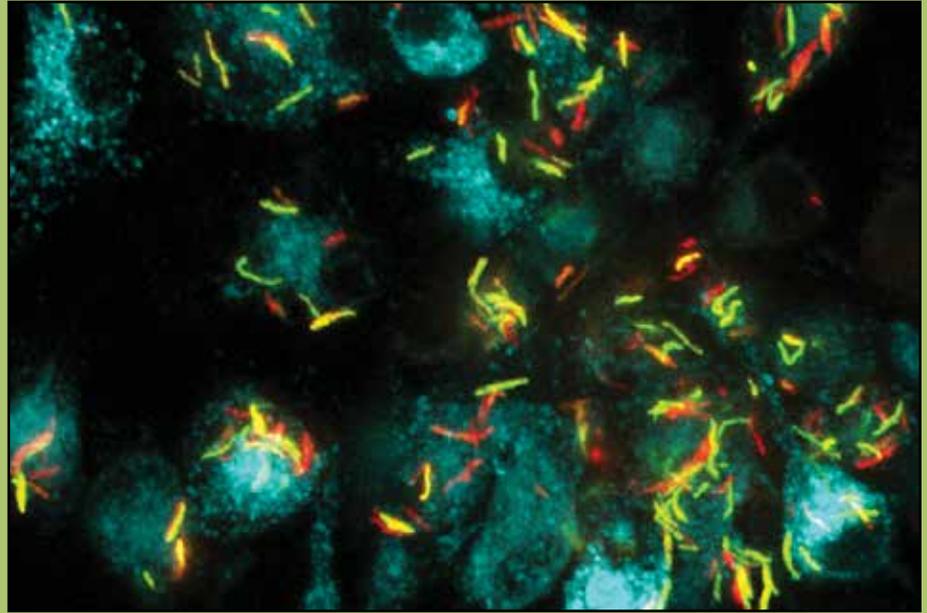
“Combating the ongoing tuberculosis epidemic represents one of the major challenges in global health,” said Abramovitch, MMG assistant professor. “The required multidrug six- to nine-month treatment regimen has fueled the emergence of drug-resistant TB, and new treatments are needed to fight this dangerous disease and reduce the overall length of drug therapy.”

A signature feature of *M. tuberculosis* pathogenesis is that the bacterium survives inside macrophages, a host immune cell that kills many other bacteria. Abramovitch’s research goals include characterizing how *M. tuberculosis* adapts to life inside a macrophage, and then applying those discoveries toward the development of new drugs.

“To achieve these goals, we are utilizing genetic, genomic and biochemical approaches to characterize new genes and proteins that enable *M. tuberculosis* to succeed as an intracellular pathogen,” Abramovitch explained.

These findings are then translated into high throughput screening platforms to identify small molecule compounds that interfere with *M. tuberculosis* adaptation physiology.

“Tuberculosis can live inside humans for years, even decades,” said Abramovitch, who has joint appointments in the MSU Colleges of Veterinary Medicine and Human Medicine. “This ability to establish a chronic infection in humans is a key factor that makes it such a difficult disease to control. My approach is to basically find new drugs that stop the ability of TB to establish a chronic infection inside the human host.”



A new project by Robert Abramovitch, MMG assistant professor, uses a biosensor that glows green when the TB bug senses low oxygen. The sensor could lead to new treatments.

The process Abramovitch is trying to target is difficult to replicate inside a test tube. *M. tuberculosis* physiology essential for establishing chronic disease is normally activated only during growth in immune cells.

Abramovitch and his research team are focusing on an oxygen-sensing system naturally occurring in the TB bacterium. The project uses a biosensor that glows green when the TB bacterium senses low environmental oxygen, a cue for the bug to establish a persistent infection.

By screening more than 250,000 compounds for molecules that prevent TB from “seeing” that cue—essentially blinding the bacterium—he hopes to find compounds that target chronic TB infection and could help shorten therapy or treat multidrug-resistant TB.

“Using fluorescent biosensors to induce visually identifiable characteristics is a new and non-traditional approach in TB drug development,” Abramovitch said. “Once we identify some of these compounds, we can focus on developing new treatments.”

In 2012, Abramovitch was named a Grand Challenges Explorations winner for his work on developing new treatments for

TB. The \$100 million initiative, funded by the Bill and Melina Gates Foundation, encourages researchers worldwide to explore ideas that can solve persistent global health and development challenges. Abramovitch’s project is one of more than 100 Grand Challenges Explorations Round 8 grants.

“Grand Challenges Explorations aims to expand the pipeline of ideas where creative, unorthodox thinking is most urgently needed,” said Chris Wilson, director of Global Health Discovery and Translational Sciences at the Bill and Melinda Gates Foundation. “We’re excited to provide additional funding for select grantees so they can continue to advance their ideas toward global impact.”

To receive funding, Abramovitch and other Grand Challenges Explorations Round 8 winners demonstrated a bold idea in one of five critical global health and development topic areas that included agriculture development, immunization and nutrition.

“My ultimate goal and the mission of my lab is to make basic research discoveries that jump-start the development of new drugs to treat tuberculosis,” Abramovitch said. 🌟

# Swarming behavior offers clues on how intelligence developed

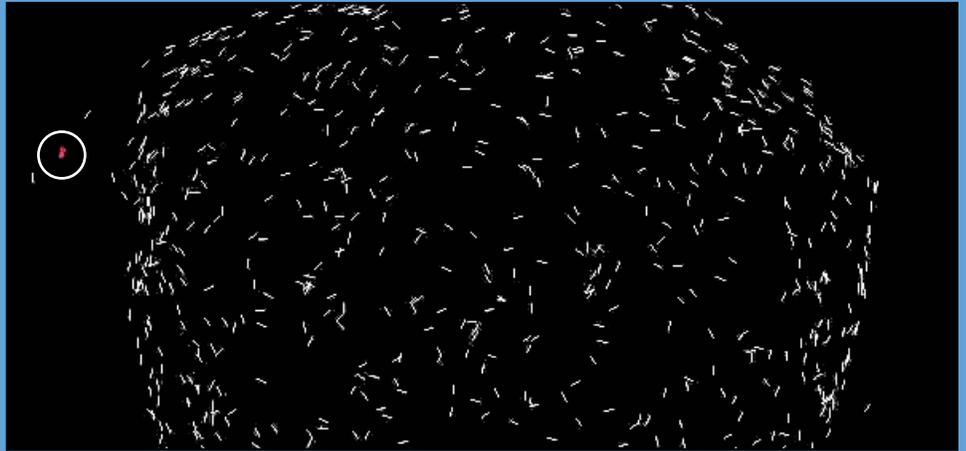
Many animals—from locusts to fish—live in groups and “swarm,” but scientists aren’t sure why or how this behavior evolved. A team of MSU College of Natural Science researchers used a model system to show for the first time that predator confusion can make prey evolve swarming behavior.

Swarming allows groups of animals to accomplish tasks they can’t do alone, such as defending themselves from a much larger predator.

“There are both costs and benefits to swarming and all other behaviors,” said Christoph Adami, professor of microbiology and molecular genetics. “The benefits are discussed all the time. But the litmus test is whether a behavior evolves because of those benefits. If it doesn’t evolve, it doesn’t mean it’s not beneficial, but if it does evolve, it’s proof that the behavior has benefits that outweigh its costs.”

The research was recently published by the *Journal of the Royal Society Interface*.

“In our system, swarming evolved as a defense to exploit the predator confusion effect,” said Randal Olson, computer science graduate student and lead author. “Rather than seeing just a few prey when the predators attack, which is what happens when prey scatter, swarming makes the



This picture is of a single swarm that evolved in the computer model due to predation (see red dot on left) in the presence of the predator confusion effect.

predators see many prey, which confuses them and allows more prey to survive.”

The researchers used a computer model system where the predators and the prey continuously interacted. The system selected prey and predators that evolved survival-enhancing behaviors—either eating prey (the predators) or avoiding being eaten (the prey). Each experiment was replicated more than 100 times to ensure that the behavior evolved due to predator confusion and not just by chance.

“Chance does play a huge role in evolution,” Adami said. “But if we repeat something many times, we start to see patterns and can talk

about averages. Evolution is a sequence of events influenced by chance.”

Studying swarming and why it evolved is a small first step toward understanding how human-level intelligence evolved in nature, a research goal of the team.

“We’re trying to learn about the problems early animals faced that made intelligent behavior a favorable trait to evolve, with the goal of working our way up to understanding how early forms of intelligence evolved into the complex forms of adaptive, social and predictive intelligence humans are capable of,” Olson said. 🍀

## Probiotics could help build healthy bones

In what could be an early step toward a new treatment for people with osteoporosis, scientists at MSU report that a natural probiotic supplement can help male mice produce healthier bones.

Probiotics are microorganisms that can help balance the immune system. For the study, the researchers fed the mice *Lactobacillus reuteri*, a probiotic known to reduce inflammation—a sometimes harmful effect of the body’s immune response to infection.

“Through food fermentation, we’ve been eating bacteria that we classify as probiotics for thousands of years,” said

Robert Britton, associate professor of microbiology and molecular genetics. “There’s evidence that this bacterium as a species has co-evolved with humans. It’s indigenous to our intestinal tracts and is something that, if missing, might cause problems.”

In the study, the male mice showed a significant increase in bone density after four weeks of treatment. There was no such effect when the researchers repeated the experiment with female mice, an anomaly they’re now investigating.

By 2020, half of all Americans over 50 are expected to have low bone density or osteoporosis, according to the National

Osteoporosis Foundation. About one in two women and one in four men over 50 will suffer a bone fracture due to osteoporosis during their lifetime.

Drugs to prevent bone loss in osteoporosis patients are already in wide use, but long-term use can disrupt the natural remodeling of bone tissue and could potentially have negative side effects, including unusual bone fractures and joint and muscle pain.

The researchers are hopeful that the new study could point the way toward osteoporosis drugs that aren’t saddled with such side effects, especially for people who lose bone density from an early age because of another chronic inflammatory condition.

## Decoding biofilm communications

**B**iofilms—or multicellular communities of bacteria—are a huge problem in the medical world. They are responsible for infections that could trigger rejection of a pacemaker, a catheter or a hip implant. They are the cause of infections of the lungs of cystic fibrosis patients. They can lead to non-healing foot ulcers in diabetics, resulting in foot amputation.

Biofilms form when bacteria attach to a surface and begin to secrete extracellular material, often referred to as extracellular slime, which protects the bacteria from external hazards such as predation by amoeba, protozoa, harsh environmental conditions . . . and antibiotics.

The biofilm problem is two-fold, according to Chris Waters, assistant professor of microbiology and molecular genetics.

“The human body’s immune system has a difficult time clearing biofilms because the protective layer formed by the bacteria does not allow the immune cells to get in and gain access to those bacteria,” he explained. “In addition, biofilms are inherently resistant to antibiotic treatment; the antibiotic may kill 95 percent of the bacteria in the biofilm, but there is a sub-population that is not killed. This leads to chronic infections that cannot be cleared.

“Our goal is to understand these processes so we can develop intervention strategies and find new compounds that will specifically work against biofilms,” he added. “Then we will be able to target these kinds of infections.”



Chris Waters, MMG assistant professor (left), discusses a recent experiment with Disha Srivastava, a sixth-year graduate student in his laboratory who will defend her Ph.D. thesis in spring 2014.

The bacteria within the community talk to each other using internal chemical signals. Waters is studying these biofilms in order to break the code that allows them to communicate with each other via these chemical pathways. He uses the model system *Vibrio cholerae* to study an intracellular signaling molecule called cyclic di-GMP (c-di-GMP), the key biofilm signal in bacteria.

Waters’ research team recently screened 70,000 small molecules to find compounds that inhibit the synthesis of c-di-GMP.

“By inhibiting its synthesis, we can prevent biofilm formation,” he said.

They were able to find some compounds that do just that. And last fall, they published a paper on the first inhibitors of the synthesis enzymes.

“Now, we will take these anti-biofilm compounds that we discovered and see if we can get efficacy in disease models,” Waters said. “Ultimately, our goal is to develop new antibiotics that can be used clinically to treat biofilm infections. We can also extrapolate this to other bacterial systems and target those pathways.”

Biofilms are also an issue in industrial processes, involving surfaces such as pipes, cooling towers and food processing equipment.

“These inhibiting compounds that we’re finding could be useful in cleaning up biofilms in these situations as well,” Waters said. 🍀

## Two MSU microbiology students awarded ASM fellowships

**J**essica Hunter and Joshua Smith received American Society for Microbiology (ASM) Undergraduate Research Fellowships in 2012, during their senior year at MSU.

The fellowship, which includes up to a \$4,000 stipend, is aimed at highly competitive students who wish to pursue graduate careers in microbiology.

“There are many outstanding students and great programs in microbiology all over the country, so to receive one of these fellowships requires that a student be strong

in research and scholastic accomplishments, and that there is a good mentoring program in place for them,” said Chris Waters, assistant professor of microbiology and molecular genetics. “Both Hunter and Smith worked in my lab for a couple of years doing exceptional research; the reviewers obviously recognized that.”

Hunter’s undergraduate research focused on how bacteria form multicellular communities called biofilms, which are associated with thousands of chronic infections that are often highly resistant to traditional antibiotic

treatment. Hunter started her graduate studies at Harvard University this fall.

“The research funded by the ASM Fellowship allowed me to develop skills that will really help me here at Harvard,” Hunter said. “My long-range career goal is to work as a professor at a research university and to mentor students like I was mentored.”

Smith’s undergraduate research was aimed at developing new antibiotics that disrupt biofilm formation and could potentially be used to treat these infections. He plans to attend dental school.



## Using bacteria to stop malaria

Mosquitoes are highly efficient transmitters of deadly diseases, causing malaria, dengue fever and other ailments. However, MMG assistant professor Zhiyong Xi is proving through his research that they can be equally adept in curing diseases.

His work, reported in the May issue of *Science*, shows that the transmission of malaria via mosquitoes to humans can be interrupted by using a strain of *Wolbachia*, an intracellular bacterium that spreads from insect mothers to their offspring. Male mosquitoes infected with *Wolbachia* can make uninfected females not produce offspring, which maximizes the number of infected individuals in the next generation.

Because *Wolbachia* can block malaria infection in mosquitoes, the end result is that treating mosquitoes would prevent them from transmitting malaria to humans—a disease that, in 2010, affected 219 million people and caused an estimated 660,000 deaths, according to the World Health Organization. Malaria has been eliminated in the United States, but it is a major public health problem in Africa and Southeast Asia.

“A *Wolbachia*-based malaria control strategy has been discussed for the last two decades,” Xi said. “Our work is the first to demonstrate *Wolbachia* can be stably established in a key malaria vector, the mosquito species *Anopheles stephensi*, which opens the door to use *Wolbachia* for malaria control.”

The *A. stephensi* species is the key malaria vector in South Asia and the Middle East, but the same technique may also work on other malaria-carrying mosquitoes, such as *Anopheles gambiae*, which predominates in Africa.

Xi’s team successfully demonstrated how *Wolbachia* can be carried by this malaria mosquito vector and how the insects can spread the bacteria throughout the entire mosquito population. Then, researchers showed that the bacteria can prevent those mosquitoes from transmitting malaria parasites to humans.

“We developed the mosquito line carrying a stable *Wolbachia* infection,” Xi said. “We then seeded them into uninfected



Research led by MMG assistant professor Zhiyong Xi shows that the transmission of malaria via mosquitoes to humans can be interrupted by using a strain of the bacteria *Wolbachia*.

populations and repeatedly produced a population of predominantly *Wolbachia*-infected mosquitoes.”

The basis for Xi’s latest findings is connected to the success of his work using *Wolbachia* to halt dengue fever. For this research, Xi focused on the mosquito species *Aedes albopictus* and *Aedes aegypti*. This work helped launch a global effort to develop *Wolbachia*-based strategies to eliminate dengue fever, which along with the associated hemorrhagic fever are emerging globally as the most important arboviral diseases threatening human populations. About 2.5 billion people are at risk of the disease, and an estimated 50 to 100 million cases occur each year.

The key to the malaria research was identifying the correct strain of *Wolbachia*—wAlbB—and then injecting it into mosquito embryos. Out of the thousands of embryos injected by MSU research associate Guowu Bian, one developed into a female that carried *Wolbachia*. The mosquito line derived from this female has maintained *Wolbachia* wAlbB infection with a 100 percent infection frequency through 34 generations. The number could grow higher as the researchers breed successive generations.

The team then introduced various ratios of *Wolbachia*-infected females into a non-infected mosquito population. In each case, the entire population carried the bacteria in eight generations or less.

Using this promising approach to tackle malaria gives scientists and world health officials another important tool to fight malaria.

“Once *Wolbachia* has been released into a mosquito population, it is quite possible that it won’t need to be reapplied, making it more economical than other methods like pesticide or human vaccine,” said Xi, who is founder and director of the Sun Yat-sen University-Michigan State University Joint Center of Vector Control for Tropical Disease. “This adds special value to the feasibility of this control strategy, considering most of the malaria endemic areas are suffering from poverty.”

Additional MMG scientists who contributed to the study are Deepak Joshi, Peng Lu, Guoli Zhou, Xiaoling Pan and Yao Xu. George Dimopoulos and Yuemei Dong of Johns Hopkins University and researchers from Sun Yat-sen University also co-authored the paper that appeared in *Science*. 🌱

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## Bacteria artfully produce 24-karat gold

At a time when the value of gold has reached an all-time high, MSU researchers have discovered that a bacterium's ability to withstand incredible amounts of toxicity is key to creating 24-karat gold.

They found that the metal-tolerant bacteria *Cupriavidus metallidurans* is able to grow on massive concentrations of gold chloride—or liquid gold—a toxic chemical compound found in nature. In fact, the bacteria are at least 25 times stronger than previously reported among scientists.

“Microbial alchemy is what we’re doing—transforming something that has no value into a solid, precious metal that’s valuable,” said Kazem Kashefi, assistant professor of microbiology and molecular genetics.

He and Adam Brown, associate professor of electronic art and intermedia, produced an art installation, “The Great Work of the Metal Lover,” which uses a combination of biotechnology, art and alchemy to turn liquid gold into 24-karat gold. The artwork contains a portable laboratory

made of 24-karat gold-plated hardware, a glass bioreactor and the bacteria—a combination that produces gold in front of an audience.

Brown and Kashefi fed the bacteria unprecedented amounts of gold chloride, mimicking the process they believe happens in nature. In about a week, the bacteria transformed the toxins and produced a gold nugget.

The researchers say it would be cost prohibitive to reproduce their experiment on a larger scale, but the researchers’ success in creating gold raises questions



about greed, economy and environmental impact, focusing on the ethics related to science and the engineering of nature.

The project was selected for exhibition and received an honorable mention at the world-renowned cyber art competition, Prix Ars Electronica, in Austria. 🌱