MICHIGAN STATE UNIVERSITY

Department of
Microbiology and Molecular Genetics

Newsletter for Alumni and Friends

SUMMER 2009

From the Department Chair...

Walter Esselman

It has been my privilege to serve as chair of the Department of Microbiology and Molecular Genetics for the past five years. Much has happened in recent years and I welcome this opportunity to share some of our stories with you.

Prior to my becoming chair, Jerry Dodgson served in the role for 14 years and ushered the department into a new state-of-the-art building, which we share with the physiology and the physics departments. Our location has become the center of a fertile ground for science on the MSU campus. Our physical connection to both the Biochemistry and the Chemistry buildings brings together hundreds of scientists and thousands of students in both the biological and physical sciences. We have seen many collaborations blossom out of the proximity of this diverse group of scientists.

Being one of the largest and oldest microbiology departments in the country, we currently have more than 50 faculty members, 300 undergraduate students, 50 graduate students and 35 research associates and postdoctoral fellows.

Alumni typically inquire about their favorite faculty, and while we cannot provide updates on all of them, we have had a number of retirements in the last five of years, including John Breznak, Bob Brubaker, Wendy Champness, Tom Corner, Al Haug, Phil Kierszenbaum, Mike Klug, Rosetta Reusch and Larry Snyder.

As transitions occur, we have been working with affiliated departments at MSU to recruit excellent new faculty. These new faces, several of which are featured in this publication, include: microbial scientists Steve Cendrowski , Todd Ciche, Kazem Kashefi, Jay Lennon, Terry Marsh, Gemma Reguera, Claire Vieille, Chris Waters and Barry Williams. Immunologists and virologists joining the department include Andy Amalfitano, Sungjin Kim, Ian York, Kefei Yu and Yonghui Zheng. Molecular geneticists Titus Brown and Brian Schutte also recently came to MSU.

The faculty form a diverse and interactive group of scientists who are pursuing research and education as they explore the disciplines of microbial ecology, microbial genetics, virology, immunology, human genetics and bioenergy. The department is at the forefront of exciting research in these areas, and while doing so, they are involving students in all areas of their work.

As an example, Jay Lennon, has recently received the support of federal stimulus funding. Jay will use these funds to study the impact of marine viruses on shifts in global climate and ocean biogeochemistry. This is one example of the department's efforts to study the role of microbial ecology in diverse systems from aquatic environment to the human gut.

As an additional example of our breadth, stimulus funding has also been awarded to Karen Friderici to expand her NIH-funded studies on next generation genetic sequencing technology examining the underlying molecular genetic mechanisms for Attention Deficit Hyperactivity Disorder (ADHD).

One of our strengths is the collaborative atmosphere that permeates all levels of operation. The department is unique because we serve four college deans along with the Michigan Agriculture Experiment Station. This means our faculty teach and align research in three medical colleges along with the College of Natural Science and MAES. These connections provide direct access to additional assets including the Center for Microbial Ecology, the Ribosomal Database Program, the Center for Microbial Pathogenesis, the Kellogg Biological Station, the Cell and Molecular Biology Program and the Genetics Program.

As is the case everywhere, our budget remains tight and we continue to balance efficiencies while keeping an eye on our core values and strengths. We have continued to receive new and competitive federal grants through NSF, NIH, DOE and other agencies. At every step of the way, we are involving our students as we provide solution-driven education and research to the world's most challenging problems.

I look forward to hearing from you and offer a standing invitation to all alumni to visit whenever you find yourself on campus.

Walt Esselman, PhD
Chair, Department of Microbiology and Molecular Genetics
Michigan State University

Faculty High-Fives

Research from two faculty members at MSU was recently featured on the cover of the *Journal of Applied Environmental Microbiology*. Todd Ciche's research, "Cell Invasion and Matricide during Photorhabdus luminescens Transmission by Heterorhabditis bacteriophora Nematodes," studied symbionts that infect nematodes. Tom Schmidt's research, Phylogenetic Characterization and Prevalence of Spirobacillus cienkowskii, a red-pigmented, spiral-shaped bacterial pathogen of freshwater daphnia, studied daphnid pathogens.

Robert Hausinger, Sheng-Yang He and Joan Rose were recipients of the 2009 MSU Distinguished Faculty Award. The annual awards recognize faculty for outstanding total service to the university.

Shen-Yang He was the co-author of an article in the May 8 issue of *Science*. The article summarizes the state of the science of how plants are attacked, and defend against, pathogenic organisms. He wrote in a special section with collaborator Thomas Boller of the University of Basel.

The National Science Foundation asked Richard Lenski to comment on evolution for a special report *The Evolution of Evolution*. His essay, "Evolution: Past, Present and Future," can be found online (http://www.nsf.gov/news/special_reports/darwin/index.jsp). Lenski received widespread attention in 2008 after an article he co-authored, "Historical contingency and the evolution of a key innovation in an experimental population of *Escherichia coli*," was published in the *Proceedings of the National Academy of Sciences*. Lenski was elected to the academy in 2006.

Thomas Schmidt is part of a MSU/U of M group which received $1.3 million to explore the microbial communities in the human gastrointestinal tract as a part of the NIH Human Microbiome Project. The project's goal is to explore how the complex communities of microbes that live inside the human body interact with it to influence health and disease.

Rachel Spurbeck and Cindy Arvidson's paper about Lactobacilli Inhibiting Gonococcal Infection was featured in ASM's *Microbe* in August. The paper, "Inhibition of Neisseria gonorrhoeae epithelial cell interactions by vaginal Lactobacillus species," was published in Infection and Immunity.

Michael Thomashow was named a fellow of the American Society of Plant Biologists in 2009. Thomashow is a University Distinguished Professor and director of the MSU/DOE Plant Research Laboratory.

RETIREMENTS

Please join us in thanking these five recently retired microbiology faculty for their decades of service in teaching and research at Michigan State:

- Wendy Champness
- Tom Corner
- Felipe Kirszenbaum
- Rosetta Reusch
- Larry Snyder

OBITUARY

Thomas Whittam, Hannah Professor of Bacterial Evolution, died in December 2008. He was a faculty member in zoology, microbiology, and the National Food Safety and Toxicology Center, and was a renowned expert on bacterial evolution with a focus on pathogens that cause food-borne diseases.

The MSU Department of Microbiology and Molecular Genetics newsletter is published annually by the College of Natural Science for alumni and friends.

Send correspondence to: Dept. of Microbiology, c/o College of Natural Science Advancement Office, 103 Natural Science Building, East Lansing, MI 48824. Ph (517) 353-9855. E-mail: natsci4u@msu.edu.

Contributing writers: Walt Esselman, Mark Fellows, Gordon Shetler, and Mike Steger. Photography: Gordon Shetler, Mike Steger and Kurt Stepnitz.

Metagenomics research in the classroom

A new microbiology class at MSU's Kellogg Biological Station this summer will teach students next generation sequencing techniques as they collaborate with an ongoing research project. Microbiology students will be immersed in the study of genomics of communities for two weeks as part of MMG 490: Microbial Metagenomics. The class is part of a new initiative in the College of Natural Science that combines instruction and real research experience.

Professor Tom Schmidt and Teaching Assistant Catherine Robinson teach a class in Microbial Genomics and Genetics in the Biomedical and Physical Sciences Building at MSU. Students learn about modern methods to study genes of bacteria and humans.

Genomic sequencing technology has traditionally been applied to study the genetic material of single organisms. The throughput of next generation sequencing technologies has increased significantly and allows sampling of DNA sequences from entire microbial communities, according to Professor Tom Schmidt. Studying the genomics of communities, or metagenomics, has only been possible in the last five years, and these new technologies are now being introduced into the undergraduate microbiology curriculum at MSU.

"Instead of sampling the DNA of a single bacterium, we're trying to identify all of the bacteria in the soil population by directly sequencing their collective DNA," said Schmidt. "I expect our students will make some important discoveries in the class. The laboratory exercises are real experiments, not practice exercises. That is exciting since we don't know what we will find."

Students will learn both fundamental theories and their practical application. During their two week stay at the MSU facility near Kalamazoo, the students have an intensive schedule of lectures in the mornings, afternoons in the lab and evenings on the computer. This class is patterned after the successful classes Schmidt taught for five years at the Marine Biological Laboratory in Woods Hole, Mass., where students learn by total immersion in hands-on scientific experimentation.

"This class teaches students techniques that are on the cutting-edge of science as this is really new technology," said Dave Dewitt, associate dean of the College of Natural Science. "They are not just taking a class. Instead, the students directly participate in ongoing research. This class is part of a new college-wide initiative to modernize our classes and labs by engaging students in solution-driven science so the next generation of researchers will have the experience and skills to solve complex problems."

The students will be working on aspects of Schmidt's research project. The class is an educational component of Schmidt's National Science Foundation (NSF) grant studying metagenomics. Schmidt is investigating the relationship between changes in microbial communities and greenhouse gas emissions at the Long Term Ecological Research site at Kellogg Biological Station.

"During the course, we spend time learning about what scientific questions you can ask and how you analyze the data to answer those questions," Schmidt said. "That is much more rewarding than doing a cook-book lab. It is more fun for me and for everybody taking the course as well. We never know exactly what we will find and we have fun learning during the process."

Schmidt added that the skills learned can be applied to any environment - the human microbiome, food or soil. Schmidt is being joined by professors Jay Lennon and Clegg Waldron in teaching the course.

Kellogg Biological Station is a year-round resident field station equipped with classrooms laboratories and living facilities to support research and education. KBS is one of the premier biological field stations in the U.S. and is home to MSU's Long-Term Ecological Research program - part of a national network of sites established by the NSF.

Finding genetic causes of diseases

While scientists have been tracing things like diabetes through families for generations, more recent advances have allowed them to locate the specific genes that contribute to many diseases. Yet, the most common diseases have a complex combination of genetic and environmental factors, so finding the genetic causes to these diseases is challenging.

Professor Brian Schutte

Associate Professor Brian Schutte came to MSU to take on that challenge. He is part of a team of collaborators who are looking for the genetic factors that contribute to common diseases in order to develop new innovative health care procedures for prevention and treatment of these diseases.

"Since the Human Genome Project, we have witnessed an explosion of discoveries of genetic factors that contribute to human diseases," Schutte said. "However, the majority of these discoveries represent the low-hanging fruit of inherited disorders - where the diseases are genetically simple and exceedingly rare."

Schutte and his wife, Debra Schutte, associate professor of nursing, have joined a team of faculty involved in a long-term community health project studying inherited forms of deafness. The team also includes Rachel Fisher, professor of pediatrics; Karen Friderici, professor of microbiology and molecular genetics; and Jill Elfenbein, associate professor of communicative sciences and disorders.

Together they formed the program Community-based Cooperative for Studies Across Generations, or CoSAGE. The program builds on a ten year relationship between researchers and community members in a cluster of rural communities in Mid-Michigan. The residents of these communities are direct descendants of a founding population of German immigrants that started in 1836. Today, 10 thousand direct descendants still live within a 90-mile radius of the original settlements.

"This group of immigrants were isolated by religion and language, so they intermarried creating a genetically isolated population," Schutte said. "It is like the government of Iceland, which is using the entire population of Iceland to discover genetic factors for diseases. Only this is on a smaller scale."

Having a genetically similar population makes finding the genetic factors involved in these diseases easier, Schutte said. Also helping the research is that the communities have remarkable genealogical records.

As part of the CoSAGE project, health professionals will interview community members, conduct a basic health analysis and take samples for genetic analysis. After analysis, the team will take the data directly back to the communities.

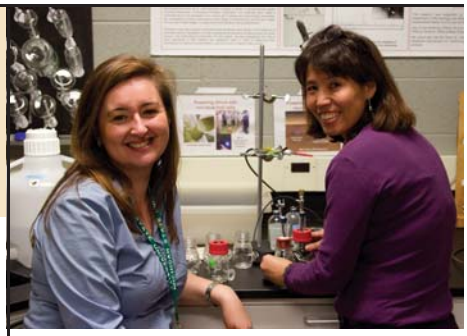
What they learn about the diseases will immediately go back to the communities to help them plan for future health care needs and identify preventative measures that could improve the health of the population. The project is based on cooperation and community involvement.

"We're currently in the beginning stages where we are talking with community members like political leaders, health care professionals and church leaders," Schutte said. "With their help, we will perform the health assessments and in a two-year time frame, we hope to have the data collected and identified so we can take information back to the communities."

Before coming to MSU, Schutte spent 17 years at the University of Iowa studying the genetic factors that cause human disease. His lab, in collaboration with others around the world, discovered the gene that causes cleft palette. The CoSAGE project is funded with a Family and Community Together (FACT) grant. FACT is a multidisciplinary coalition from MSU and community organizations and funds research that addresses community needs.

Microbes provide solutions to energy issues

After three years of research, Assistant Professor Gemma Reguera has developed a process that can be harnessed to produce clean, cheap electricity and fuel from plant biomass. Microbial fuel cells are attracting interest as they are inexpensive to manufacture and produce no harmful by-products.



Professor Gemma Reguera and Research Technician Kwi Kim

Using a specific selection of metal-reducing microorganisms in the *Geobacter* species – a bacteria that are natural inhabitants of environments abundant in metals – Reguera was able to design a microbial fuel cell that acts as a natural battery to convert plant biomass into electrical power and produces a high yield, low cost cellulosic ethanol product.

"Finding the exact match was difficult because there are billions of microbes living in the soil and water," Reguera said. "By observing the natural processes of these organisms over time, we were able to reproduce these processes and develop a technology by matching up the right microbes.

"All the work of this process is done by bacteria inside a microbial fuel cell," Reguera continued. "Some of the bacteria decompose plant material while others move electrons to survive. The electron-moving microorganisms such as those in Geobacter naturally replace metal oxides with electrodes to get energy. This process is similar to how we breathe oxygen and exhale carbon dioxide."

Although producing ethanol is viewed as the main purpose, Reguera adds that having the fuel cell create electrical power as a by-product has added benefits. In the future, farms could be powered by their own plant by-products and fuel their own tractors from the same microbial fuel cell.

Making good matches between bacteria has yielded amazing results, but genetic manipulation could take the technology to a completely new level, Reguera said.

As part of her work with the Great Lakes Bioenergy Research Center, Reguera has modified a type of *Geobacter* to live in the same conditions as Cyanobacteria. Cyanobacteria are bacteria that produce energy from sunlight. The combination of these two types of bacteria means the fuel cells can produce electricity directly from sunlight.

Reguera's next step is to make the fuel cells more efficient and successful at a larger scale. A team of Australian researchers is currently experimenting with microbial fuel cells to treat waste water effluent from a brewery while producing power. Microbial fuel cells are also being tested in ethanol biorefineries to remove toxic products from biomass pretreatments while generating ca. 25% of the electrical power needs of the biorefinery.

"I tell my students 'you have to be very brave to be in my lab' because they have to know how to do the entire process from the primary research to application," Reguera said. "But they get really motivated when they see how small technologies can make huge impacts."

Reguera's work is funded by the Michigan Agricultural Experiment Station, the Rackham Fund Foundation, and the Great Lakes Bioenergy Research Center - a partnership between MSU and the University of Wisconsin-Madison. The center is funded by the U.S. Department of Energy to conduct basic research aimed at solving some of the most complex problems in converting natural materials to energy.

We like to hear from alumni and encourage you to stay connected...

- Visit the alumni section of naturalscience.msu.edu to send your career news and address updates.
- Network with alumni by joining the MSU College of Natural Science groups on Facebook or LinkedIn.
- Join the alumni association and become involved in the college alumni organization.
- Visit the department web site for the latest news at http://mmg.msu.edu.

Disrupting the population dynamics of malaria

Professor Ned Walker is taking on one of the biggest killers in the world — malaria. He believes he can help win the battle to save lives, especially the lives of children. With a $1.7 million grant from the National Science Foundation, Walker is leading a research team to study how insecticide-treated bed nets can disrupt the population dynamics of the parasite that causes the deadly disease, as well as the mosquito that transmits the parasite. The scientists will focus on an area of western Kenya.

According to statistics from the World Health Organization, Malaria kills about 3,000 children each day in Africa. Research has shown that using bed nets may cut mortality in half.

A microbiology and molecular genetics and entomology researcher, Walker's research focuses on how infectious diseases are transmitted, especially those that use mosquitoes as a mechanism to spread.

"We'll be evaluating the effectiveness of the bed nets over the long term," Walker explained. "Malaria has resisted past attempts to control it. But the bed nets have emerged as a powerful and simple control tool. They only cost about $10 a piece. The big question is whether the bed nets will continue to work over time. That's what we'll be studying."

Follow the blog with students from Ned Walker's lab and get reports on malaria and bed net research: http://msunothingbutnets.blogspot.com/

So far, *Anopheles gambiae*, the mosquito species that is responsible for transmitting malaria to humans in Africa, hasn't demonstrated any resistance to the insecticide used in the bed nets.

"It appears that the *Anopheles gambiae* population declines and doesn't recover," Walker said. "So the parasites that cause malaria shift into a different mosquito that feeds mainly on cattle. Since these mosquitoes don't bite people as often and cattle don't support the malaria infection, malaria transmission goes way down."

Walker and his colleagues also will be looking at the population structure of the malarial parasites to see how the population responds to decreasing mosquito populations.

"The parasites have a deep population structure—males outnumber females by about 8 to 1," Walker explained. "If there is a drop in total parasite numbers, it could be even harder for the parasites to mate."

According to Walker, this is important for two reasons. Malarial parasites are notorious for developing antibiotic resistance. Restricting the population would restrict the gene flow, which would limit spread of the resistance. Walker's team will be using genetic markers to track the flow of genes. Second, when malaria transmission goes down, it tends to be the more virulent strains of the disease that survive.

"We don't want that to happen, so we'll be studying virulence factors to monitor it," Walker said.

The study also will examine how well people accept and use bed nets in their daily routines.

"I'm very excited to begin the project," he continued. "Bed nets are an inexpensive, easy-to-use method to control the disease. This research is international in scope and will help us help people, which is one of our land-grant principles."

Joseph Messina, associate professor of geography, also is participating in the project.

This research is funded by the National Science Foundation and supported by the Michigan Agricultural Experiment Station. The Kenya Medical Research Institute and the U.S. Centers for Disease Control and Prevention are collaborators.

ALUMNI CLASS NOTES

John Ohlsson, B.S. ’58, M.S. ’60, is in his 43rd year as a dentist and is practicing at Coast Dental in Florida.

Lois Ohlsson, B.S. ’58, is a social and exercise leader in Florida after working 23 years as a public school teacher and 20 years as a dental office manager.

May Tevethia, Ph.D. ’64, is a professor of microbiology and immunology in the College of Medicine at the Penn State Milton S. Hershey Medical Center. The major effort in her laboratory is directed toward elucidating the mechanisms utilized by the oncogenic DNA virus simian virus 40 (SV40) to alter cell growth properties and to induce tumors.

Satvir Tevethia, Ph.D. ’64, is a distinguished professor of microbiology and immunology in the College of Medicine at the Penn State Milton S. Hershey Medical Center. The primary emphasis of his laboratory is directed toward elucidating the role of the immune response to pathogenic and oncogenic DNA tumor viruses.

Fred Stutzenberger, Ph.D. ‘67, is retired but still publishing review chapters. His latest was Nanotechnology in the Detection and Control of Microorganisms, Chapter 4 in Advances in Applied Microbiology, 2008.

Helen Engelbrecht Ownby, Ph.D. ‘68, is enjoying retirement from the American Red Cross, Southeastern Michigan Blood Services.

Paul Watkins, B.S. ’74, is Vice CEO of Bioactive Bone Substitutes in Oulu, Finland. He has more than 20 years experience in the biomedical technology sector and has held senior positions in biotech, research products, genomics, and specialty pharmaceuticals companies. He has been involved in three VC-funded companies, two successful IPOs and has specialized in emerging hi-tech start-ups, joint ventures and business spin-offs.

Brandon West, B.S. ‘82, is celebrating his 23rd year practicing podiatric medicine and surgery in Walled Lake, Mich.

Mark A. Batzer, B.S. ‘83, M.S. ‘85, is an LSU System Boyd Professor and the Dr. Mary Lou Applewhite Distinguished Professor in the Dept. of Biological Sciences at Louisiana State Univ., in Baton Rouge. His research in comparative genomics focuses on the contribution of transposable elements or mobile DNA to mammalian genomic diversity and the genetics of healthy aging, and was selected as one of the top 100 stories for 2008 by *Discover*. He was elected a fellow of AAAS in 2007.

John Sherwood, Ph.D. ‘84, is department head for the Dept. of Plant Sciences and Plant Pathology at Montana State Univ.

Eric Ayers, B.S. ‘85, is program director for the Internal Medicine and Pediatrics Program at Wayne State Univ. School of Medicine. He serves on the Executive Board for the Med-Peds Program Directors Assoc. and served as President in 2006.

Linda Smith Sherwood, Ph.D. ‘85, is co-author of Prescott’s Microbiology, one of the leading microbiology textbooks. She is currently working on the 8th edition and teaching the general microbiology class offered by the Dept. of Microbiology at Montana State Univ.

Mark Terry, B.S. ‘86, is a freelance writer and editor covering clinical diagnostics, public health, medical practice management and biotechnology. He has written three novels and numerous market research reports about the clinical lab industry. His fourth novel is scheduled for release next year.

Hueiwen Tan, B.S. ‘04, received a masters degree from the Univ. of Scranton and is a research associate at Regeneron Pharmaceuticals.

Travis Reed, B.S. ‘05, recently graduated from the MSU College of Veterinary Medicine and is serving a one-year internship in Small Animal Medicine and Surgery at the Ontario Veterinary College, Univ. of Guelph in Ontario.

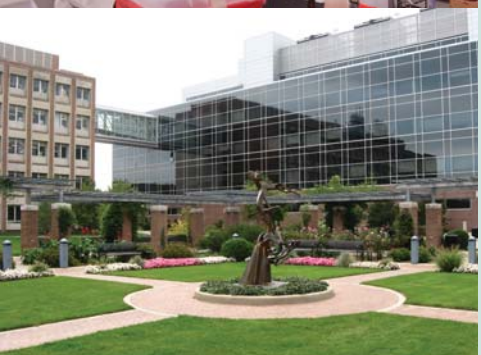
Kirsten Marie Kulek, B.S. ‘07, the Lead Research Specialist at Yerkes Primate Research Center at Emory University, Atlanta, has taken a new research position at Loyola Univ. with research focusing on cardiac protein abnormalities.

Sheena Tapo, B.S. ‘08, has completed her first year of teaching life science for the Teach for America program in an Atlanta Public School.

Brian Glasby, B.S. ’07, recently received a teaching position at Westside K8 Elementary in Orlando, Florida, where he is teaching 6th and 7th grade science.

MICHIGAN STATE
UNIVERSITY

DEPARTMENT OF MICROBIOLOGY AND MOLECULAR GENETICS
College of Natural Science
103 Natural Science Building
East Lansing, MI 48824-1115



Bacteria, viruses subject of stimulus grant

The oceans teem with microscopic bacteria that produce much of Earth's oxygen as they absorb carbon dioxide greenhouse gas. But fast-mutating viruses also populate the seas, attacking marine bacteria in an ages-old evolutionary arms race.

Jay Lennon, assistant professor of microbiology and molecular genetics, will probe that ancient dynamic against the backdrop of environmental and climate change, and the pivotal role played by aquatic bacteria in maintaining the Earth's biological balance. Lennon will pursue his research using a $199,000 National Science Foundation grant, including American Recovery and Reinvestment Act funds. He will collaborate with microbiologists at the University of Tennessee and biochemists at Oak Ridge National Laboratory.

In laboratory settings, cyanobacteria can take just weeks to evolve resistance to viruses, Lennon said, while viruses similarly mutate to find new ways to infect them. Cyanobacteria play a role in sequestering ocean nitrogen and phosphorus nutrients, during which they remove carbon dioxide from the air and produce oxygen. Understanding how they evolve to resist viruses could unlock information critical to environmental and climate studies.

In addition to the NSF grant, Lennon's work is supported by the Michigan Agricultural Experiment Station, the Gordon and Betty Moore Foundation and the Broad Institute at Harvard University and the Massachusetts Institute of Technology, which will sequence virus genomes for the research project to genetically evaluate how they evolved.