Dr. Jill Mikucki, New Assistant Professor, Studies Life Below Antarctica’s Ice

Jill Mikucki, one of UT’s newest microbiology professors, sits at her office desk on a hot and muggy May afternoon talking ice. More specifically, Mikucki talks about how her interest studying microbial communities below the surface of Antarctica’s ice sheets spawned from a love for the cold.

“If you can marry several things that are very important to you, you will be more productive and engaged in the long run, and I was a ski bum,” laughs Mikucki, explaining how various undergraduate interests fused into lifelong passions. Mikucki majored in environmental studies as an undergraduate, but through her postgraduate work at Portland State and Montana State universities, she developed a particular interest in microbial metabolism, or how microbial communities capture energy needed to survive and prosper.

For an unblemished view of how microbe communities interact and influence one another, researchers must go to the far reaches of Earth for samples and take painstaking care not to contaminate them with outside organisms or materials. What better field site for watching microbes interact without outside intervention than Antarctica?

-Continued on Page 2

Dear Friends of Microbiology:
The past year has been an exciting one for the Department as reported in this issue of The MicroScope. Some of the highlights of the past year were:

- Three new faculty members, Nathan Schmidt, Jill Mikucki, Karen Lloyd are starting their amazing research programs
- Another Governor’s Chair, Terry Hazen, has joined our faculty (with a co-appointment in the School of Engineering and the Department of Earth and Planetary Sciences)
- Our faculty members have excelled in their research performance, teaching, and service to the University and the microbiology community

-Continued on Page 3
Mikucki's interest in Antarctica began while earning her doctoral degree in Montana. Her doctoral fieldwork took place in Antarctica's McMurdo Dry Valleys, where she would spend three months at a time conducting research. After receiving her doctorate, she served as a postdoctoral fellow at both Harvard and Dartmouth universities.

In total, Mikucki has spent roughly 2 years in Antarctica between nine separate excursions. Antarctica, the coldest, driest, windiest continent on our planet, is a largely unexplored region. Such logistically challenging field research requires interdisciplinary knowledge and collaboration.

Mikucki focuses on microbial communities below Antarctic ice, but due to technological challenges in drilling and clean sampling, she also works with researchers interested in deeper insight into what controls ice sheet stability and the hydrology—the makeup and movement of water in a particular environment—below the surface of glaciers.

Antarctica was long seen as a “dead” place, but in the past few decades scientists have detected a diverse mix of microbial life living in the cold extremes of the continent, both within and below the ice. These developments, coupled with Antarctica’s sparsely inhabited landscape, necessitate researchers collaborating on new methods to study organisms in such harsh environments. “[The research] can tell us how life survives in cold extremes,” Mikucki says. Not only does Mikucki’s research help describe how organisms live in one of Earth’s polar frontiers, but she is also interested in whether similar life forms can exist elsewhere in the Universe.

Antarctica serves as the best terrestrial testing site for life beyond Earth. “Subglacial environments provide one of our best earthly analogs to study the most planet in the Universe.”

Researchers take great care to avoid contaminating samples, and Mikucki is particularly concerned about collecting Antarctic samples cleanly. Drills and other sampling equipment must be vigorously cleaned to avoid contamination of pristine subglacial environments. Researchers also use ultraviolet radiation or chemical processes to help create a sterile environment. Mikucki is an investigator on the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) project, funded by the National Science Foundation, which is working to develop clean hot-water drilling methods for such a purpose.

Another one of Mikucki's current collaborations is with aerospace researchers at the University of Aachen (Germany), which involves developing and testing their IceMole craft. Once fully developed, IceMole will serve as an unmanned craft capable of collecting samples from icy environments both on Earth and hopefully beyond. Mikucki, along with other US collaborators and the German IceMole team, plan to test the IceMole in Antarctica in 2013.

With so much experience collaborating between various scientific disciplines, Mikucki saw UT as a great place to be. “I consider myself to be fairly interdisciplinary,” Mikucki says, explaining her interest in coming to UT. “I saw the opportunity to learn a lot from my future colleagues as well as provide an interesting system for folks to think about,” she says.

- Eric Gedenk
New Assistant Professor Nathan Schmidt Searches for New Malaria Cure

"I wanted to get into a research field that would have a translational impact, and something that would really have an impact on human health, not only in the US, but around the world," he says.

Schmidt is not only interested in studying how the human body's immune system responds to the *Plasmodium* parasites that cause malaria, but he also wants to create an effective vaccination to prevent the disease.

One of the highlights of Schmidt's post-doctoral tenure was discovering that antibodies—proteins in the body that help identify and bind to foreign objects—can effectively prevent malaria infections. It was this discovery that made UT such an attractive place for Schmidt. Dr. Tim Sparer, UT associate professor of microbiology, specializes in a particular method of generating large quantities of proteins that aligns itself very well with Schmidt's research.

Using this approach Dr. Schmidt will generate *Plasmodium* proteins and use those in a vaccine to generate antibodies that recognize the proteins. The end objective is to identify the level of these antibodies necessary to prevent a *Plasmodium* infection. He hopes that this information will also provide a benchmark in the evaluation of future malaria vaccines. In addition, Schmidt plans to collaborate with UT assistant microbiology professor Dr. Vitaly Ganusov to better understand how the immune system recognizes and eliminates *Plasmodium*-infected cells.

In addition to antibodies, which are produced by B cells in the human body, other malaria research relies on creating vaccinations that work with the body's T cells—particular white blood cells that identify infected cells in the body and destroy them.

Most approved vaccines are based on the body's B cells, which only strengthens Schmidt's hypothesis. "I think antibody-mediated protection against the parasite is a critical component to a successful vaccine; however the most successful malaria vaccine will likely incorporate B cells and T cells," Schmidt says. Student response to Schmidt's research has also been positive. "Several people have already been interested in joining the lab," Schmidt says. "Obviously this is something that I'm passionate about, but to see other people passionate about it is exciting to me." Schmidt was able to take on one graduate student in his lab during the 2011-2012 school year, and has had several undergraduate students volunteering in the lab as well.

In addition to vaccinating with *Plasmodium* proteins to combat the parasite, Schmidt hopes to understand why immune system responses to the parasite infection do not develop natural protective immunity.

UT has provided Schmidt with a stable of able collaborators for his research, but also a good sense of community over the last year. "The move to Knoxville has been great, and my family and I have really enjoyed settling in here," Schmidt says. "The University of Tennessee has been a great place to start a faculty position, but also from a personal perspective. The community here has been a good fit for me and my family."

- Eric Gedenk

**UT-ORNL Partnerships Push the Front Line of Microbiology Forward**

What do a world-class national laboratory and flagship state university have in common?

In the case of the University of Tennessee–Knoxville (UT) and Oak Ridge National Laboratory (ORNL), the institutions share highly motivated researchers who not only advance research in their respective fields, but also educate next-generation microbiologists.

"We are facilitating the collaboration between faculty members and students at both places," says Dr. Terry Hazen, an environmental biologist who runs laboratories at both institutions by serving as UT's newest Governor’s Chair. Hazen, who has UT appointments with the Engineering and Earth and Planetary Sciences departments in addition to Microbiology, specializes in bio-remediation, or using microorganisms to help clean polluted environments.

-Continued on Page 6
Former Tennessee Governor Phil Bredesen started the Governor’s Chair program to help foster collaboration between UT and ORNL. Hazen, one of the most recent Governor’s Chairs, became renowned for his work on the Deepwater Horizon oil spill in the Gulf of Mexico.

Hazen’s research team, then based at Lawrence Berkeley National Laboratory (LBL), discovered oil-eating bacteria near the site of the oil leak that helped remove oil from the ocean.

In addition to Hazen, Dr. Frank Loefller also serves as an environmental microbiology Governor’s Chair, specializing in detoxifying environments through the use of microbes. Hazen noted that East Tennessee’s wealth of microbiologists aided in both he and Loeffler’s decision to become Governor’s Chairs. “There is a tremendous number of microbiologists here,” Hazen says. “We had a reception for lead principal investigators in microbiology at Oak Ridge and UT. There were over 100, and that does not include post-docs or graduate students. It allows us to draw on a lot of expertise.”

Governor’s Chairs’ ability to foster and direct collaborations between different science disciplines and institutions has helped create a thriving interdisciplinary environment at both UT and ORNL. “One of the reasons we’re so successful is because of direct interaction with the Governor’s Chairs at ORNL,” said Dr. David Graham, group leader of Microbial Ecology and Physiology at ORNL and a Joint Faculty Research Associate Professor of Microbiology at UT.

Graham’s group studies how microbes transform the environment and how microbial genes affect Earth’s carbon cycle. This research helps find improved conditions for biofuel production, capturing and storing carbon from the environment, and bioremediation. Graham leads the Biogeochemistry team in a new project directed by Dr. Stan Wullschlegler at ORNL’s Next-Generation Ecosystem Experiments in the Arctic, to understand impacts of increased thawing in Arctic permafrost areas. Graham notes that although the Arctic has long been seen as a carbon sink, meaning it captures and holds more carbon than it produces, increased melting could reverse this trend. This project is funded by the Department of Energy’s (DOE) Office of Biological and Environmental Research.

Dr. Mircea Podar, who leads the Systems Genetics group at ORNL, also works on various projects connected to UT as a Joint Faculty Research Associate Professor of Microbiology. Podar’s research interests are multidisciplinary. One of his current projects is based on a DOE-funded grant to study and model the interaction between two single-celled organisms capable of living in extreme heat, Ignicoccus and Nanoarchaeum, by combining evolutionary and functional genomic approaches to the research.

Another project, funded by the National Institutes of Health, focuses on uncultured microbes in the human body. This research aims to more thoroughly identify the genomes of more mysterious bacteria at work in our bodies. By using a combination of single cell genomics and metagenomics, which gleans genetic material directly from an organism’s environment, this research aims to provide insights into bacterial groups and their functions which, though so far unknown, may provide greater insight into human health and disease.

Other ORNL-based projects in Podar’s group include studies of the poplar tree microbiome, which is comprised of the microorganisms in the area of soil influenced directly by root systems known as the rhizosphere. That work, led by Dr. Christopher Schadt, also a UTK Microbiology Joint Faculty member, hopes to identify what organisms and plant-microbe interactions most positively influence plant growth and can aid in greater poplar cultivation for bioenergy biomass production.

One of the largest collaborations between UT and ORNL falls in the context of a nationwide project with major environmental implications. The Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA) project, a DOE-funded $12.5 million per year project based at LBL, seeks greater detail about how microbial communities interact in various environments, namely those polluted with heavy metals such as mercury, uranium, or chromium. Hazen is the environmental lead, while Dr. Dwayne Elias leads an ORNL-based ENIGMA team studying microbial community dynamics and physiology at ORNL, in collaboration with Loeffler, Podar and Dr. Steven Brown of ORNL. Every year, roughly $1.3 million comes to UT and ORNL from the ENIGMA project.

Not only are these ORNL staff members driving major research collaborations, but they also are working to help UT faculty train students. Both Graham and Podar are part of the Research Experience for Undergraduates program, funded by the National Science Foundation and run by the Microbiology department. Students coming to UT for the summer will have opportunities to work at ORNL as well as the UT departmental laboratories (see story on page 8).

- Eric Gedenk
Microbiology Department to Host National Science Foundation-funded Undergraduate Collaborations for Summer Research Experience

As the UT microbiology department grows, its faculty and staff are always looking for new ways to foster collaboration and train next-generation microbiologists. What better way than to host a diverse mix of undergraduate students for a 10-week research experience over the summer?

“The way many places make themselves better is through training programs,” Dr. Steven Wilhelm, UT microbiology professor, said. “This creates the opportunity to bring in students that have different ideas and experiences and integrate that into how we do things here. It also creates the opportunity for our own students from Tennessee to meet people of different backgrounds.”

This rationale got Wilhelm and associate professor Dr. Erik Zinser thinking about how they could entice students to come work at UT over the summer. The professors applied for one of the National Science Foundation’s (NSF’s) Research Experience for Undergraduate (REU) Site grants for 2013, and they succeeded.

“We are very excited that the NSF awarded us an REU; these are highly competitive grants,” said Zinser. “I think one of the main reasons why we’re successful is the strength and breadth of microbiological research in the area, not only in the Microbiology department, but across the UTK campus and at Oak Ridge National Laboratory as well.”

Ten students’ will relocate for the summer to work side by side with accomplished researchers in various fields. The NSF places particular emphasis on identifying qualified students in areas typically economically or geographically underrepresented in science. In the case of Wilhelm’s and Zinser’s grant, students will work side by side with an interdisciplinary mix of researchers based at both the University of Tennessee and nearby Oak Ridge National Laboratory (ORNL).

The program’s title is “Microbial Community Interactions and Function.” The various labs will expose students to topics ranging from Antarctic microbe communities living below ice to the physiology of fungal communities and how they affect their surround areas. In addition to microbial organisms, students will also be interacting with one another and learning to function inside a variety of research labs based on professors’ expertise. “The focus is to really get these students integrated into research labs,” Wilhelm said.

About 20 faculty members have signed up to help this process in various ways. Some will participate in structuring the program, while others will host students. In addition to microbiology faculty, professors from the Biosystems Engineering & Soil Science, Earth & Planetary Science, and Ecology & Evolutionary Biology departments will participate in this REU Site. In addition, adjunct professors based at ORNL will host students.

Graduate students will serve as “big siblings” to help the visitors acclimate to both the research environment and Knoxville in general.

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“While the individual research projects will in most cases be performed in a single lab, there will be many opportunities for the students to interact with other students and faculty in the program,” said Zinser.

“This will add breadth to their experience here in the summer.”

Receiving an REU Site grant is a pretty competitive process, as the NSF is only able to fund 8–15% of proposals they receive, but the student application process will be competitive as well. Wilhelm says typical REU Sites receive 100’s of applications for only 10 spots. Students need to be returning to their home universities as undergraduates the following fall to qualify for the program, and a committee of 3–5 faculty members will make decisions based on students’ letters of interest, transcripts, and reference letters.

UT students themselves will not be left out of similar opportunities. The Department of Microbiology has issued endowment funds over the past five years to provide UT undergraduates with similar opportunities. The UT Office of Research also provides similar opportunities.

In essence, UT faculty involved in this project are not just teaching undergraduates during the school year, but offer dozens of motivated undergraduates paid research opportunities to work with them throughout summer.

The faculty who runs the UT Microbiology REU Site varies greatly in their fields of study, ages, and experiences, but there is a common bond holding them together. “Many of the faculty that are the leaders of this program actually had experience as undergrads doing research themselves, to the point where many of them contributed to scientific papers,” Wilhelm said.

By established this program, many of the faculty will see their careers come full-circle by guiding research experiences that were the origins of their own career paths. -Eric Gedenk
Microbiology Students Venture Into the World

UT Microbiology students leave their marks in various ways. One thing they have always done, though, is take opportunities to enrich their learning by venturing out of the friendly confines of Knoxville and collaborating with other research environments.

**Padilla-Crespo Works on the U.S. Science Agenda at the NSF Headquarters**

Elizabeth Padilla-Crespo (pictured above) is one such case. Padilla-Crespo, a doctoral candidate in the Microbiology department, wanted to enrich her knowledge of the field by working in the funding environment at the National Science Foundation (NSF). With encouragement to apply, Padilla-Crespo became an intern for the summer at the NSF’s central offices in Virginia.

“The guidance and mentorship I have received in the UT-Microbiology Department, especially from my advisor Frank E. Loeffler, gave me the confidence to apply,” Padilla-Crespo said. “I’ve been lucky to have great teachers who have also served as mentors, they have not only given me the tools to become a competitive microbiologist and researcher, but they have also inspired me to take my science outside the conventional settings of classrooms and laboratories.”

**Steffen Takes Her Research to Germany**

Second-year graduate student Morgan Steffen also got experience while abroad. Steffen was selected to take part in a two-week bioinformatics course in Bremen, Germany at Jacobs University. Steffen works in Dr. Steven Wilhelm’s lab and studies Microcystis, a toxic cyanobacteria that lives in freshwater environments. Through this NSF-funded course, Steffen worked to develop new techniques to analyze her own data from UT.

“It gave a really comprehensive overview of important tools that can be used for bioinformatics analysis, but more importantly how to ask appropriate questions,” Steffen said.

“Whenever you’re interacting with other people, especially in science, you learn the value of establishing connections with different people,” Frank said. “I still maintain contact with each one of my course mates, so I know that right now I have 21 other individuals I can talk to about different subjects.”

Frank was selected for a fellowship based at the University of Lousanne that covered all of her expenses. The opportunity to interact with up-and-coming researchers like herself on a subsidized trip was invaluable.

“Whenever you’re interacting with other people, especially in science, you learn the value of establishing connections with different people,” Frank said. “I still maintain contact with each one of my course mates, so I know that right now I have 21 other individuals I can talk to about different subjects.”

**Frank learns bioremediation techniques in Switzerland**

Another second-year graduate student, Ashley Frank, knows the value in making connections with other young, motivated researchers. Frank was encouraged by her adviser, Dr. Alison Buchan, to apply for a two-week environmental biotechnology course based at the University of Lausanne in Switzerland last summer.

Frank collecting samples with a pipette at the University of Lausanne in Switzerland

The course, which consisted of 11 American and 11 European students, had all students working together on different aspects of bioremediation in contaminated soil. The students remained extremely busy, working from 8 a.m. to 10 p.m. most every day, but that was part of the beauty of the course for Frank. “We barely had time for meals, as the work was very concentrated, but it was incredible,” she said.

Frank was encouraged by her advisor, Dr. Alison Buchan, to apply for a two-week environmental biotechnology course based at the University of Lausanne in Switzerland last summer.

Steffen (right) working on analyzing her data at Jacobs University in Bremen, Germany.
A highly successful Board of Visitors meeting was held in Knoxville on April 29-30, 2012. The Board of Visitors (See Photograph) was re-established after some years of inactivity. The twelve-member Board membership is listed below.

Davis Allan, Physician, Summit Medical Group, Knoxville, TN
Karen Goss, Head of Science Dept., South College, Knoxville, TN
Roger Hubbard, CEO, Molecular Pathology Laboratory Network, Maryville, TN
Teresa Compton, Vice-President for Research, Biogen Idec, Cambridge, MA
Oladele Ogunsietan, Head of Dept of Population Health & Disease Prevention, U. Alabama, Irvine, CA
Guy Caldwell, Professor of Biology, University of Alabama, Tuscaloosa, AL
Tim Townes, Head of Dept. of Biochemistry and Molecular Genetics, U. Alabama, Birmingham, AL
Rod Bunn, Vice-President, Vashaw Scientific, Inc., Atlanta, GA
Sandra White, Microbial Insights, Inc., Rockford, TN
Frank Bowden, Physician, Bowden Eye Associates, Jacksonville, FL

The Board met faculty, graduate students, undergraduate students, and College administrators to learn about the accomplishments, needs, and goals of the Department.

We trust that in future years the Board will take an active role in its Mission of:

1. facilitating communication, cooperation, interaction and investment between the Department of Microbiology and the profession,
2. serving as an advocate for the Department to the College of Arts & Sciences and the University of Tennessee as a whole,
3. advising the Department in many areas to advance the impact and tradition of the microbiology profession through teaching, research and service,
4. reviewing program goals and recommending strategies for both current and future challenges and initiatives,
5. providing counsel to the department in areas that facilitate the prestige of our programs including, curriculum and courses, research and teaching, collaboration with industry, and student and faculty recruitment,
6. identifying prospective individual and corporate donors with the potential of investing in the Department and to help reach out to alumni in order to strengthen their ties back to the Department.

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Dr. Liz Fozo received the Undergraduate Faculty Teaching Award for excellence in undergraduate instruction.

Kathleen Hauther received the Lisa Kahn Undergraduate Research Award for her superior work as an undergraduate researcher in the Sparer lab.

Nathan Cude and Chris Gulvik received the Graduate Teaching Award for excellence in undergraduate instruction.

Liying Huang was awarded the Excellence in Graduate Research Award.

Brietta Lusby received the Microbiology Staff award for excellence in administrative work.

Nathan Cude (Buchan), Sarah Davis (Reynolds), Chris Gulvik (Buchan), Anthony Montedonico (Reynolds), Wilson Robinson (Sparer), Neha Sarode (Reynolds), Abby Smartt (Sayler), Seraj Uddin (Becker), and Tingting Xu (Sayler), all received David White Travel Awards to continue their research in the future.

Madelyn Crawford (Becker lab), and Shafer Belisle (Wilhelm Lab) received Awards in UT’s Exhibition of Undergraduate Research and Creative Achievement. The pair both won for their projects, C-terminal His6-tag Influences the Function of a Model G Protein-coupled Receptor (Crawford) and Is rea a Driver for Microcystis Blooms? (Belisle).

Jace Natke and Travis Sullivan (Undergraduates), received pre-med scholarships for 2012-2013.

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Mary Holtman-Reed, director of alumni programs and adviser to the Student Alumni Associates (SAA), received the Outstanding Advisor Award by the Affiliated Student Advancement Program (ASAP).

Alison Buchan received the Chancellors Honors Award for Professional Promise in Research & Creative Achievement (Spring 2012).

We Want to Hear from You!

Your full name: ________________________________

Address: ____________________________________________________________

Graduation year(s): ________________________________________________

Degree(s): ________________________________________________________

Place of employment: __________________________________________________

Job title and description: _____________________________________________

How did your time at UT prepare you for this position? ____________________________________________________________

You may also send your comments to microbiology@utk.edu. Please include “The MicroScope 2011-2012” in the subject line.

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