MICHIGAN STATE UNIVERSITY

DEPARTMENT OF
Biochemistry and Molecular Biology

NEWSLETTER FOR ALUMNI AND FRIENDS DECEMBER 2010

From the Department Chair...

April 1961 was the official beginning of the Department of Biochemistry at Michigan State University, so 2011 marks 50 years for our department. We will have events celebrating our accomplishments over the past five decades, and I invite all alumni, friends, and benefactors to join us on April 20-21, 2011.

Biochemistry was an early interdisciplinary science with origins in agricultural chemistry, biological chemistry, and medicinal chemistry. These core influences were important in the establishment of a separate department at MSU.

Over the years the medical connection has grown, especially because of funding opportunities at the National Institutes of Health, and the strength of plant sciences at MSU has kept plant biochemistry strong within the department.

The long-term outlook for the department is excellent. The department enjoys strong support thanks to the tireless efforts of the faculty in their teaching and research. Even in an era of shrinking budgets we have been constantly in one phase or another of a search for new faculty since my arrival in 2008. Because we have had the resources to continue hiring when some of our competing institutions have not, we have hired some truly fantastic faculty members (see page 4).

The research within the department remains among the most intensive at MSU. Many of us are holding our breath, waiting to see what happens with federal funding of research as many projects are anxiously awaiting approval of budgets.

This year we saw a significant increase in the number of undergraduate students doing senior theses. Experience in a research lab is an invaluable introduction to the world of original research, and getting more students into research in our labs, and more senior theses, was a priority for me. This may reflect my own story as I did a senior thesis in 1974 that was published. For me, this opened up a world I didn't know existed and a world I have inhabited ever since. I see similar experiences in today's students.

Tom Sharkey

When I mentioned doing a senior thesis to a student recently, she immediately said "definitely not." But then she asked, "what would that be like?" She has now done the research and will soon write her senior thesis. Though I like to think brilliant and inspired lecturing is what undergraduate students remember, the reality is that experience in a research lab creates more lasting memories and a lifelong love of learning.

One of the greatest assets of our program is that we are a Tier-1 research university with faculty doing fundamental research unique to their field. Connecting undergraduate education to this is essential, and having students experience the hands-on joy of the scientific process is an opportunity we continue to grow.

Support from our alumni has allowed us to increase undergraduate research experiences. Gifts supporting many aspects of undergraduate research, including research scholarships, provide students opportunities to do publishable research in a lab as opposed to working a part-time job with no direct impact on their education. The scholarships are a fundamental component in providing the experience.

Yet undergraduate research scholarships are awarded to students who are already at MSU and working on their degree. A missing link has been recruiting students to come here and be involved in biochemistry. This year we had several alumni particpate in the Spartan Scholarship Challenge and as a result, there are scholarships now in place to recruit students by offering 4-year scholarships. The commitment and support from alumni has been amazing as it significantly adds to the success of our students and faculty, and the long-term outcomes of our research and education.

America's research universities will likely continue to face challenging times as competition for reduced research dollars intensifies. The slow growth of family income also means it is becoming harder for parents and students to pay tuition. Great research universities, which have done much to enhance lives throughout the world, are stressed more than at any other time in the last 70 years.

The role of the state in maintaining student access and in assisting research is being supplanted in large measure by philanthropy. If you are interested in finding a way to make difference for the future of the department and university through philanthropy, there are many ways you can make a difference.

Thomas D. Sharkey, Ph.D.
Chair, Department of Biochemistry and Molecular Biology
Michigan State University

Next Gen Research Provides Clues in Gene Mysteries

Big science has always required big tools - from super colliders that reveal the forces binding atomic nuclei to super sequencers that reveal the genes in a cell's nucleus. The complexities and costs of these latest tools involved in 21st century science make it impractical to have them in individual laboratories. Instead, these tools are part of a hub of facilities which connect research in diverse areas of science – whether it is fighting disease or improving biofuels.

The complexity of the instruments is such that no single researcher can effectively master all the needed technologies, says Dave DeWitt, senior associate dean for the College of Natural Science. He says the trend is to consolidate these tools into centers where specially trained staff can provide researchers with sophisticated analyses while keeping updated on the technology.

At MSU, the Research Technology Support Facility (RTSF) is a collection of six analytical facilities which, together, provide the fundamental tools for modern life science research.

The RTSF started under the direction of biochemistry faculty, including professors Charles Sweeley and Jack Preiss. Sweeley founded the mass spectrometry facility in 1968. Preiss established the Macromolecular Structure, Sequencing and Synthesis Facility in 1986 with the goal of providing timely cutting edge analysis of a variety of biomolecules. With support from the Michigan Life Science Corridor, the facilities have developed into the RTSF - one of MSU's most powerful research cores.

Among the tools, the next generation sequencers are the most in-demand.

"The expertise and protocols needed for next-generation sequencing are complex and changing almost daily," DeWitt says. "As a central resource for researchers, we can keep current with the latest developments and provide the edge needed for MSU researchers to lead in a very competitive research environment."

Shari Tjugum-Holland, director of DNA Sequencing for the RTSF Genomics Core, prepares a slide for use in one of the DNA sequencers.

The MSU facility can produce nearly 50 GB of data each day – more than 15 times the data in a single human genome. Researchers attach DNA to glass slides and use one of the two Illumina sequencers to amplify it 10,000 times before running a sequence reaction and assembling the sequence.

"Sequencing capabilities are increasing exponentially, like Moore's law for computing," DeWitt adds. In the past couple years the increased capacity to sequence DNA has changed the way genetic research is conducted.

The sequencers are one of the first steps in the process of providing solutions for complex problems.

Dean DellaPenna, professor of biochemistry, relies on the next generation sequencing for a Grand Opportunities grant from the National Institutes of Health. His lab is examining the tissues of 14 plants that make medicinal compounds.

"Identifying and understanding the genes involved in the synthesis of these plant compounds is a first step that can lead to new drug development and increased production efficiency," DellaPenna says. Each experiment can yield as many as 500 million base pairs of DNA sequence, and the entire project is generating approximately 240 billion base pairs of information, the equivalent of roughly 80 human genomes.

Identifying specific genes and their roles is a common task for research using the next-generation sequencing. John Ohlrogge, professor of plant biology, studies the genes involving fat metabolism. His work in understanding where fat is synthesized and the genes involved is helping engineer plants that produce more fat and are more beneficial to developing biofuels.

Technology

Continued on Page 3.

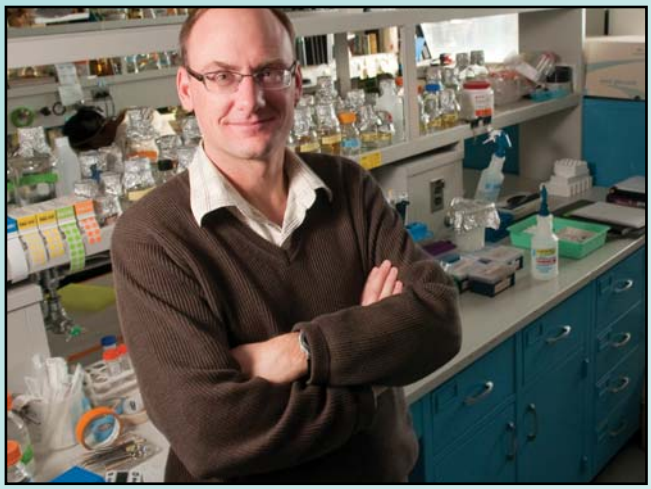
Examining How a Plant Hormone Binds Two Proteins to Form a Receptor

The discovery of a hormone acting like molecular glue could hold a key to bolstering plant immune systems and understanding how plants cope with environmental stress. Professor Gregg Howe recently revealed how the plant hormone jasmonate binds two proteins together to form a receptor – an emerging new concept in hormone biology and protein chemistry.

The research explains how a highly dynamic form of plant immunity is triggered. The study also identifies the receptor's crystal structure to provide the first molecular view of how the hormone and proteins fit together.

For years, Howe's research has focused on understanding the intricacies of jasmonate - the last major plant hormone to have its signaling pathway decoded. Together with Sheng Yang He, professor of plant biology, they published earlier findings on the mechanism of action of jasmonate.

The production of jasmonate in response to stress is the final step of a pathway that begins when a plant is attacked by insects or pathogens. Jasmonate acts as a molecular glue that enables the F-box protein COI1 to bind to transcriptional repressor proteins called JAZ. This hormone-induced formation of the COI1-JAZ co-receptor complex results in destruction of the JAZ repressors, and subsequent activation of hundreds of defense-related genes. Thus, the presence of jasmonate allows the plant to mount an effective immune response.



Gregg Howe, professor of biochemistry, studies the plant hormone jasmonate and recently revealed how the hormone binds two proteins together to form a receptor.

Now that researchers understand the structure, they can design new hormone derivatives or other small molecules that can trigger a desired response. Such compounds could help to increase agricultural productivity by aiding plants in resisting bugs and diseases. The work of Howe and He may also hold potential benefits for humans as these techniques can be used to improve the design of drugs.

The research by Howe and He was published in the October 6 issue of *Nature* and was funded by the National Institutes of Health, the Department of Energy and the Michigan Agricultural Experiment Station.

Technology

Continued.

Curtis Wilkerson, professor of biochemistry, along with other researchers in the Great Lakes Bioenergy Research Center, study the genes that synthesize cell walls. They are working toward plants designed with cell walls that can be easily converted to biofuels.

For other MSU researchers like Rich Lenski, Hannah Professor of Evolutionary Biology, the facility is providing answers to his 20-year evolution experiment. When he began the experiment, no one imagined detailed analyses would be possible. Fortunately, Lenski froze samples at various steps in the experiment, and researchers in his lab are now able to analyze these samples and provide a historical DNA timeline of evolution. A single run on the sequencer can completely sequence 7-14 E. coli isolates and allow researchers to watch evolution occur at the molecular level.

This window into the process of evolution is at the heart of a Science and Technology Center recently established by the National Science Foundation at MSU. Computer scientists then use these answers to develop algorithms to apply these methods computationally.

"We have leveraged the technology life cycle to develop a facility which is efficient and productive – researchers use the most effective tools and focus on getting their experiments done," DeWitt says. "The new technologies have changed the way we do science and allow us to conduct experiments unimaginable before. Our system allows the faculty to best utilize these tremendous resources as they tackle complex problems in biofuels, health, energy and other important areas."

New Program on Molecular and Metabolic and Diseases

The College of Natural Science has launched a new interdisciplinary program focused on the molecular, genetic, and cellular changes involved in metabolic diseases. The Molecular and Metabolic Disease Program involves faculty from biochemistry, microbiology and physiology, and is initially working with research related to obesity, diabetes and inflammatory bowel disease.

This focus on human health is a defining aspect of the work being done by the group. Metabolic diseases are a rapidly growing area of research and the program will be extending its translational research with medical professionals and their patients.

"Mouse models are fine to get you to first base," says Pam Fraker, University Distinguished Professor and member of the National Academy of Sciences. "But the ultimate goal of our metabolic disease research is to find solutions for humans."

Fraker is one of the principal researchers in the program and has ongoing research projects rooted in all three core areas. Her current research on gastric bypass surgery is with Sparrow Hospital in Lansing and serves as a model for translational research.

The program members have an array of related research projects involving cell biology and metabolism. Another biochemistry faculty member in the program is Barbara Atshaves who came to MSU this year to be part of this group. Her research involves using human tissue samples to understand storage of dietary lipids.

University Distinguished Professor Pam Fraker is one of the principal faculty members in the new Molecular and Metabolic Disease Program at MSU.

Four faculty from the Department of Physiology are also involved. Nara Parameswaran analyzes blood samples for changes in immune system responses in these metabolic diseases. Julia Busik and Susanne Mohr are investigating the link between diabetes and vision loss. Laura McCabe researches changes in bone growth in diabetic and inflammatory bowel patients.

"By formally bringing together this interdisciplinary group of faculty, we have formed a new core area of strength at MSU which will serve as the foundation for additional research and education," says R. James Kirkpatrick, Dean of the College of Natural Science. "Focusing on the biochemical and physiological basis of the development of metabolic diseases, such as type II diabetes and obesity, with an aim at preventing or lessening their most crippling outcomes, holds great promise for the impact we can have on society."

Fraker hopes that the Molecular and Metabolic Disease Program will bring new attention and energy to the research being done at MSU on human health. She sees the work from the program as a model for the two medical schools at MSU as they move to translational research.

The Molecular and Metabolic Disease Program is in the early stages of development at MSU. Additional faculty from biochemistry, physiology and microbiology will also be part of the program.

New Biochemistry Faculty

Join us in welcoming these new faces to the department faculty:

Barbara Atshaves joined the faculty in January as an assistant professor. She works in metabolic biochemistry and her lab is researching mechanisms of lipid regulation at the intracellular level. She comes to MSU from Texas A&M where she received her Ph.D. in Chemistry in 1993.

Hideki Takahashi joined the faculty in October as an assistant professor. His research focuses on plant transportation and assimilation of sulfate or ammonium and the sensing of nitrogen and sulfur. He received his Ph.D. in Pharmaceutical Sciences from Chiba University in 1998 and previously worked at the RIKEN Plant Science Center Joint Laboratory in Yokohama, Japan.

David Kramer joined the faculty in August as a John Hannah Distinguished Professor and is part of the MSU-DOE Plant Research Library. His research is on plant processes at the molecular and physiological level with a focus on energy use. He was Chair of the Molecular Plant Sciences Program at Washington State University and received his Ph.D. in Biophysics from the University of Illinois at Urbana-Champaign.

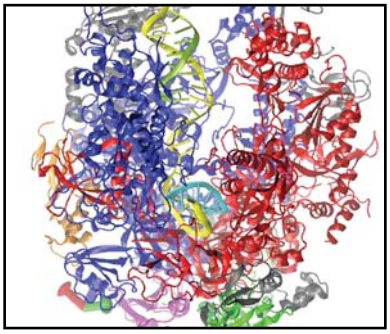
Susanne Hoffman-Benning recently joined the faculty as an assistant professor. Her work in plant growth and development focuses on phloem transport, its role in long distance signaling, and cell wall and cuticle changes during rapid expansion. She received her Ph.D. from MSU's Genetics Program and she previously worked at the MSU Mass Spectrometry Facility.

Processors Replace Microscopes in a Non-Traditional Lab

Computational Biophysics Associate Professor Michael Feig has assembled an impressive biochemistry research lab at MSU: three graduate students, five post-docs, 100 computers, 30 workstations, and not a single microscope. In his laboratory, Feig is pushing the boundaries of biochemistry.

Amidst the countless lab benches and growth chambers of the Biochemistry Building sits Feig's lab which looks more like an office than a laboratory. The floors are carpeted. The traditional black lab benches are missing and in their place are computer workstations with large, flat screen monitors. The steady electrical hum of computer processing fills the rooms.

Feig is answering long-standing questions of fundamental importance to biochemistry. He runs computer simulations of the formation of protein structures and their interactions with other molecules to better understand how proteins function in a living system. He focuses on two aspects of proteins - the interactions between proteins and nucleic acids and the prediction of protein structure - and has received two grants from the National Institutes of Health.



This image is from a multi-scale simulation of RNA polymerase II done by the Feig lab to understand details of the transcription mechanism.

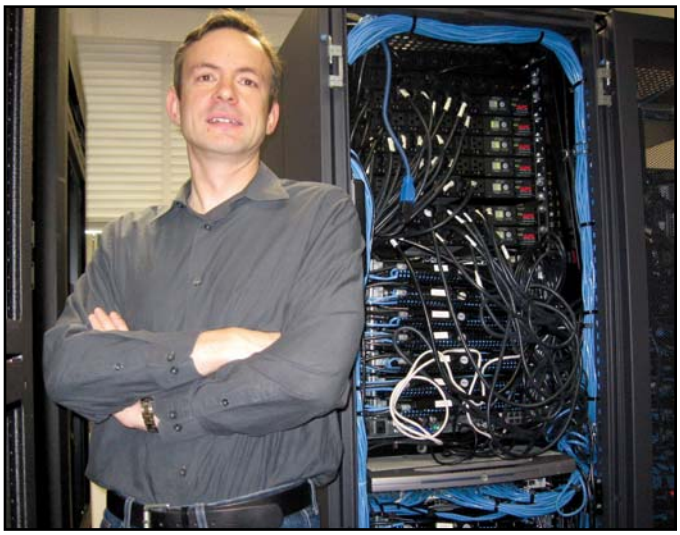
One of the grants supports Feig's study of the interaction between the protein MutS and DNA. MutS is a mismatch recognition protein which instigates the repair of incorrectly matched or missing DNA bases. The repair of incorrectly paired DNA is an essential process for human health and it is compromised in some types of cancer.

The second grant supports Feig's development of new computational methods to better predict protein structures. "We have beautiful structures from crystallography, but they don't tell the whole story because the dynamics component is missing," Feig says. "It is very difficult to get at that from an experimental view."

Computer simulations offer a less expensive and faster alternative to crystallography. Feig also emphasizes the advantages of studying protein structures in a dynamic state. Proteins do not form in a vacuum, rather amino acids form proteins while surrounded by liquid in a living system. Feig developed a hypothetical simulation of the formation of a protein structure using computers to calculate the variables present in the environment.

"Conceptually, it is very simple," Feig said. "We start with a given structure and the structure defines all the positions of the atoms in space and then we calculate the forces that act on each of the atoms."

The computer simulation calculates how forces act over a short time frame to form a new structure, Feig explains. The forces of the atoms in their new positions are calculated again and the simulation forms the next structure. This process is repeated millions of times to create snapshots of evolving protein structures.

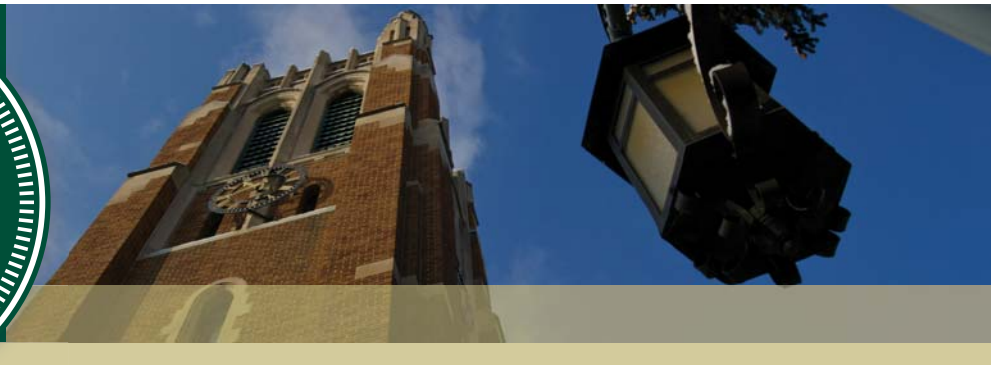


Associate Professor Michael Feig stands amongst a rack of servers in his lab where he uses the processing power to model and predict protein structures and interactions.

Feig joins the snapshots together into a movie and researchers can watch the process of protein structure formation.

"One of these force calculations may take a few seconds, yet we are doing millions of them," Feig says. "We use processing from more than one hundred computers, but even that isn't enough. We also rely on parallel and high performance computers supplemented by government supercomputers to increase the computing power."

While Feig's lab lacks the bright lights and faint smell of chemicals that most biochemistry students remember, his research group is on the cutting edge of biochemical research. As their work and technology advances, they hope to someday realize their goal of simulating the workings of an entire cell with these methods.



ALUMNI CLASS NOTES

David L. DeWitt, Biochemistry '91, has been named chair of the Department of Biology and Chemistry at Liberty University in Lynchburg, Virginia. He also recently published "Unraveling the Origins Controversy".

Travis P. Reed, Biochemistry and Molecular Biology '05, has started a new position as a small animal surgical intern at Veterinary Specialists of Rochester, NY, and has had an article accepted for publication in the *Journal of the American Veterinary Medical Association.*

Ryan McInnis, Biochemistry and Molecular Biology '05, has taken a new position with Thermo Fisher Scientific as the Manual Liquid Handling sales representative selling manual and electronic single and multichannel pipettes. His territory is Michigan, Indiana, Ohio, Kentucky, Tennessee and West Virginia.

Allen Mueller, Biochemistry and Microbiology '05, has co-authored *Novel antimicrobial peptides that exhibit activity against select agents and other drug resistant bacteria.*

Keith Schlender, M.S. Biochemistry '63, Ph.D. Biochemistry '66, notes that he has quickly "failed" retirement and is the Associate Vice President for Academic Affairs and Dean of the Graduate School at Lourdes College in Sylvania, Ohio. He had recently retired after 37 years in the Department of Physiology and Pharmacology at the Medical University of Ohio (currently the University of Toledo College of Medicine) where he served 17 years as Dean of the College of Graduate Studies.

Alumni Profile: Georgia Watson
Making a Difference in the Classroom

Two years ago, Georgia Watson was testing soil samples for heavy metals. She was a lab tech by training, yet her heart was aching with another aspiration. Teaching.

"For me to be as bubbly and outgoing as I am, I started feeling like the lab wasn't really the place for me," said Watson who received her B.S. in Biochemistry in 1999.

She began working as a substitute teacher in schools near her Indianapolis home. Watson then became a Woodrow Wilson Indiana Teaching Fellow as a way to earn her teaching certification.

Watson is now in her own classroom, certified and helping high school students build the confidence they need to master science.

The fellowship Watson received is part of an alternative certification program. It includes a $30,000 stipend and prepares individuals with experience in mathematics or science fields to teach in high-need school districts in less than two years.

The fellowship is available at MSU for the first time beginning in 2011 and the first cohort begins this summer.

"It is more important than ever that we have teachers of science and mathematics who not only are well prepared, but committed to supporting the learning of children in schools with the greatest need," said Gail Richmond, MSU program director and associate professor of teacher education.

"We are quite excited about this new phase of our partnership with the Detroit and Grand Rapids school districts and with the challenge of creating a program that will prepare MSU Fellows for productive careers as urban teachers."

MSU is one of six universities selected to participate in the Michigan initiative. It was created after the W.K. Kellogg Foundation awarded a $16.7 million grant to the Woodrow Wilson National Fellowship Foundation, which administers the programs.

Fellows will take summer courses on content and teaching methods, and complete a full-year teaching internship in Detroit or Grand Rapids.

Watson's cohort in Indiana included students ranging in age from 25 to 69. The group shared a common mission: to make math and science learning more effective. Watson says it gave her the chance to use her expertise where it's needed most.

"Do I want to produce scientists? Totally. But is that a goal of mine? Not necessarily," Watson said. "I just want my students to be able to analyze things, think critically and make informed decisions. To me, that's what science is all about."

Alumni Profile: Diane Husic

Making a Difference in our Environment

Trained as a bench scientist who studied molecules, Diane Husic now works on a much larger scale to revitalize our environment. She received her Ph.D. in biochemistry from MSU in 1986 with Ed Tolbert as her mentor, and is now a professor in the Department of Biological Sciences at Moravian College in Pennsylvania.

"Ed was always one for trying to connect experiments and data to the big picture," says Husic. "The grad students and post-docs in the lab routinely rolled our eyes at how far he seemed to stretch these connections and speculations. But I realize now that he was giving us important lessons in grantsmanship and in learning to communicate with others about the 'so what' of research - the broader significance of what we were doing at the bench."

It was while teaching at Moravian College, Husic became interested in the Palmerton Superfund site as part of an NSF grant to involve undergraduate students in plant science.

"I believe students learn best when they 'do' and the site became part of their coursework," says Husic. "Several students are actively involved in the restoration research at the site."

Husic teaches a number of courses at Moravian College that focus on the social impact of science and technology.

"Interdisciplinary teaching is extremely valuable to show students connections and relevance, and to get them used to working in diverse teams to be better able to address the complex problems facing us today," says Husic.

More recently, she has been working in the areas of climate change adaptation and policy on a state and global level. This work has a grassroots element to it and demands citizen science, or public participation.

Diane Husic at the United Nations Climate Change Conference.

In December 2009, Husic was chosen to attend the U.N. Climate Change Conference in Copenhagen as a civil society observer. She took a group of students with her and many were overwhelmed by the complexity of the process and the divergent opinions.

"I gained an amazing insight into international politics," says Husic. "I left Copenhagen with a much more optimistic view about the future of our planet than one might have garnered from the media."

This optimism and belief in citizen science is reflected in Husic recently being named a 2010 TogetherGreen Fellow. She is working with regional environmental educators to develop ways to involve the public in learning about phenology and climate change, and getting them to collect data as a means to aid scientists in their research on the topic.

It is building these connections between the small pieces of data and the big picture which builds understanding and change - something she learned years ago from Ed Tolbert.

Of her time at MSU, Husic recalls working with the people in the mass spec and their camaraderie. She also has fond memories of attending basketball and hockey games.

Leykam Retires

Joe Leykam retired in December 2010 after working 23 years at MSU. Leykam worked in the department's Macromolecular Structure, Sequencing and Synthesis Facility, assisting in the facility's rise as a national resource for protein analysis. He was recruited by the founder of the facility, Jack Preiss, only a year after the project began at MSU. Leykam has worked with graduate students, faculty, researchers, and universities from around the world. He also worked with the National Institutes of Health and is proud of the facility's use by private concerns, including many Michigan companies.

Leykam credits students as the reason for his long tenure at MSU. "Students are primarily the reason I stayed...it's a recharge every September," Leykam said. He also appreciated his time on what he called one of the most beautiful college campuses. Leykam has moved to Oregon to be closer to his family.

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SAVE THE DATE

Join us for the

BMB 50th Anniversary Celebration

April 20-21, 2011

Anniversary events include:

- Special Anniversary Seminar,
- Seminar by the R. Gaurth Hansen Award Recipient,
- 50th Anniversary Retrospective by Emeritus Professor Clarence Suelter,
- Department Awards Banquet celebrating 50 years of BMB at Michigan State, and
- Annual Nathan Edward Tolbert Lecture presented by Douglas Randall, BMB Alumnus and member of the National Science Board.

Join BMB alumni for two days on campus and help celebrate 50 years of BMB. Events will be held at the MSU Union and the Spartan Club. For details, go to www.bmb.msu.edu/dept/alumni.htm.

Faculty Recognition

Christoph Benning received the Terry Galliard Award at the 19th International Symposium on Plant Lipids in Cairns, Australia, and also presented the lecture on "Lipid Metabolism and Trafficking during Chloroplast Development and Maintenance."

Shelagh Ferguson-Miller has been chosen to recieve the 2011 Anatrace Membrane Protein Award from the Biophysical Society for her seminal contributions to the field of molecular bioenergetics and advances in membrane protein biochemistry.

Gregg Howe received the Distinguished Faculty Award from the College of Natural Science.

Laurie Kaguni has been selected by the Academy of Finland as a Finnish Distinguished Professor, to be appointed for 5 years within the FinMit Centre of Excellence/ Institute of Medical Technology at the University of Tampere.

Thomas Sharkey has been named series editor for the book series *Advances in Photosynthesis and Respiration.*

Jon Stoltzfus received the Quality in Undergraduate Teaching Award and the Teacher-Scholar Award - both from the College of Natural Science this year.

Timothy Zacharewski received the Distinguished Faculty Award from the College of Natural Science.