futures

MICHIGAN
AGRICULTURAL
EXPERIMENT
STATION

SUMMER/FALL 2009
VOL. 27 NOS. 2 & 3

New Research Frontiers

TODAY'S
"WHAT IF..."
BECOMES
TOMORROW'S
PRACTICAL
APPLICATION

looking into futures

New Research Frontiers

The Michigan Agricultural Experiment Station's rich history of excellence and innovation makes Michigan State unique among state research institutions. Throughout the years, the MAES has funded the visionary work of scientists whose ideas sometimes were met with uncertainty but ultimately led to advances that have benefited people, the environment and the economy around the world. Maintaining this excellence requires conducting an ongoing prioritization process as well as seeking out the best minds in established and emerging research fields. The MAES prides itself on being flexible and willing to fund research that some might consider outside its traditional purview.

In this issue of *Futures*, you can read about the work of several relatively new MAES scientists who are serving as catalysts for multidisciplinary research in cutting-edge areas such as genomics, bacterial fuel cells, domestic violence, posttraumatic stress disorder, childhood obesity and advertising, and fertility, research that is leading to practical applications and results for Michigan citizens.

"We're constantly looking at the research and the researchers we fund and considering how it all fits into the overall mission of the MAES and the university," said John Baker, MAES associate director. "We want to be ahead of the curve, providing technology and information to policymakers, industry and the public before the need is recognized."

High-quality research that makes a positive difference, both locally and globally, is a critical component of both the university's and the Michigan Agricultural Experiment Station's missions. Another is to advance outreach and economic development activities that lead to a better quality of life for people and communities around the world.

"MAES faculty members have the potential to interact with a large cadre of non-MAES scientists on campus, which helps expand the mission of the MAES as well as interdisciplinary research at MSU," said J. Ian Gray, MSU vice president for research and graduate studies and MAES director from 1996 to 2004. "The MAES captures research strengths across the institution and harnesses them to serve the mission of the MAES and the university as a whole."

We hope you enjoy this issue of *Futures* on cutting-edge projects being conducted in plant and soil science, family and child ecology, and animal science, and that it helps you understand a little more about the Michigan Agricultural Experiment Station and the research it funds. If you have comments about this issue or would like to subscribe (it's free!), send a note to *Futures* Editor, 109 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039, or send an e-mail to depolo@msu.edu. You also can call 517-355-0123.

For the latest information about MAES research and events, I invite you to subscribe to the free MAES e-mail newsletter. Sign up by visiting the MAES Web site at www.maes.msu.edu/news.htm. You also can view this and past issues of *Futures* on the Web site by clicking on the "research publications" link.

— Jamie DePolo

futures

MICHIGAN AGRICULTURAL EXPERIMENT STATION | SUMMER/FALL 2009 VOL. 27 NOS. 2 & 3

All photography by Kurt Stepnitz, Greg Kobuth and Erin Groom, University Relations photographers, except where noted.

Cover photoillustration by Christine Altese. Photograph by Shutterstock

MICHIGAN STATE UNIVERSITY
www.msu.edu
maes research
www.maes.msu.edu

Jamie DePolo, *Editor*
Christine Altese, *Art Director*
Val Osowski, *Writer*
Steve Pueppke, *Director*
John Baker, *Associate Director*
Doug Buhler, *Associate Director*

Futures is published twice per year by the Michigan Agricultural Experiment Station. To receive *Futures* free of charge write to *Futures* Editor, 109 Agriculture Hall, MSU, East Lansing, MI 48824, or call (517) 355-0123.

Standing on the Shoulders of Giants

The Michigan Agricultural Experiment Station's rich history of excellence and innovation makes MSU unique among state research institutions

The MAES, created on Feb. 26, 1888, by the federal Hatch Act, has a 120-plus-year history of pushing the boundaries of research to explore new frontiers and develop technologies that have become commonplace in society. Throughout the years, the MAES has funded the visionary work of scientists whose ideas sometimes were met initially with uncertainty but ultimately led to advances that have benefited people around the world.

For example, when MAES microbiologist and molecular geneticist Mike Thomashow came to MSU in 1986, there was a lot of skepticism in the scientific community about whether his chosen line of investigation, the study of cold-regulated gene expression, could offer enough information and knowledge to provide significant new insight into the genetic basis of freezing tolerance.

Today, Thomashow is recognized around the globe for his work on the molecular mechanisms of cold acclimation and drought tolerance in plants.

Ten MSU faculty members have been elected members of the National Academy of Sciences in the history of the institution. Of these 10, four — Pam Fraker, Richard Lenski, Jim Tiedje and Mike Thomashow — are current MAES faculty members, and three — Jan Zeevart, Edward Tolbert and Martin Bukovac — are former MAES faculty members. Election to the academy is considered one of the highest honors that can be accorded a U.S. scientist or engineer.

In 2007–08, MSU was granted 37 patents; 25 of those patents were led by MAES faculty members. In 2006–07, MAES scientists were responsible for 14 of 35 patents awarded to the university.

Approximately 75 percent of the MSU faculty members associated with the Great Lakes Bioenergy Center (GLBRC) are MAES faculty members. MSU and the University of Wisconsin-Madison are partners in the GLBRC, one of three U.S. Department of Energy Bioenergy Research Centers created in 2007. Based in Madison, the center is funded with $125 million over 5 years. MSU is using approximately $50 million for basic science research aimed at solving some of the most complex problems in converting natural materials to energy, and MSU recently received approximately $2 million in new GLBRC funding to study the environmental benefits and consequences of cellulosic biofuel crops.

As of August 2009, the MAES funded the work of almost 400 scientists (383 to be exact) in six colleges at MSU: Agriculture and Natural Resources, Communication Arts and Sciences, Engineering, Natural Science, Social Science, and Veterinary Medicine.

"The Michigan Agricultural Experiment Station is doing a great job," said MSU Provost Kim Wilcox. "In these trying budget times, the university has to rely on its strengths, and the MAES is one of our strengths. We are expecting more of it now than ever."

"The MAES is ranked as one of the top experiment

MSU provost Kim Wilcox, MAES associate director John Baker and MSU vice president for research and graduate studies Ian Gray *(left to right)* discuss how the Michigan Agricultural Experiment Station fits into the Michigan State University research portfolio.

KRIS BERGLUND

Welcome to Fermentation Station

What do a salt substitute, distilled spirits and the chemical intermediate succinic acid have in common? They are all natural products created from fermentation processes developed over the past 20 years by MAES forestry and chemical engineering and materials science researcher and MSU distinguished professor Kris Berglund.

"The basis of all this work has to do with some sort of fermentation process," Berglund said. "We start out with a basic idea that can be applied to a variety of renewable resources — for example, starch from grains and corn, cellulose [residues extracted from plant stems and stalks that aren't food products] and hemicellulose from forest products. We have a number of raw materials we can choose from and five or six fermentations we are studying."

One of the most notable products in Berglund's research portfolio is a salt substitute commercially known as AlsoSalt. The notion for this product came from Berglund's knowledge of the five tastes identified in Japanese science — bitter, salty, sour, sweet and umami (which means "savory" or "deliciousness").

"Umami is the sense of flavor enhancement," Berglund explained. "MSG is the classic umami flavor – it intensifies the taste of food. As it turns out, lysine — an amino acid that is one of the major products fermented from corn starch — is mildly salty and also possesses this umami flavor. We were already studying lysine, so we asked what the basic problem was with salt substitutes. The answer is that they have a bitter taste that needs to be masked."

Their interest piqued, Berglund and his colleagues started testing lysine and a number of other amino acids.

"It wasn't some great hypothesis — we just tasted things and figured out what tasted salty and what didn't, what masked the bitterness and what didn't," Berglund said. "Through trial and error, we came up with a particular formulation of potassium chloride and lysine that gives the salty flavor without having any salt in it. That's what AlsoSalt is."

Patented in 1999, AlsoSalt was introduced to the U.S. market 5 years ago. This spring, Heinz announced that it was using AlsoSalt in a reformulated version of its no-salt ketchup.

"When we started this work, most people were interested in artificial sweeteners — they didn't care about salt," Berglund continued. "Now there's a much stronger appreciation of the health effects of sodium in people's diets."

Berglund's research contributions reach beyond product development. Legislation passed in Michigan last year that allows small distillers to market and sell their products on site was based on 11 years of research by Berglund. The law, the most producer-friendly of its kind in the country, is expected to bolster the state's economy by encouraging entrepreneurs to start distilling businesses in Michigan.

Berglund's work has also spawned enterprises in Michigan, Sweden and France.

"Our main objective is to use fermentation processes to add value to agricultural and forest products," Berglund said. "We're taking renewable resources and turning them into high-value, high-quality products that serve to further Michigan's bioeconomy."

— VAL OSOWSKI

stations in the country," said J. Ian Gray, MSU vice president for research and graduate studies and MAES director from 1996 to 2004. "The MAES captures research strengths across the institution and harnesses them to serve the mission of the MAES and the university as a whole. It's a catalyst for multidisciplinary research in cutting-edge areas."

MAES administrators agree that maintaining excellence requires an ongoing prioritization and evaluation process, as well as seeking out the best minds in established and emerging research fields. The MAES prides itself on being flexible and willing to fund research that some might consider outside its traditional purview.

"The MAES captures research strengths across the institution and harnesses them to serve the mission of the MAES and the university as a whole."

— IAN GRAY

"We're constantly looking at the research and researchers we fund and considering how it all fits into the overall mission of the MAES and the university," said John Baker, MAES associate director. "We want to be ahead of the curve, providing technology and information to policymakers, industry and the public before the need is recognized."

A recent example is research started 10 years ago by Ray Miller, who oversees forestry research at MAES properties in the Upper Peninsula and serves as director of the U.P. Tree Improvement Center (UPTIC), one of 15 MAES field research stations. In September 2008, Miller was named MAES forest biomass development coordinator in recognition of the growing importance of using trees as raw materials for biofuels and bioenergy. But Miller's foresight in this area reaches back to 1988, when, soon after being named UPTIC director, he planted clone trials of poplars and willows, two tree species that show the most promise for the biofuel market. In 1997, he put in a poplar plantation that was harvested in the fall of 2007, providing the first and only hard data on yields of trees grown specifically for biofuel production in Michigan. The data is being used to build computer models to simulate production under various conditions. Because of this, Miller and MSU have developed several research partnerships with companies such as the Mascoma Corporation, which is working to create a commercial cellulosic biofuel production plant, and other companies developing wood-fired power plants.

"It's quite impressive how Ray has refocused much of the research at UPTIC on cellulosic biofuels," Baker said. "The work up there is now more interdisciplinary and aims to study issues that have become hugely important to Michigan in the past few years."

Another example is a 4-year, $5.4 million grant through the U.S. Department of Agriculture Cooperative Agriculture Project (CAP) to improve the quality, yield, drought tolerance and disease resistance of potatoes and tomatoes. Led by two MAES scientists — Dave Douches, MSU potato breeder and crop and sciences researcher, and Robin Buell, plant biology researcher — the project will use DNA sequencing data to improve potato and tomato varieties. The largest of the nine grants awarded, the MSU grant is the first non-grain, non-forestry project funded through the CAP program and the first that is working on two species.

"It's extremely gratifying to see this innovative and important research be acknowledged and supported by the USDA, and it is a testament to the caliber of researchers we have in the MAES and at MSU," said MAES director Steve Pueppke. "Research funding at this level is essential to improving agricultural efficiency and sustainability and addressing critical and emerging national priorities and needs."

"These are the types of projects the university needs MAES scientists to lead," Gray added. "MAES faculty members have the potential to interact with a large cadre of non-MAES scientists on campus, which helps expand the mission of the MAES as well as interdisciplinary research at MSU."

"The MAES has a unique role at MSU because it has a presence across the state through the field stations," Wilcox added. "That sets up opportunities for MSU that other universities don't have."

Advancing knowledge, transforming lives

High-quality research that makes a positive difference, both locally and globally, is a critical component of the university's mission. Another is to advance outreach and economic development activities that lead to a better quality of life for

MICHAEL THOMASHOW

Beating the Heat, Conquering the Cold

After being raised and living most of his young adult life in southern California, it was a shock to MAES microbiologist and molecular geneticist Mike Thomashow's system when he moved to Pullman, Wash., for his first job in the early 1980s. It was also a turning point is his research career.

"Winter was very cold in Pullman," Thomashow recalled. "I remember looking out my laboratory window at plants surviving in minus 20-degree weather and asking myself, 'How are these plants dealing with this incredible cold? How do they overwinter in such a harsh environment?' This got me interested in understanding the genetic mechanisms that plants have evolved to withstand freezing and other environmental stresses."

When Thomashow came to MSU in 1986, there was a lot of skepticism in the scientific community about whether his chosen line of investigation, the study of cold-regulated gene expression, could offer enough information and knowledge to provide significant new insight into the genetic basis of freezing tolerance.

Twenty-three years later, Thomashow is internationally recognized for his work on the molecular mechanisms of cold acclimation and drought tolerance in plants.

One of Thomashow's biggest breakthroughs was the discovery of the CBF cold-response pathway in *Arabidopsis*, a small flowering plant related to cabbage and mustard that is considered a model organism in the study of basic plant processes.

"This is the genetic pathway that controls freezing tolerance," Thomashow said. "It also works to increase the plant's tolerance to drought and high salt concentrations. Now that we know what the pathway is, we want to see if we can influence various plant species and improve varieties."

Plant breeders at universities and private companies are now using this pathway as a type of master control switch to regulate a suite of genes responsible for dehydration stress, which can be caused by drought, freezing and/or high salinity.

Thomashow and members of his laboratory are now looking at why certain crops such as wheat, rye and canola have freezing tolerance, while others, such as tomatoes and potatoes, don't.

"Although tomatoes and potatoes have a CBF pathway, there is a deficiency in the system that prevents these plants from developing freezing tolerance," Thomashow said. "We are currently experimenting with a wild tuber-bearing variety — *S. commersonii* — that can cold acclimate to help us determine whether the CBF cold-response pathway of potatoes and tomatoes can be altered to improve their cold tolerance.

"Ultimately, the goal is to increase drought and freezing tolerance so that there is a longer growing season and an expanded growing region for as many crops as possible," he said.

— VAL OSOWSKI

RICHARD LENSKI

Evolution in Action

Evolution takes on a whole new look and feel in the work of MAES evolutionary biologist Richard Lenski. Most evolutionary biologists study evolution by examining fossils or by comparing different species. Lenski studies evolution by doing experiments with fast-reproducing organisms where he can watch evolution in action.

"Evolution is like a game that combines luck and skill, and I thought that, perhaps, bacteria could teach me some interesting new games," said Lenski, who is also a Hannah distinguished professor at MSU.

In 1988, Lenski started an experiment with 12 populations of *E. coli* bacteria — all starting with the same ancestral strain and all living in identical environments — to see just how similarly or differently they would evolve. He wanted to keep the experiment going for at least a year and culture about 2,000 bacterial generations. Twenty-one years and almost 50,000 generations later, the experiment is still growing strong.

Lenski's laboratory received quite a bit of attention last year when one of the 12 populations of *E. coli* being studied evolved the ability to eat a chemical called citrate — a compound that, until now, *E. coli* could not grow on.

"This development was particularly exciting because it showed that, in a relatively short period of time — a couple of decades — a brand new function could evolve," he said.

Although Lenski does basic research, his work has led others to think about various applications, including microbial forensics, strain improvement and computational evolution.

"After the anthrax attacks that came soon after the 9/11 terrorist attacks, it became imperative to understand how to track the source of bacterial populations that might be used in bioterrorism," Lenski said. "Because of this long-term experiment, we now have the best data on how quickly strains change at the genomic level and how much genetic variation exists within a sample. This study has become a reference point for understanding the evolution of other bacteria."

Further, Lenski said, it's increasingly recognized that evolution can be used alone or, better, in combination with genetic engineering to produce bacterial strains that have desirable features such as the ability to produce alternative fuels or remediate pollution.

Lenski's work also crosses over into in the digital world. Over the past decade, Lenski has teamed up with MSU computer scientist Charles Ofria and MSU philosopher Rob Pennock, as well as Chris Adami, a physicist from Keck Graduate Institute in Claremont, Calif., to study computer programs that self-replicate, mutate and evolve the ability to do new functions.

"Computer scientists and engineers are looking to evolution to inform their endeavors and garner new ways of solving problems," Lenski said. "My colleagues have developed software that can be used to demonstrate and explain evolutionary mechanisms and help develop new technologies in the areas of networks, communication systems and robotics. Darwin would be amazed to see where his ideas have led."

— VAL OSOWSKI

"We want to be ahead of the curve, providing technology and information to policymakers, industry and the public before the need is recognized."

— JOHN BAKER

people and communities at home and around the world. The Carbon2Markets program, led by MAES forestry scientist David Skole, fulfills both of these goals. Carbon2Markets uses basic and applied research to simultaneously fight global warming and poverty, improving people's lives and helping to protect the planet.

By combining sustainable forest management and remote-sensing technology with emerging carbon markets, Skole and the rest of the Carbon2Markets team are helping small farmers in developing countries grow crops that slow climate changes as well as improve the farmers' standards of living. The MSU team is working with farmers, researchers and government agencies in 10 African and Asian countries, including Thailand and Laos.

The farmer groups are integrating high-value forest crops, such as jatropha, teak or shea, into the crops they're currently growing using methods that are smart and sustainable. Then the farmers use techniques and standards created by MSU remote-sensing experts to accurately measure and record the carbon stored by the trees and soil. Storing carbon in the soil and plants keeps it out of the atmosphere, which helps slow global warming. This also is one of the first efforts to help small landowners gain access to the carbon offset market.

The farmers also use and sell the forest products they grow. Jatropha tree nuts can be used to make biodiesel, which is then used to run farm equipment or produce energy for a village. Shea tree nuts yield shea butter, a staple ingredient in high-end moisturizing lotions and other cosmetics. The trees also provide food, timber, firewood and medicines.

MSU was founded on the idea that practical knowledge could be combined with traditional scientific and classical studies. Skole said that the Carbon2Markets program is the application of more than 20 years of basic research on climate change and tropical forest conversion. In other words, the MSU scientists are applying basic research and remote-sensing technology to develop creative solutions to climate change. These solutions involve, educate and improve the quality of life of people who are counted among some of the world's poorest — the average annual income in the area of Thailand involved in Carbon2Markets is about $1,200.

Closer to home, MAES chemical engineering researcher Dennis Miller's work in Michigan to demonstrate the feasibility of small, local canola biodiesel cooperatives parallels the Carbon2Markets work in developing countries. One of Miller's collaborators, visiting researcher Lars Peereboom, is working with Skole to set up oil processing equipment in Thailand. Miller and Peereboom bought and set up a machine to crush canola seeds at the Michigan Brewing Company in Webberville. They figured out how to run it optimally and meet American Society for Testing and Materials (ASTM) standards for biodiesel.

"In these tight budget times, expectations are going up across campus," Wilcox said. "As a university, we have to rely on our strengths, and the MAES is one of those strengths. The MAES has unique resources, such as the field stations and the ability to offer joint appointments. All of these help the MAES act as a bridge to interdisciplinary research and catalyze thematic research on key issues."

"The MAES is coming to terms with the globalized world of the 21st century, our role as part of the modern research university, and our complex and interrelated food, agricultural and natural resource system," Pueppke said. "We have built a powerful basic research engine and focused it on problems that need solving. We have discovered expertise across the campus and used MAES resources to apply it to issues that are important to Michigan. The MAES will be a leader as we work through these complexities."

— Jamie DePolo

JIM TIEDJE

Sleuthing the Mighty Microbe

For more than four decades, MAES crop and soil sciences researcher and university distinguished professor Jim Tiedje has been studying the hidden world of microscopic creatures such as bacteria, fungi and viruses to better understand microbial processes in nature.

"The microbial world is hugely diverse," said Tiedje, who is also director of the Center for Microbial Ecology at MSU. "Some microbes can cause disease, and some carry out very valuable processes. The challenge has always been how to detect them."

Scientists began to make significant progress in microbial analysis in the late 1990s when genetic analysis and the identification of molecular markers at the DNA level opened the door to the use of miniaturization processes and microfluidics — the science of designing, manufacturing and formulating devices and processes that deal with microscopic amounts of fluid.

These innovations greatly enhance the sensitivity, speed and sample output of genetic analysis and pathogen detection. The development of tools such as DNA chips and lab-on-a-chip-type devices take advantage of such miniaturization technologies.

Tiedje and MAES environmental engineering researcher Syed Hashsham are using a gene sequence database to develop probes (molecules that identify a certain signature sequence of DNA) and primers (molecules that copy DNA) that are then dispensed in the chambers of multifluidic devices to detect pathogens.

"These devices, which are much like a miniaturized plumbing system, allow us to follow chemical reactions at a scale that is 100 to 10,000-fold smaller than was possible with traditional analysis," Hashsham said. "This technology also lets us screen for multiple pathogens and antibiotic resistance at the same time, giving us the ability to examine the relationship between pathogens and potential treatment options in a faster, more cost-effective manner."

"The total number of microorganisms that could compromise the safety of air, water, food, animals and agricultural products runs into the hundreds, so developing parallel detection tools is very important," Tiedje added.

Over the past several years, Tiedje and Hashsham have developed a lab-on-a-chip in a portable system that tests for 30 pathogens.

"The overall goal is to use these devices to target the really bad guys and to help more broadly in ecosystem management," Tiedje said. "These types of systems can be valuable in identifying diseases and infectious agents, whether in plants, animals or humans."

In the next 5 to 10 years, applications are expected in a variety of areas, including clinical diagnostics, water and food testing, produce supply chain monitoring and antibiotic resistance tracking.

Tiedje and Hashsham ultimately want to make these devices foolproof so they can be used quickly and easily by many people.

"Our goal is to emulate over-the-counter pregnancy tests, which sell for around $10, are very easy to use and have output that is easily recognizable in any language, without the need for computers or other electronic equipment," Hashsham said. "This is a very exciting time for the field."

— VAL OSOWSKI

Pushing the Plant and Soil Science Envelope

A rush of nationally funded projects in the past several years has MAES scientists looking at plants in a whole new way

Shortly after the Michigan Agricultural Experiment Station was created, the bar for plant and soil science research was set very high. In 1871, William Beal saw the need for a campus botanical garden and immediately set about creating one. In 1877, he was the first scientist to cross-fertilize corn, a step that increased yields by 53 percent and eventually led to the development of high-yielding corn varieties. In 1927, MAES researcher George Bouyoucos invented the hydrometer, the simplest, most widely used method to determine soil composition. In 1931, MAES scientist C.H. Spurway designed the first soil testing kit in the United States.

Today, Michigan State University is recognized as having one of the finest plant and soil science research programs in the world, in large part because of the cutting-edge research of MAES faculty members, including a cadre of new scientists who are successfully competing for national research funding.

"Looking under Rocks" for New Technology

MAES plant pathology scientist Brad Day, who started his fourth academic year at MSU this fall, received more than $200,000 from the National Science Foundation through the American Recovery and Reinvestment Act in September to purchase a laser capture microdissection (LCM) instrument. LCM is the most advanced method available to analyze single cells from plants and animals and provide a cellular "snapshot" of what happens in individual cells during processes such as metabolism or stress response.

"LCM is pretty incredible," Day said. "You can focus on a single molecule within a cell or select a single chromosome within that cell and sequence it. We can determine the levels of hormones, the rates of gene expression or protein content in a single cell, and we can analyze 1,000 cells a minute."

A self-described extrovert who likes to collaborate with scientists in and out of his home department, Day asked around as he was writing the grant and found 35 other MSU scientists who said they would use the LCM instrument. He believes this large pool of interest contributed to the grant's successful funding.

"Once the machine is up and running, we're going to be pushing the envelope of answering basic plant biology questions," Day said. "There are only six institutions around the country using LCM for plant biology, and we're the only institution in Michigan using it that way. The companies that make the instruments want to partner with MSU to beta test new technologies and uses for the equipment."

In his lab, Day studies how plants protect themselves from diseases, drilling down to the subcellular level to see how proteins move as plants fight off pathogens. By figuring out why proteins go to specific regions of the cell, he's gaining a better understanding of the resistance process, as well as the cellular processes of plant death.

"Plants are remarkable in the ways that they defensively adapt to stresses such as diseases, pests, heat and drought," he said. "They can drop a leaf and protect the rest of the plant. I want to understand how plants do everything."

Before he wrote the grant for the LCM instrument, Day already was pushing the envelope by using variable angle epifluorescence microscopy (VAEM) to look at live plant subcellular structures in fine detail. VAEM combines the power of laser confocal microscopy with the ability to fine-tune the laser, allowing scientists to view single, fluorescently labeled macromolecules. In work funded by a National Science Foundation Early Career Award, Day and the researchers in his lab are using this technology to visualize how proteins and protein complexes move within living plant cells to activate disease resistance.

"Using VAEM to look at disease resistance in plants hadn't been done before," he said. "One of my research goals is to develop new technologies. I'm always looking under rocks for new things I can use in my research."

Working with Chris Staiger at Purdue University, Day hopes this application will uncover previously unknown mechanisms of disease resistance signaling in plants.

Since coming to MSU, Day has enthusiastically embraced agriculture. He is working with MAES plant pathologist Mary Hausbeck to figure out the mechanism of cucumber resistance to downy mildew, a disease that can devastate cucumbers, squash and melons. Cucumbers in Michigan had been resistant to downy mildew for many years, but in 2005 the disease was confirmed here. Michigan is the largest producer of pickling cucumbers in the United States (about 30,000 acres) and also grows about 5,000 acres of slicing cucumbers for the fresh market. Pesticides are available for controlling the disease, but the cost of effective control can make growing the crop unprofitable. Because the cost of control is so high, downy mildew threatens the future of Michigan's pickle industry. Pickle Packers International is helping to fund Day and Hausbeck's downy mildew research.

MAES plant pathologist Brad Day studies how plants protect themselves from diseases at the subcellular level. He's collaborating with MAES scientist Mary Hausbeck to figure out how cucumbers resist downy mildew and wrote the grant that secured for MSU a laser capture microdissection instrument — the most advanced method available to analyze single cells.

"We're sequencing the downy mildew pathogen," Day said. "Michigan plants used to be resistant to downy mildew, but now they're succumbing. What is it in the pathogen that is allowing it to be successful? We know that the environment plays a big role in the virulence of the disease. As we sequence the various strains of the fungus, we'll be able to build a blueprint of the pathogen's composition."

One result of the scientists' work could be the development of new cucumber varieties that have partial or nearly complete resistance to the pathogen. Another could be the design of a new pesticide or biological control to counter the disease.

"Sequencing the various pathogen strains allows us to 'fingerprint' each one," Day explained. "The downy mildew that affects squash won't affect cucumbers; if we know it's that strain, cucumber growers won't have

Robin Buell, MAES plant biologist, helped sequence the rice genome and is part of the consortium that recently released the first draft of the potato genome. She's also helping lead a $5.4 million USDA grant to use genomics to improve potato and tomato varieties.

to spray, helping both the farmers and the environment.

"Working on downy mildew is exciting for me," he added. "Most of my work is basic research, but this project is very applied. We're taking models developed in the lab and applying them to help control a disease. It's very gratifying to see something I've worked on being used to help growers."

Generating Genomic Information

MAES plant biology scientist Robin Buell, who came to MSU less than two years ago from the Institute for Genomic Research, has helped sequence the rice genome and is part of the consortium that recently released the first draft of the potato genome. Along with MAES potato breeder Dave Douches, Buell also is leading a $5.4 million U.S. Department of Agriculture (USDA) grant aimed at using emerging DNA sequence data with basic research data to improve potato and tomato varieties. And in collaboration with Kevin Childs, postdoctoral researcher in her lab, she's creating an easily accessible, Web-based database of genomic information on any crop that can be used to produce cellulosic ethanol, including all the grasses — such as corn, rice, maize and wheat — and other biofuel species such as poplar, spruce and pine.

"Genomics is a relatively young field," Buell said. "It's only about 12 years old. When we started, we thought sequencing a genome would give us a blueprint of the organism. But it turns out that we don't know what about half the genes do."

Genomics is the study of DNA (deoxyribonucleic acid), large molecules shaped like a double helix. DNA is made up of four bases: A, G, C and T. The particular arrangement of base pairs along the DNA strand is called the DNA sequence. DNA is arranged into distinct chromosomes — physically separate molecules that range in length from about 20 million to 1 billion base pairs. Each chromosome contains thousands of genes, which are specific sequences of base pairs that tell a cell how to make proteins.

The genome is an organism's complete set of DNA. Genomes vary greatly in size — the smallest is for a bacterium with about 600,000 base pairs. Plant genomes are usually bigger and more complex than animal genomes. The human genome has more than 3 billion base pairs; the wheat genome has more than 16 billion base pairs — five times as many as the human genome.

"Sequencing technology has advanced rapidly in the past few years," Buell said. "It's a lot easier and less expensive to do sequencing. Now our challenge is to understand what the genes do."

To figure out gene function, scientists sequence a number of different cultivars of the same plant. They then look for variation in the genomes and how those variations manifest in the plant. For example, when Buell was working on the rice genome, she helped sequence 20 rice lines.

Buell's lab maintains a centralized, Web-based database of rice genomic information with uniform annotations (notes or descriptions of the genes) that receives more than 2 million hits per year.

"One important component of a genome sequence is accurate, uniform annotation of genes and their function," she said. "We've modeled rice genes, incorporated experimental evidence into gene models and identified related sequences in other plants.

"Another challenge we're facing is the overwhelming amount of data," she continued. "We have to figure out how to process and handle it. The data is coming out so fast, and it's all in different formats. As new data comes out, we compare it to the rice genome data we have and add any relevant information."

This field of storing, updating and annotating this genomic information is called bioinformatics and requires a huge amount of high performance computing power. Buell's lab is planning on tripling computing capacity in the next few months.

"Because plant genomes are so big and a lot of people don't have the physical resources to handle the data, we're sometimes dealing with predictions rather than concrete data," Buell explained. "For example, we may predict 30,000 total genes for a new genome, but experimental work may have been done on only 20 of the genes. So for the other 29,980 genes, we use computers to make predictions about their structure and function."

"We have to work on many things at the same time," Childs added. "We make the best hypotheses about what's in the genomes through annotations and then share it with the community."

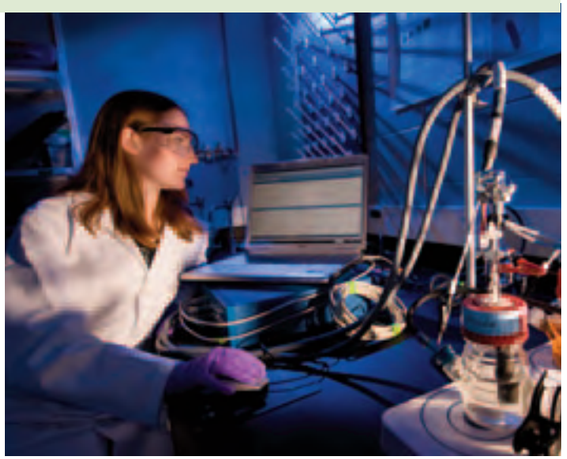
The USDA grant, called the SolCAP project, is using potato and tomato genomic information to improve the quality, yield, drought tolerance and disease resistance of potatoes and tomatoes. It's the first non-grain, non-forestry project funded under the Cooperative Agriculture Project (CAP), a USDA program that funds multiyear, multi-institutional collaborative projects. SolCAP also is the first CAP project that is studying two species.

"The potato is the most important vegetable worldwide, and the *Solanaceae* family — which includes potatoes, tomatoes, peppers and eggplants — is the most important vegetable family, so this represents a very important and significant investment by the USDA," Buell said.

Like Brad Day, Buell finds herself working with plant scientists across campus. In her 24 months at MSU, she's written four collaborative national grants that have been funded.

"There is a lot of interest in using bioinformatics and genomic information to address plant problems," she said. "Through these projects, we're developing resources that will be valuable for scientists at MSU and around the world."

MAES microbiology and molecular genetics and crop and soil sciences researcher Gemma Reguera *(above)* has created a palm-sized microbial fuel cell that converts plant biomass into electric power and cellulosic ethanol. Doctoral student Allison Speers *(below)* works in Reguera's lab on the *Geobacter* bacterium, one of the main components of the fuel cell.



Bacterial Matchmaking Gives Birth to Fuel Cell

In general, MAES microbiology and molecular genetics and crop and soil sciences researcher Gemma Reguera studies how microbes adapt to their environment and then looks for ways to harness what the microbes are doing to produce beneficial products and processes. Since coming to MSU three years ago, she's specifically been studying *Geobacter sulfurreducens*, a bacterium that lives in environments full of metal.

The *Geobacter* species has a unique metabolism — it moves electrons to survive. The bacterium naturally uses fermentation byproducts that reduce the efficiency of the process used to produce biofuels such as ethanol. *Geobacter* takes out the electrons in the byproducts and transfers them to metal oxides. The process is similar to the way people breathe in oxygen and exhale carbon dioxide, except that *Geobacter* takes in electrons and protons and then expels electrons, a basic form of energy. Reguera's lab has found that the metal oxides can be replaced with electrodes so the *Geobacter* produces electricity from waste fermentation products.

"We started with *G. sulfurreducens* because it can use fermentation byproducts and ethanol wasn't one of them," Reguera explained. "And everything that it does is environmentally friendly. This bacterium is not a human pathogen.

"Our idea was to find another bacterium to partner with the *Geobacter* to see if we could make the reaction bigger," she continued. "But we were very particular about the type of organism we wanted. It had to degrade biomass and produce only food for the *Geobacter*."

Reguera's lab found the perfect partner in another type of bacterium that breaks down agricultural waste, producing a byproduct that is about 80 percent ethanol and 20 percent

MAES horticultural scientist Ning Jiang studies a specific type of transposable element — Pack-MULEs — in plants, including rice. Pack-MULEs are mutator-like transposable elements that carry fragments of genes with them.

food for the *Geobacter*, which rapidly converted the byproduct to electricity. The process seems amazingly efficient. No other byproducts are produced, only ethanol, carbon dioxide and electricity.

Using the bacterial couple, Reguera designed a palm-sized microbial fuel cell in her lab that converts plant biomass into electrical power and produces cellulosic ethanol.

"Our challenge is to scale up the process," she said. "The scale we have now is good for genetic engineering, so we can manipulate the bugs and make the process faster and more efficient. Productivity is key for industry. If this type of fuel cell is to be commercially viable, we need to speed up the process and make it larger. If our grant proposals are funded, we could be there in three years."

Reguera is collaborating with MAES chemical engineering and materials science researcher Bruce Dale to convert chemically pretreated agricultural waste into ethanol and electricity. The bacterial partners in the microbial fuel cell can remove toxic products that result from biomass pretreatments and produce ethanol from agricultural waste for a fraction of the current cost, an attractive platform for cellulosic ethanol biorefineries. Current estimates show that the fuel cells would simultaneously generate about 25 percent of the electricity needed by the biorefinery. Both Reguera and Dale also are members of the Great Lakes Bioenergy Research Center, a partnership between Michigan State and the University of Wisconsin-Madison funded by the U.S. Department of Energy (DOE) to conduct basic research aimed at solving some of the most complex problems in converting natural materials to energy.

Reguera also has looked at how *Geobacter* produces electricity. Her lab discovered that the bacterium can grow in thick stacks on electrodes using electrically active hairlike filaments known as pili, which transfer electrons from cell to cell. The pili form a type of electronic network throughout the bacterial community, which works like a nanopower grid. The discovery hints at other promising ways to produce electricity from bacteria and at new applications for these microbial "nanowires" in biotechnology.

"When conditions for growth are unfavorable, *Geobacter* produces the pili so electrons can be transferred without damage to the bacterium. Our lab was the first to prove that these filaments were conductive. Now we want to know why the filaments are conductive and how we can get other bacteria to produce them."

Reguera credits the relatively quick success she's had to the dedication, intelligence and inquisitiveness of the people who work in her lab.

"The bugs are good to work on, but the people are better," she said. "Everything is integrated, and everyone has to know how to do the entire process from the primary research to the application. It's very rewarding to mentor students and show them how small technologies can make a huge impact."

Jumping Genes Pack a New Look at Plant Evolution

MAES horticultural scientist Ning Jiang is helping create a map of what has been unexplored territory in the world of plant evolution.

Jiang studies transposable elements — so called "jumping genes" — in plants. The genome sequence is in a certain order. If the order of the genetic material changes, a gene's function can change. Transposable elements have the ability to move around in the genome, potentially disrupting normal gene function.

"In humans, jumping genes don't move that much," she explained, "but in plants there is much more activity than in mammals. It could be one possible reason why some plant genomes are so much larger than mammal genomes. In general, the genome size is proportional to the number of transposable elements there are."

Ning Jiang *(left)* is studying the function of some Pack-MULEs in *Arabidopsis*, a member of the mustard family. Here, she evaluates an experiment with research associate Veronica Vallejo *(center)* and doctoral student Ann Armenia.

Jiang uses Indian corn as an example. An ear of Indian corn can be mainly rows and rows of purple kernels. Then a yellow kernel suddenly shows up. That's due to a transposable element inserting itself into the gene responsible for the purple color.

Jiang arrived at MSU in 2004, fresh from a postdoc at the University of Georgia. One month later, she published her second paper in the noted British science journal Nature. The paper focused on a specific type of jumping gene, mutator-like transposable elements, called MULEs. Some MULEs carry fragments of genes with them — they're called Pack-MULEs — and Jiang's paper explained how these relative unknowns were potentially star players in the process of plant evolution.

Although Pack-MULEs were initially reported about 20 years ago, they weren't considered significant because very few had been discovered.

"Because the Pack-MULEs are moving gene fragments around, they have the potential to create a new gene," she said. "Just because they're there doesn't mean they're actually creating genes, but we're starting to figure out their potential impact on plant evolution."

A native of China, Jiang is a scientist with a personal link to her field of study, transposable elements in the genomic sequences of cereals, including rice. Rice has been a strong thread running throughout her life.

"Rice is the most important food for me; nothing else can replace it," Jiang said. "In the first 15 years of my life, the rice straw was the major fuel for us to cook our food."

The rice genome was sequenced in 2002 and contains about 430 million base pairs. After the genome was sequenced, scientists, including Jiang, began working on identifying genes and their functions, as well as how genes copy themselves. The first Pack-MULE Jiang found in rice was carrying one of the genes that triggers cold responses in plants.

In 1998, MAES molecular geneticist Mike Thomashow and colleagues found that increasing a plant's expression of certain regulatory genes, called CBF genes, helps plants withstand freezing temperatures, drought and high salt concentrations.

Jiang's familiarity with Thomashow's work made her wonder why a supposedly insignificant transposable element was carrying around such an important gene. So she and a team of researchers at Washington University used a new technique. They took a genomewide approach, using a computer and special software to look at the entire rice genome sequence and ultimately found more than 3,000 Pack-MULEs. The Pack-MULEs may have created the genetic mutations that allow long-grain rice to thrive in tropical climates and round japonica rice to flourish in temperate zones.

"My research has been influenced by Dr. Thomashow's work," she said. "The CBF gene created by a transposable element uncovered the abundance of Pack-MULEs in the plant genome. It shows that transposable elements may play a bigger role in plant evolution than was previously thought. My goal now is to prove that Pack-MULEs are really doing something in plants."

Jiang is studying the function of some Pack-MULEs in *Arabidopsis*, a member of the mustard family that often is used as a model plant by scientists because of its relatively simple genome, as well as rice, which is more complex. Early results suggest that one of the Pack-MULEs seems to promote flowering when it is expressed in *Arabidopsis*.

Jiang said the information she's discovered about this particular Pack-MULE could be used to regulate the

MAES soil ecologist Stuart Grandy studies how organisms in the soil interact with their surroundings to control a number of processes, including how nutrients move through the soil and how organic matter is recycled in both managed agricultural systems and undisturbed natural systems.

growth of plants such as petunias. Most growers want plants to be in flower when they're for sale because consumers are more likely to buy a plant that's blooming. Activating the Pack-MULE would allow growers to start the plants later in the season, instead of in January, so greenhouses wouldn't have to be heated as long and growers would save money.

"That's my hypothesis," Jiang said. "We need to prove that it works in *Arabidopsis* and then in other plants."

Pushing the Envelope of Basic Soil Science

"I've always loved soil," said MAES soil ecology scientist Stuart Grandy. "Soil is the foundation for sustaining civilization — it's the bridge between human and natural worlds. When I was looking at various areas of ecology, soil ecology was the best fit for me. At MSU, I'm always trying to push the envelope of basic science, but at the same time, I want to do research that produces results that are relevant to Michigan growers."

Grandy, who came back to campus in 2007 (he received his doctorate from MSU in 2005), primarily studies managed agricultural systems, looking at how organisms in the soil interact with their surroundings to control a number of processes: the movement of nutrients through the soil, the recycling of organic matter, the release of trace amounts of gases, and the productivity of the soil and the crops planted on it.

"I also look at undisturbed natural systems because they represent what well-managed farms can be," he said. "By comparing managed and natural systems, we can see if and how the organisms and processes have changed."

In one project, Grandy is examining whether planting a more diverse array of row crops can boost soil microbial diversity and improve soil functions in Midwestern farming systems. Typically, plant diversity in Midwestern ag systems is limited. Farmers may grow corn continuously year after year or, more commonly, may rotate corn with soybeans and/or wheat. Other growers may include cover crops or alfalfa and other forages in the rotation mix. Research has shown that increasing cropping system diversity can help control insects, diseases and other pests, but few rigorous studies have looked at how the soil responds to agricultural plant biodiversity. Grandy's hypothesis is that plant diversity enhances microbial diversity in the soil and improves the ability of nutrients to cycle through the soil, as well as the soil's ability to retain organic matter. Both of these processes influence how much fertilizer a farmer adds, crop yield and quality, and production of the greenhouse gases nitrous oxide and carbon dioxide.

"My lab is one of the first to look at what's happening in the soil with increased crop diversity," he said. "We're using a number of cutting-edge technologies to understand the effects of plant biodiversity on soil. For example, in collaboration with the Lawrence Livermore National Lab, we're using a new technology called NanoSIMS to examine spatially explicit processing of soil carbon by various microbial communities. There are only a handful of those instruments in the world, so we're pretty excited."

The NanoSIMS instrument is a high-resolution secondary ion mass spectrometer that maps isotopes and elements. NanoSIMS data will allow Grandy to look at microorganisms and organic matter at the mineral-soil interface and examine how minerals hold onto carbon at the nano scale. He'll also be able to look at the spatial relationship between soil microorganisms, carbon and minerals.

Understanding how soil holds onto carbon and the factors that affect that relationship may have far-reaching effects on global warming and greenhouse gas emission research. Keeping carbon in the soil keeps it out of the atmosphere (in the form of carbon dioxide), which helps slow global warming.

Grandy also wants to understand whether the ways in which nitrogen cycles through soil are influenced by crop diversity. Nitrogen helps crops grow; if soil is low in nitrogen, farmers often add it in the form of fertilizer.

"Nitrogen is the primary limitation on crop productivity," he explained. "Farmers try to synchronize the level of available nitrogen in the soil with the amount the crop will use so there isn't any excess that can run off or be used by soil organisms to produce nitrous oxide, a potent greenhouse gas, through a process called denitrification. We're studying whether the structure and activity of these denitrifying communities is influenced by crop diversity."

Grandy also is investigating how crop diversity affects the chemistry of organic matter in the soil. As crops grow and are harvested, various bits of crop material — called litter — and roots mix in with soil. Grandy is wondering if this plant litter influences the chemical composition of the organic matter in the soil, which he plans to analyze with pyrolysis gas chromatography and mass spectrometry.

The results of his investigations will tell Midwest row crop farmers how increasing or decreasing the diversity of their crops will affect the soil.

"We know that more acres of corn are being grown," Grandy said. "Part of that comes from marginal land being put back into production, and part is due to other crops not being grown because the price of corn was so high that many farmers are deciding to put in more of it. There are a lot of opinions on the effects of growing more corn. This research will provide information on what's going on at the soil level."

The research also has implications for biofuel production in the United States. Corn-grain ethanol currently is the primary biofuel being produced, so many farmers are adding more corn to their rotations to meet the demand, but the effects of reducing diversity to plant more corn aren't well-known.

"The results will be relevant for any farmer, though," he said, "not just for those growing biofuel crops."

Grandy also is using a grant from Project GREEEN, Michigan's plant industry initiative housed at MSU, to help potato growers. Potatoes grow in sandy soils that have little organic matter and don't hold water or nutrients very well. Potatoes also are susceptible to a number of diseases, including early die caused by *Verticillium* fungi, that can substantially reduce yields.

"Many potato diseases are vectored by soil organisms or have a stage in the soil," Grandy explained. "We're investigating whether we can build up soil microbial communities and food webs to help the plants resist the diseases."

Grandy is looking at the volatile organic compounds (VOCs) produced as microbes decompose organic material in the soil. Grandy's theory is that the chemical composition of the VOCs varies depending on the microbes present in the soil and what they're digesting. Some VOCs are likely to suppress disease. Introducing the appropriate microbe-food combination into the soil may be able to help potatoes consistently resist disease for long periods of time.

"There's only a small amount of information available on soil VOCs," Grandy said. "In particular, little work has been done on the soil-microbe-organic matter combinations that produce specific VOCs. It's an opportunity for both organic and conventional growers to possibly control diseases on the basis of biology."

At the same time, Grandy wants to understand how soil microbes interact with other soil organisms, such as mites, and how those interactions affect the chemistry of soil litter and carbon decomposition and sequestration.

"People have been studying the decomposition of litter for a long time, but we still don't completely understand it," he said. "There is a lot going on there."

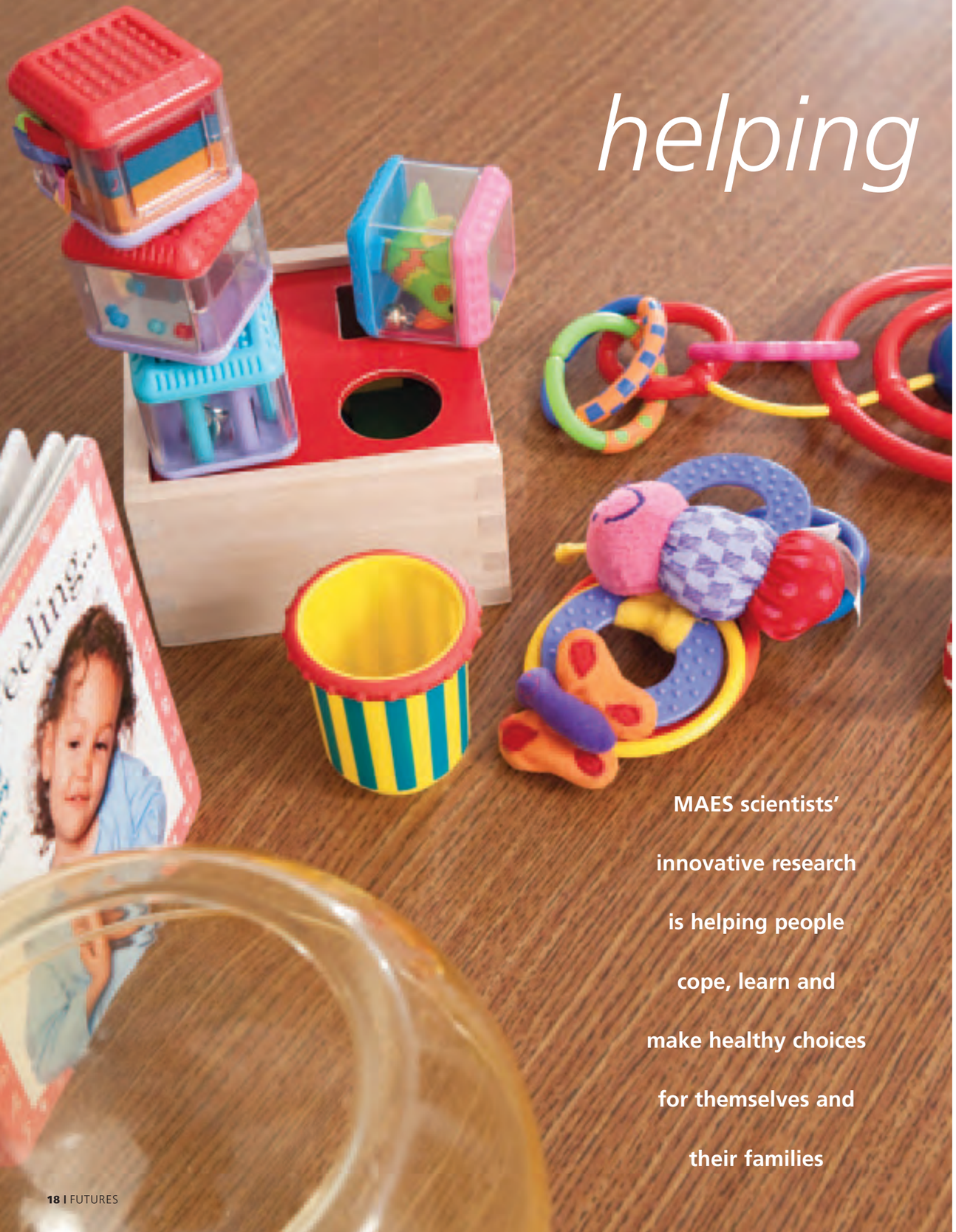
Grandy is looking at three aspects of litter decomposition: the chemical complexity of the litter, the diversity of the microbial community, and the communication between the soil microbes and the mites. He's overlaying that information with data on how various agricultural practices affect soil communities and how those changes affect litter decomposition.

For part of this research, Grandy and postdoctoral researcher Kyle Wickings are investigating how corn goes through the gut of soil mites, bit by decomposing bit. The scientists collect the mite waste very carefully with a fine brush for months until they have enough to test. Wickings explained that there are 100 to 200 mites per gram of decomposing litter, or more than 5.3 million mites per cubic foot of soil.

"We're collecting mite poop and then analyzing its chemistry," Grandy said. "It may sound trivial, but there are so many mites in the soil that their digestive processes could be having an effect.

"Again, this research will have applications for any managed ecosystem, not just agriculture," he added. "It's valuable for anyone interested in the global carbon cycle."

— Jamie DePolo



helping hands, helping humans

MAES scientists' innovative research is helping people cope, learn and make healthy choices for themselves and their families

The Michigan Agricultural Experiment Station funds researchers in six colleges, including the colleges of Social Science and Communication Arts and Sciences, but the word "agricultural" in the name conjures strong images of crops, animals and insects in many people's minds.

Still, studies on youth, aging, family dynamics, food choices and parenting have always been part of the MAES mission. In the past year, the MAES has revitalized its commitment to family and community research, hiring a number of new faculty members who are changing the way research in this area is being done with new approaches and tools.

MAES criminal justice researcher April Zeoli, who has a background in health policy, is studying domestic violence from a public health perspective.

"It's a relatively new way to look at violence," she explained. "But if you look at the top 10 causes of death among age groups, homicide is in the top five for women ages 15 to 34 [for women age 20 to 24, homicide is the No. 2 cause of death]. Given the numbers, it's obviously a public health issue."

Zeoli, along with MAES advertising scientist Elizabeth Quilliam and MAES family and child ecology scientists Adrian Blow, Kathy Stansbury and Holly Brophy-Herb, are part of a growing cadre of researchers who are redefining what social science research means to the MAES.

"Social science research is an integral part of our mission," said John Baker, MAES associate director. Baker's administrative duties include maintaining liaison with the colleges of Social Science and Communication Arts and Sciences. "In partnership with MSU Extension and our affiliated colleges, we have made specific investments in faculty positions that are addressing family issues that are of immediate concern to Michigan and the nation. From posttraumatic stress in soldiers returning from Iraq and Afghanistan to childhood obesity, we have a commitment to study what's important to Michigan families and communities." ▼

MAES family and child ecology scientist Adrian Blow worked with the Michigan National Guard to help develop a reintegration program for soldiers returning from Iraq and Afghanistan and their families.

> "I had real bad flashbacks. I couldn't control them.... It was just horrible for anyone to experience."
>
> *23-year-old Iraq war veteran*

Home but Struggling with "Welcome"

Since Sept. 11, 2001, more National Guard troops have been deployed to Iraq or Afghanistan than at any other time since World War II.

"About 40 to 50 percent of the forces deployed are from the National Guard," said Blow, who also is a licensed marriage and family therapist. "When National Guard troops come back, most of them don't come back to a military base. They immediately come back to civilian life. They're not hanging out with fellow soldiers that have been deployed and returned. Likewise, their families don't have the support network that comes from living on a base."

According to a 2008 study by the RAND Corporation, nearly 20 percent of military service members who have returned from Iraq and Afghanistan — 300,000 in all at the time of the study — report symptoms of posttraumatic stress disorder (PTSD) or major depression, yet only slightly more than half have sought treatment.

Blow said that some of this reluctance to get help stems from the stigma attached to seeing a counselor. Veterans often say they are hesitant to seek treatment in part out of fear that the information will be used to derail their careers. (Commanders typically have access to a service member's military medical records.) For some veterans, seeking mental health counseling is seen as a weakness that runs counter to being ready to fight a combat mission.

"When you're deployed, you live with adrenaline and PTSD all the time," he said. "It's a way of coping with danger. But in civilian life you don't need that."

Suicide also is on the rise in the military. The number of suicides reported by the Army has risen to the highest level since record keeping began 30 years ago. According to reports in the New York Times and on the Army's Web site, 192 active-duty soldiers and soldiers on inactive reserve status committed suicide in 2008, twice as many as in 2003. The 2009 numbers are likely to be higher: from January to mid-July, 129 suicides were confirmed or suspected. This is more than the number of American soldiers who died in combat during the same period. Though these figures are disturbing enough, they don't tell the full story. Suicide statistics are usually low, and there are no reliable figures for veterans who have left the service. The Department of Veterans Affairs systematically tracks suicides only among hospitalized patients, and no regular suicide reports are distributed.

To help members of the National Guard returning from Iraq and Afghanistan, Blow and Lisa Gorman, a recently graduated doctoral student who studied with Blow, in partnership with the Michigan National Guard (the Michigan National Guard assistant adjutant general, Brigadier General Jim Anderson, is an MSU alumnus) helped develop a reintegration program for National Guard soldiers and their families that uses other veterans to link the returning soldiers to counselors and other professional treatment.

"The program is unique because it's aimed at both the service members and their families," Blow explained. "It's a family reintegration program exclusively for the National Guard. About six workshops are conducted per year — it's mandatory for the soldiers, and they're encouraged to bring their families. We've worked with everyone in the Michigan National Guard who has come home in the past three years."

Additionally, in collaboration with the Michigan National Guard and the University of Michigan, he helped create the Buddy-to-Buddy program (www.buddytobuddy.org) for returning Michigan National Guard members. The program offers each soldier the opportunity to be paired with another veteran to confidentially discuss any problems and issues.

"Buddy-to-Buddy was designed to help returning soldiers deal with the many challenges they may face when readjusting to life at home," he said. "There aren't Veterans' Affairs offices everywhere. Someone living in the U.P. may have to drive a long way to get to a VA office. The Buddy-to-Buddy program can offer help closer to home."

Blow and Gorman run the workshops with two Vietnam veterans who had difficulty reintegrating into civilian life when they returned from duty. The veterans received treatment for PTSD and depression and talk frankly about what they went through and continue to experience. The workshops are among several other programs aimed at easing the reintegration process for returning soldiers.

"There's this expectation that when the soldier returns, everything will be better," Blow said. "But it doesn't always work that way."

Data that Blow has collected indicate that some returning soldiers face difficulties with depression, PTSD and alcohol use/abuse, as well as marital/relationship stress and parenting challenges. Spouses of soldiers report similar struggles.

"A 15-month deployment can have a huge effect on the family," he said. "The spouse has had to do everything in the home, and now the soldier has to be put back into the family structure. There is a shift in the balance of power. Everything has to be renegotiated. In some cases, soldiers can feel like they're on the outside looking in — no one listens to them — about 10 percent of male soldiers have had children born while they were deployed. In other cases, the spouse is exhausted from doing everything and just dumps it all on the soldier; it's like, 'I did it all that whole time, now it's your turn.' Our goal is to help both the soldier and the spouse understand what the other went through during deployment."

Michigan's bleak economic outlook doesn't help mitigate any of the scenarios. Blow said that many soldiers don't have jobs to return to when they return from deployment.

"Either they joined the National Guard because they didn't have a job or the job changed drastically while they were gone," he explained. "Work issues are huge."

The workshops help give voice to what is going well in soldiers' lives, as well as what isn't working. The soldiers and spouses are separated for parts of the workshop, allowing each group to focus on the most pressing issues.

"Alcohol and tobacco use, which are connected to a lot of depression, is a bigger problem for soldiers than it is for spouses," Blow said. "Drinking is a way to celebrate successes but also can be used as a way to cope with stress."

Blow's research has found that the ability to cope is very dependant on each individual and each deployment. Some soldiers find that each subsequent deployment is more difficult; others find that they cope better each time they return. On the basis of what he's learned from the research, he and his team have helped add more programming for spouses and children to the reintegration process.

"We want to expose the soldiers and their families to the resources that are available, as well as raise their awareness of issues that may come up," Blow explained. "Some issues have incubation periods and may not manifest right away. Above all, we want them to know that it's OK to get help." ▼

> “The hitting became beatings almost every day. Even though I was pregnant, he did not care.”
>
> *18-year-old domestic violence survivor*

Bang and Blame

According to the Michigan Resource Center on Domestic and Sexual Violence, 58 percent of Michigan women experience some type of violence perpetrated by a man, and 38 percent of women who have ever had a husband or live-in male partner have experienced some type of violence perpetrated by that partner. Though statistics on domestic violence and divorce are difficult to find, one study in Oklahoma found that 30 percent of divorces in that state involved domestic violence. It’s not completely clear how many of these divorce cases involve children, but research suggests that more than 1 million children in the United States are affected by domestic violence.

MAES criminal justice scientist Zeoli is investigating child custody in divorce cases involving people with a history of domestic violence.

“I want to know what happens if there has been domestic violence and the victim is forced, through court-ordered custody and visitation arrangements, to maintain contact with the perpetrator,” she said. “Early research suggests that the violence continues, but there is no concrete evidence at this point. Our study will go a long way to offering solid data on what’s happening.”

Zeoli’s study is limited to women victims of domestic violence because women make up the majority of domestic violence victims. The perpetrators are almost always men.

A history of domestic violence charges might seem to make a person less likely to be awarded any type of child custody, but Zeoli explained that, in Michigan, domestic violence is not a factor that immediately would eliminate someone from having or sharing custody.

“Domestic violence is just one of 12 factors that a judge considers when deciding on custody,” she said. “A lot of domestic violence is difficult to prove, even if there is a history of personal protection orders. The victim can come across as unstable or drained because of the ordeal of violence. And the perpetrator can be calm, cool and more believable. It’s very much a case of ‘he said, she said’ in many instances.”

The topic also is somewhat difficult to study because many people don’t want to admit that it exists, especially in intact families. And while domestic violence isn’t a new problem, it is newly illegal, relatively speaking. Michigan’s first anti-domestic violence laws were passed in 1978, the same year the legislature created the Michigan Domestic Violence Prevention and Treatment Board within the Michigan Family Independence Agency (now known as the Department of Human Services). Domestic violence has been studied in an organized way for only about 25 years.

Zeoli’s study is looking at how the specter of domestic violence is perceived in court. If it’s mentioned, how does the court react? How does the court determine the credibility of domestic violence allegations? Does domestic violence influence custody decisions? And do court procedures and custody decisions affect whether the violence continues after the divorce? She’s also looking at whether the age of the children has any affect on whether the violence continues and whether violence is increased if the woman has other children that are not the biological children of the perpetrator.

In many cases, the perpetrator may use children as emotional abuse weapons against the victim, threatening the kids with both physical and/or sexual harm to coerce the victim into doing things his way. Or he might say horrible things about the woman to the kids so that they come to disrespect her so that the man regains control. According to a report released by the Michigan Legislature, children in families where the mother is abused suffer higher rates of abuse than children in other families. Some children are injured while trying to protect their mothers; others identify with the violent perpetrator and begin to abuse their mother and other siblings themselves.

“My interest is in the emotional and physical safety of the women and children,” Zeoli said. “Even if the child isn’t being directly abused, research shows that children still suffer in a home with domestic violence. But I don’t only want to find out what goes wrong. I want to find out what goes right. If the man stops abusing the woman and the children are safer, what were the factors that contributed to that? Are there policy changes that we can put in place to make that outcome more likely?”

Supervised visitation sites are one example of a possible policy change that may help decrease domestic violence after divorce. At a supervised visitation clinic, each parent arrives and leaves through a different entrance, and the former partners are kept completely separated throughout the entire visit. Trained staff members supervise the visit and ensure the child’s safety.

“Maybe those types of resources need to be more plentiful,” Zeoli speculated. “Or maybe court processes need to change. Maybe courts and mediators need to focus more on domestic violence as a contributor to divorce.

“Right now, joint custody is thought to be better than single-parent custody,” she continued. “But maybe in cases with domestic violence, it’s not. There’s really not a lot of research on this topic to inform decision making. We’re hoping to fill some of the data gaps with this study.”

In a related study, Zeoli is investigating whether arrest laws play a role in escalating domestic violence. She’s looking at the number of intimate partner homicides in states with discretionary domestic violence arrest laws (Michigan is one of these states) compared with states with mandatory arrest laws. In states with discretionary laws, police officers can use their discretion in deciding whether to arrest the alleged abuser. A mandatory arrest law means that the police must arrest an alleged perpetrator when a complaint is made, if there is probable cause. Some research suggests that mandatory arrest laws are more dangerous than discretionary laws, but Zeoli is skeptical of this research.

“Mandatory arrest laws vary greatly from state to state,” she said. “Some laws require that the alleged victim has an injury or that a dangerous weapon was involved in the assault to trigger mandatory arrest. Some states only mandate that officers arrest within a certain amount of time of the assault, and some states actually build discretion into the mandatory arrest laws. For example, the Nevada law states that arrest is mandatory ‘unless mitigating circumstances exist.’ The picture may not be as clear as previous research suggests. It may be that certain aspects and requirements of these laws are helpful while others are harmful. As we do more research, we hope to offer policymakers more data so new policies can be based on science.” ▼

MAES criminal justice scientist April Zeoli, who has a background in health policy, is studying domestic violence from a public health perspective, a relatively new way to look at violence.

To understand any cause-and-effect relationship between childhood obesity and food marketing to kids, MAES advertising scientist Elizabeth Quilliam is studying online games that incorporate named food products. ❯

> “I am deeply concerned about the current unhealthy trend toward poor nutrition and childhood obesity,
>
> which the Institute of Medicine has linked to the prevalence of television advertisements for fast food, junk food, sugared cereals and other foods wholly lacking in nutritional value. If this trend continues, our children could be the first in generations to enjoy shorter life expectancies than their parents.”
>
> *U.S. Rep. Edward J. Markey (Mass.)*

Pour Some Sugar on Me

In results that should surprise no one, many studies have found that advertising influences the foods that children ask for, buy and eat. It’s unlikely that food and beverage companies would spend nearly $10 billion per year marketing their products to young kids and adolescents if they weren’t getting some return on their investment. As expenditures on selling food to children in the United States have increased, so has childhood obesity. In the past 20 years, childhood obesity rates have more than tripled. The National Center for Health Statistics reports that 17 percent of children aged 2 to 19 are overweight.

A 2005 study found that candy, sweets and soft drinks were the top products in television ads aimed at kids. Another study in 2006 found that 89 percent of the foods advertised during children’s television programming were classified as unhealthy, with most being especially high in sugar.

“It’s a very complex issue, but overall, there is evidence that marketing to kids does shape their food choices and contributes to childhood obesity,” said MAES advertising researcher Elizabeth Quilliam. “But we really don’t know how much.”

To help tease apart any cause-and-effect relationship, Quilliam is studying a relatively new food marketing tactic: online games that incorporate branded food products, which have been dubbed “advergames.” In one now-deleted advergame for M&M’s candies, “Amazing Crispy,” the child became an M&M’s “spokescharacter” named Crispy. To win the game, the child (as Crispy) had to collect as many M&M’s as possible, earning a point for each M&M collected and moving to higher game levels as more candies were collected.

Instead of simply sitting and watching as they do with television ads, children actively participate in online game playing, which may lead to more positive feelings about the game and the brands contained in it. In addition, though television shows aimed at children are required to make a clear distinction between the program and advertising, some researchers wonder if younger children can separate the persuasion from the entertainment in online advergames.

“I’m interested in the games because, unlike television, where ads are limited to 30 seconds, there is no limit on how long a child can stay online,” she said. “They may be playing advergames for hours and interacting with the food products the entire time. We suspect that these online games will affect children differently, but we need to do the research to see if that’s true.”

Quilliam and MSU advertising colleagues Mira Lee and Richard Cole and former MAES advertising researcher Yoonhyeung Choi (now at Hanyang University in Korea) first analyzed advergames in 2006. The scientists evaluated a random sample of 250 games for brand integration strategies, the extent to which the advergames educated children about nutrition and healthy eating, the types of food promoted by the games and the proportion of products the games were promoting that were classified as low-nutrient foods.

The researchers found that almost all the food featured in the games were high in fat, salt and sugar — about 84 percent of the food products advertised in advergames were classified as low-nutrient foods. The study also found that very few advergames educated children about nutrition and health issues.

“From a policy perspective, there has been a lot of discussion about how food marketing to kids may be contributing to childhood obesity,” Quilliam said. “But we haven’t seen any regulatory changes. There are so many factors that go into policy changes, it’s hard to say if this research will lead to any reformulations.”

In a proactive move, 15 of the largest food and beverage companies joined the Children’s Food and Beverage Advertising Initiative (CFBAI), a voluntary group launched in 2006 whose members have pledged to devote at least half of their television, radio, print and online advertising aimed at children younger than 12 to “better-for-you foods” and/or messages that encourage good nutrition and healthy lifestyles. Four of the companies have pledged to stop marketing directly to children younger than 12. Ten of the companies have pledged that all of their advertising aimed at kids will be for foods and beverages that meet the company’s nutritional standards. The nutritional standards used to determine better-for-you foods appear to be somewhat less than stringent: under Kellogg standards, Froot Loops are considered better-for-you — even though a 1-cup serving contains 13 grams of sugar (41 percent of the product by weight). In comparison, a serving of three Chips Ahoy chocolate chip cookies has 10 grams of sugar, and a serving of 11 Gummi Bears candies has 13 grams of sugar.

Another self-regulatory program, the Children’s Advertising Review Unit (CARU), sets guidelines for product advertising directed at kids in all media, as well as online privacy practices that affect children. CARU guidelines aim to ensure that advertising directed at children is not misleading, unfair or inappropriate for the intended audience.

“We’re currently updating the advergame study because the CARU guidelines now include online content and advergames,” Quilliam said. “We want to know if this is having an effect on the types of foods being promoted in the advergames. We’re also going to compare advergames for products made by CFBAI companies to those of non-participants to see if there is a difference in the types of foods that are being promoted. Ultimately, we want to understand how the games work and see if the same techniques can be used to promote healthy eating habits. That would be a nice contribution to make.”

In a related study, Quilliam and MSU advertising colleagues Bruce Vanden Bergh and Nora Rifon, MAES packaging researcher Laura Bix, and food science and human nutrition researcher Lorraine Weatherspoon are examining the packaging of children’s food products to see how it contributes to kids’ food choices. The scientists will do a content analysis of the packages and later examine the effectiveness of various techniques — using a celebrity on the package, for example. They’ll be using eye-tracking software to see which images or words children and parents look at first and what holds their attention the longest.

“It’s similar to the advergame study — those are two marketing strategies that may fly under the radar of parents,” Quilliam said. “Once we analyze what’s being done, we’re going to compare the packaging of nutrient-dense foods to the packaging of less nutrient-dense foods to see if there are differences based on nutrient levels. And like the advergame study, if the less nutritious foods are using more successful marketing strategies, we’d like to see if we can use those strategies to promote healthy foods and healthy lifestyles.” ▼

MAES family and child ecology researcher Kathy Stansbury *(right)* is studying how the relationship between mother and child affects babies' and young children's responses to stress. One of MAES scientist Holly Brophy-Herb's *(left)* recent projects has been to develop a curriculum that parents can use to encourage healthy emotional development in infants and toddlers.

> "At 10 a.m. I was tired. Having slept fitfully the night before, I was already at the end of my emotional rope.
>
> It was during the early weeks of an unplanned pregnancy. My 4-year-old son, Luke, was bored and amused himself by taunting his 2-year-old brother, Ben. By the third round of shrieks, I snapped. I screamed at them both to stop and lunged at them in anger. Luke turned away and Ben gasped. Suddenly I noticed their faces. Terror."
>
> *24-year-old mother of three*

Teach Your Children Well

On the surface, the relationship between a mother and baby usually is filled with love, nurturing and protection. It only hints at the blend of biology, behavior and emotion swirling below the surface that all work together to teach the baby how to react to various emotional situations.

MAES scientists Kathy Stansbury and Holly Brophy-Herb are keenly interested in the social and emotional development of infants and toddlers, with each studying a different facet of this development. Stansbury focuses on how the relationship between mother and child affects babies' and young children's responses to stress; Brophy-Herb focuses on how parents teach their young children to express and manage their emotions.

"I'm interested in infants' stress responses from an evolutionary perspective," Stansbury explained. "I want to know how a mother's behavior, stress hormone levels, heart rate and other physiological factors affect how a baby responds to stress — basically I want to know how the system works. The terms 'good parenting' and 'bad parenting' aren't helpful to me. My goal is to understand what's happening at a physiological level so others can provide interventions if they're needed."

Emotion helps people move toward goals. For example, being buoyed by a random act of kindness from a stranger may make a person more likely to help someone else. Though babies have emotions, they may need to recruit help from their environment, usually a parent, to deal with their emotions or to fulfill a goal. If a young child is doing a puzzle and gets frustrated and starts to cry because he can't finish it, his mother will likely step in, calm the child and offer strategies to help him finish the puzzle. To do that, the mother needs to be able to regulate her own emotions and be present and paying attention to what's happening so she can objectively help the child. The process is natural and happens in all societies from New York City high rises to rainforest huts.

"But stress can distract a mother from the baby," Stansbury said. "If she is a single parent and is worried about having enough food and paying rent or perhaps involved in a relationship that is violent, then her ability to manage her own stress behavior may go by the wayside in favor of meeting more pressing basic needs.

"I'm not making any judgments," she added. "Food and shelter are very important and necessary for the baby's survival. If the environment the mother and baby are in isn't stable, then it's perfectly natural that a mother would be preoccupied with fixing that."

Fixing an unstable environment affects the mother's behavior, which in turn affects her stress and hormone levels, which affect her mental health. All of these factors then affect the baby's physiological development. Stansbury's research suggests that a mother's ability to regulate her emotions, as measured by heart rate, blood pressure and stress hormones, affects her ability to keep the baby on track emotionally.

"The job of the mother is to convey the level of safety or threat in the environment to the baby, and the baby's response will match that," she explained. "We're looking at the behavioral, emotional and physiological factors that affect how this works within the mother-child interaction. As far as I know, this is the first time the relationship among these factors has been investigated in such a systematic way."

Stansbury and her colleagues are preparing to publish a study demonstrating a synchronous match in stress hormone levels between mothers and their 6-month-old babies across a number of activities, including play and a stressful situation.

The scientists found a similar match in stress level hormones between mothers and children up to 4 years old in another study, but with one important difference.

"The match in stress hormone levels for 2- to 4-year-olds depended on whether the mom was good at organizing her child's behavior," Stansbury explained. "If she wasn't good at this, there was no match at all in stress hormone levels. This likely means the children are using other things, other cues, to organize their environment and react to situations."

Stansbury is now beginning to investigate the role that genetic variation may play in the relationship. She's screening saliva collected from mothers and 2-month-old babies for commonly occurring variants in the genes related to stress hormones.

"We want to know if we can use genetics to help predict stress response outcomes," she said. "In several stress-related genes, some variants seem to mean that the babies' stress response will be more affected by the environment. So we suspect that the babies with certain variations of common genes that receive very high quality maternal care will do better than babies without the variant that also receive very high quality maternal care. Similarly, babies that have the variant and receive lower quality care will do worse than babies without the variant that receive the same level of care."

Viewing the same issue through a different lens, one of Brophy-Herb's recent projects has been to develop a curriculum that parents can use to encourage healthy emotional development in infants and toddlers. The Building Early Emotion Skills (BEES) curriculum features four sections focused on building parents' emotion-related parenting skills, building sensitive parenting skills, identifying and labeling emotions, and becoming aware of how children regulate their emotions. Before the BEES curriculum, no empirically based curriculum was available to help parents teach infants and toddlers how to express emotions in a healthy way — BEES is the first of its kind.

Emotion-related parenting skills include techniques such as labeling emotions, responding with empathy to a child's emotions, letting the child know that expressing emotion is acceptable, modeling appropriate strategies for managing emotions, and providing support as infants and toddlers work to control their emotions.

"Expressing emotion in an acceptable way underlies a number of life skills that begin to develop in early childhood," Brophy-Herb said. "School readiness, handling oneself in the lunchroom, navigating peer conflicts — these all depend on healthy emotional development, which affects how well children do in school and how likely they are to stay in school."

In a recent paper, Brophy-Herb and colleagues found that lower income parents knew that they needed to demonstrate appropriate ways to manage emotions to their children. The fact that parents' discipline practices didn't necessarily match their beliefs reflects the need for tools to enhance early emotion-related parenting.

Implementing and evaluating the BEES curriculum involved 173 parents and infants/toddlers in central and upper lower Michigan who were enrolled in Early Head Start (EHS) programs. Early Head Start is a federally funded, community-based program for low-income families with infants and toddlers and pregnant women. Although the final analysis of the curriculum isn't completed, early results suggest that low-income parents' beliefs about the appropriateness of emotion expression by their children, as well as the parents' use of strategies to support early self-regulation in parent-child interactions, are related to toddlers' self-regulation skills.

Besides Brophy-Herb, BEES curriculum research team members are, from MSU: Hiram Fitzgerald, Laurie Van Egeren, Mildred Horodynski, Esther Onaga and Sara Dupuis; from the University of Wisconsin-Milwaukee: Rachel Schiffman; from Louisiana State University Health Sciences Center: Erika Bocknek; from the Jackson Community Action Agency: Mary Cunningham-DeLuca and Shelley Hawver; from Eightcap, Inc.: MaDonna Adkins; and from the Mid-Michigan Community Action Agency: Joanne Pittman.

— Jamie DePolo

New Frontiers in Animal Science:

"The whole is greater than the sum of its parts."

— ARISTOTLE

It's a new day for animal science at MSU. Advances in genetics and genome sequencing, increasing emphasis on cross-disciplinary collaboration, and a research framework that increasingly considers entire systems have given birth to research endeavors that move beyond the traditional focus on livestock production and performance efficiencies to a broader context that includes animal health and welfare, and environmental considerations.

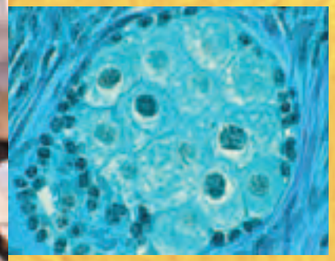
"We're using these three core areas to look at where we are, what's helpful and what the future looks like," said Karen Plaut, chairperson of the Department of Animal Science and MAES scientist. "In its broadest sense, our vision is about social responsibility, whether you're talking about healthy animals and people, nutrition or environmental stewardship. Department faculty members are looking at the interface between health, environment and welfare and are asking, 'What are the tradeoffs when a change or alteration is made in a certain system? What are the actual health implications for the animal and for humans? What are the environmental implications?'"

Plaut said systems research is an important part of where the department is going.

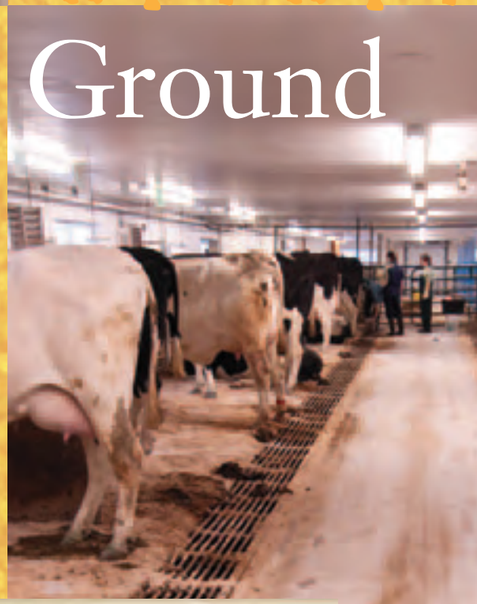
"It's really about bringing all these pieces together and helping people understand how they fit," she said. "Some make the assumption that one system is better than another based on one single parameter rather than what the whole system looks like. That's been one of the limitations of the research that's out there. You can't just take one single parameter in isolation and make a determination."

To broaden the breadth and depth of their research, PLaut said animal science faculty members are partnering with other groups.

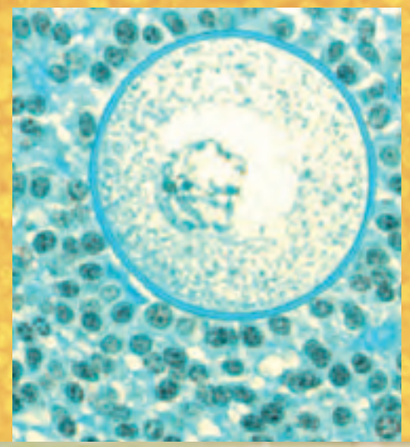
"We're building relationships in the medical health



Covering Fertile Ground



MAES animal science researchers are studying how changes to systems affect both animal and human health, the environment and animal welfare to fulfill the department's vision of social responsibility.



Department of Animal Science chairperson Karen Plaut says systems research is an important part of the department's research focus. Faculty members are partnering with scientists across campus and around the globe to broaden the depth and breadth of their research.

arena and already have strong relationships in physiology and obstetrics and gynecology because of the implications of our research to human health. We also have international partners in China, Ireland, South America and other places around the world. Collaboration is key."

One area that MAES animal scientists are playing an increasingly important role in is health, and one of the critical areas related to health is reproduction.

"Fertility research in animal agriculture is critical — without fertile animals and the ability to reproduce, you don't have your next generation of animals," Plaut said. "We focus on both animal and human health because there are basic needs in animal agriculture that cross over into areas that are also important in human health, and fertility is certainly one of those areas.

"Over the past several years, we've expanded our portfolio in the reproductive area," Plaut explained. "We've developed a core group of people whose work ranges from basic, fundamental research to applied research. This allows us both to help farmers today with the challenges and issues they face and to continue discovering and building innovations to help farmers tomorrow. And while we're helping the farmers of tomorrow, there's also the opportunity to help humans, especially in areas such as fertility."

Riding the Wave of Cattle Fertility

MAES animal scientist Jim Ireland studies bovine reproduction, searching for new ways to enhance animal production, health and profitability in Michigan and beyond.

"There are two key problems related to cattle fertility in agriculture," Ireland said. "First, there's no way to predict fertility levels. You can't look at the animal and predict if it's going to have high or low fertility. Second, the dairy industry has historically selected for high milk production, which has negatively affected fertility."

Fertility in female animals may be dictated, in large part, by number of oocytes or eggs present in the ovary when animals are born, Ireland said.

"There are never any more produced, so they are born with a finite number of eggs that continue to disappear rapidly throughout the rest of their life, even before they reach adulthood," he explained. "For example, once a dairy cow has reached two years of age, she has already lost 80 percent or more of the original stock of oocytes she had when she was born."

Until recently, Ireland said, there was no effective way to measure this variability unless the ovaries were removed from the cow and examined — a process that can take up to a year and renders the animal no longer useful for breeding.

Ireland and members of his laboratory decided to experiment with ultrasound technology to access ovary size and egg numbers in heifers. Follow-up studies were also conducted in the country of Ireland with beef heifers.

"What we found is that when a cow's ovary is relatively small, it also has a small number of eggs," Ireland said. "In addition, cows with smaller ovaries had lower progesterone secretion, lower hormonal production and fewer high quality eggs than those with larger ovaries — all factors related to reduced fertility levels. We're now using this information to sort out whether that variation has any impact on fertility, health and longevity."

Ireland and his team have also identified a protein — known as anti-Müllerian hormone or AMH — in blood that is also useful in categorizing cows on the basis of follicle numbers (each egg is surrounded by a group of support cells called the granulosa cells — together the egg and support cells are housed in a follicle) and ovary size and predicting fertility levels.

"This work has agricultural implications because if you identify — at an early age -- animals that have smaller ovaries and a smaller number of eggs, you can cull them out of a herd and increase the overall herd fertility," Ireland said. "This could have a major economic impact on the agriculture industry in Michigan, the United States and internationally."

Ireland is also interested in how this research might be applied to human fertility research.

"We are very interested in the cow as a biomedical model, not only to improve agricultural productivity and efficiency but to advance our understanding of what might be influencing fertility in humans and by identifying markers for infertility and then developing therapies to correct them," he said.

MAES animal science researchers *(left to right)* George Smith, Richard Pursley and Jim Ireland are working on reproduction in cows, with goals of enhancing animal health, profitability and human reproductive health. All are strong advocates for using farm animals as research models for biomedical research.

For example, Ireland said, recent studies completed with collaborators at the University College Dublin show that a 25 percent reduction in nutritional energy during the first trimester of pregnancy in cattle does not alter birth weight of female offspring but reduces ovary size and number of eggs by 50 percent.

"This important finding implies that nutrition during pregnancy may play an important role in the fertility of human offspring," Ireland said. "The cow is an excellent model for studies on reproduction in the human because it's one of the few species that actually has follicular growth dynamics very similar to what takes place in humans."

Timing is (Almost) Everything

MAES animal science researcher Richard Pursley said a lot of his applied work is based on fundamental reproductive biology data produced 15 to 20 years ago by scientists such as Ireland.

"Their research really helped applied scientists understand how follicles grow and regress on ovaries of cattle," he said. "It gave us the foundation we need to conduct the applied research that, in turn, benefits dairy and beef producers."

Pursley said that pregnancy success rates and estrus detection have been significant problems faced by the dairy industry over the past 15 years.

"It is very difficult to detect cows in estrus — in heat — and then, even when detected, the chances of pregnancy are about half of what they are when these cows were heifers [young animals that haven't had a calf]," he said. "As heifers, they have a high probability of a pregnancy, but once they begin to lactate, their chances drop by about half. This presented a major challenge to dairy farm profitability because, in order for a cow to produce milk, she must have a calf. And in order for her to have a calf, she must become pregnant."

To address this problem, Pursley and University of Wisconsin mentor Milo Wiltbank developed a technique to help farmers artificially inseminate dairy cows at the proper stage in their reproductive cycle without continuous heat detection. The method, called Ovsynch, uses two hormones already approved for dairy cattle to synchronize ovulation and allows dairy farmers to inseminate cattle at a prescribed time. Thus, all cows can receive artificial insemination at any given time in lactation.

"This completely solved the problem with estrus detection," Pursley said.

Pursley added that, although Ovsynch enhances numbers of pregnancies over time, the percent of cows that become pregnant following a single artificial insemination is still too low — about 40 percent.

"We still haven't solved the fertility problem, but we're

"We focus on both animal and human health because there are basic needs in animal agriculture that cross over into areas that are also important in human health, and fertility is one of those areas."

getting there," Pursley said. "We've actually produced some data in the past few years that have dramatically improved fertility of cattle by having greater control over follicle and corpus luteum [what's left of the follicle after a cow ovulates] development. Ovsynch is also an excellent research tool that is helping us evaluate factors leading to low fertility in cows."

A key problem with cows is that the follicle can grow for a very long time.

"Our data show that that the longer a follicle grows and the older and larger it gets, the less fertile the egg becomes within that follicle," he said. "So we're working on ways to control the follicle at the time of ovulation so it's at an ideal size and age for fertility. Our goal is to increase fertility and pregnancy rates in cattle to allow producers to operate their dairy operations more efficiently."

To help disseminate information about Ovsynch and other promising research findings, Pursley and two colleagues from the University of Wisconsin developed a workshop called Bovine Reproduction, Education and Discussion. Sixteen workshops have been completed in the past four years, and more than 500 veterinarians in the United States, Canada, Italy and Brazil have been educated on how to improve Ovsynch-type programs.

"The impact that these workshops are having is very encouraging," he said. "For example, as a result of the workshops we've done in Canada, we've impacted 70 percent of the cattle in that country. In the United States, it's impacted about 40 percent of the cattle these veterinarians oversee. Those are pretty impressive numbers."

Enhancing Egg Quality for the Health of It

MAES animal science researcher George Smith's overarching goal is to make fundamental discoveries that are applicable to both animal and human reproductive health.

"The focus of my lab for the past several years has been on investigating what makes a good egg a good egg, what makes a bad egg a bad egg, how you tell the difference, and what tools can be used to enhance the quality of the bad egg," Smith said.

Smith and his colleagues are using the cow as a dual-purpose biomedical model because, in addition to creating new solutions to address infertility in beef and dairy cows — one of the industry's biggest challenges — the work has significant implications for human infertility.

In a human clinical setting, the tools available to predict egg quality are very limited, Smith said. So he wanted to find ways using the cow model to predict the best quality eggs before they are fertilized to increase the rates of pregnancy success.

"One of the things that make it difficult to solve this problem is that we don't really know what causes infertility in cows," Smith explained. "It may be that egg quality is a major determining factor, but, until recently, there weren't any viable tools to study egg quality short of collecting eggs from a thousand cows, individually fertilizing them and then waiting nine months to see what happens. Obviously, that's not practical."

Thanks to the sophisticated tools now available through genomics and genome sequencing, Smith and his lab have been able to compare eggs and the surrounding cells using models that have poor quality eggs and models that have good quality eggs to see what's different.

"We've now identified some gene differences that may have implications for diagnostics, but it doesn't stop there," Smith said. "We're also interested in the functional role these genes play, so we've identified markers in the surrounding cells that are predictive of a bad quality egg. Based on that knowledge, we've developed treatments that can be added while these eggs are maturing so that more embryos develop and can be transferred to the cow."

Smith's team also identified a protein molecule — follistatin — in the egg itself that influences its ability to proceed through embryonic development after fertilization. Their studies demonstrated that when follistatin was added back during the initial stages of embryo culture, the embryos divided faster and generated more blastocysts (the developmental form of the egg that is necessary to achieve an actual pregnancy).

"In terms of practical application on the bovine side, this new discovery will allow us to enhance reproductive efficiency, certainly for in vitro production of embryos," Smith said. "This is an exciting breakthrough."

Smith wanted to take this discovery a step further, so he teamed up with Cathi VandeVoort at the National Primate Research Center in California to see whether the same result could be achieved when follistatin was added to cultured rhesus monkey embryos.

"The answer is yes," Smith said. "Rhesus embryos cleave more quickly and more blastocysts are generated, showing that this discovery is translatable from a bovine model to a non-human primate model," he said, "which makes us think there could be potential clinical applications in humans as well."

Improving the Odds of Pregnancy Success

MAES physiologist and animal biotechnology researcher Jose Cibelli said his lab is working on a big project that links nicely with Smith's efforts to control embryo development in the cow.

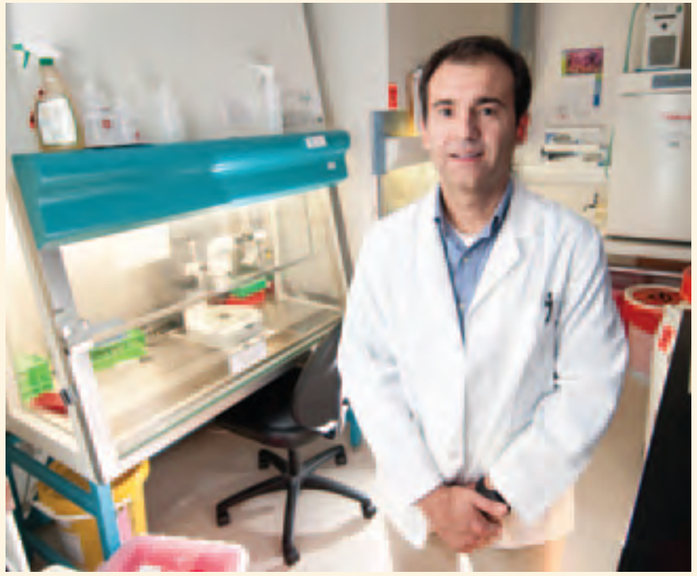
"In our lab, we're trying to determine which eggs will actually produce a healthy baby," Cibelli said. "A big problem at fertility clinics is that, once the eggs are collected from a woman, there is no way to tell which one of the eggs has the best chance of producing a baby. As a result, the pregnancy rate of women who use in vitro fertilization is 36 percent or less. And of the 36 percent that are successful, at least one third of them result in multiple births because, in order to increase the chances of a pregnancy, doctors often transfer two or three eggs."

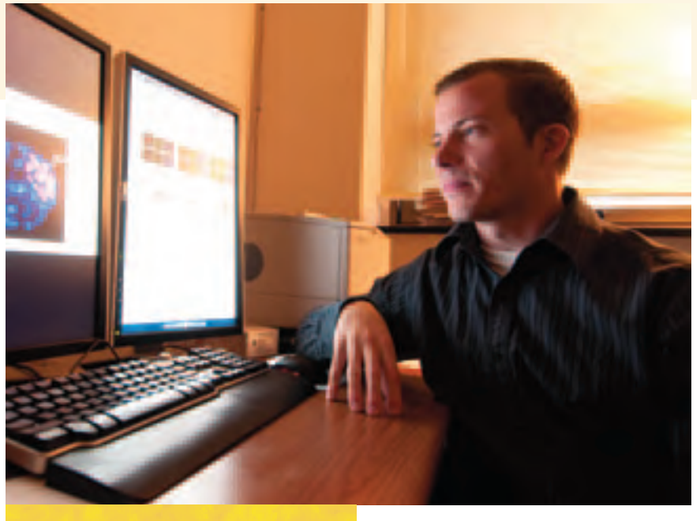
To address this problem, Cibelli and members of his laboratory started brainstorming about what might help them identify the most promising eggs.

"It seemed that the obvious thing to do was to look at the cumulus cells — the cells around the egg that nurture it during its growth and maturation," he said. "So we developed a simple hypothesis that the gene expression profile of the cumulus cells could be used as a signature to predict a healthy baby."

Collaborating with clinics in Santiago, Chile, Indiana and San Francisco, Cibelli and members of his lab collected and analyzed thousands of cumulus cell samples. After six years of research, Cibelli and his team identified a signature with about 200 genes.

"We're now in the process of applying these signature findings in the same clinics to rank collected eggs, with a goal of increasing pregnancy success rates using a single egg," Cibelli said. "This technique was something that started in bovine domestic animals and is very translatable to human medicine."





MAES animal scientists Jose Cibelli *(top)* and Jason Knott are studying embryo development and early embryo loss at the genetic level, seeking to identify genes that control these functions. Their work has important implications for both people and cows.

Stemming the Tide of Embryo Loss

Despite advances in reproductive science over the past 20 years, early embryo loss remains a significant challenge. In the United States, about 80 percent of embryos generated by assisted reproductive technologies such as in vitro fertilization and embryo transfer do not result in live offspring, according to fertility experts.

MAES animal science researcher Jason Knott is investigating early development events that occur right after egg fertilization up until the time of implantation. Using a mouse model, Knott and members of his laboratory are studying pre-implantation embryos and embryonic stem cells to try to answer questions about the causes of early embryo loss.

MAES scientist Lorraine Sordillo, who holds the Meadow Brook Chair in Farm Animal Health and Well-being, studies mammary biology in cows to prevent diseases such as mastitis. She's expanded that work to include a breast cancer component.

Knott said that genes do not always, in and of themselves, determine the origin of defects or chronic conditions. Rather, how genes and environment interact in the early embryo dictates health or disease, success or failure. Employing epigenetics — an emerging field of study that looks at the mechanisms and processes that regulate gene activities and expression — Knott and his team are examining how certain epigenetic factors dictate which genes are turned on and off in various cell types and tissues in the embryo and what might be influencing this regulation.

"Our hunch is that low quality embryos that fail to implant and develop into healthy offspring have defects in specific epigenetic mechanisms that contribute to their demise," Knott said. "By determining the identity and function of certain epigenetic factors, we may be able to better grasp why such a high number of pregnancies are lost during the first trimester."

Of particular interest to Knott is a regulatory protein known as Brahma Related Gene 1 (Brg1).

"In a certain cell type in the embryo, Brg1 fails to turn off a gene critical to early embryo vitality, which is why we think these particular embryos aren't developing properly," Knott said. "By manipulating Brg1 and depleting it from the early embryo, we can examine what effect its absence has on normal development. Brg1 has already been linked to embryo failure in other animal models — our research is testing this hypothesis further."

Knott contends that this work has important implications for humans and cattle because the stages being looked at in mouse development where the highest number of pregnancies are lost — those occurring between days 0.5 and 6.5 — correspond to the early stages of development for humans and cattle.

"An increased understanding of epigenetic regulation in early embryonic development may ultimately result in better methods for selecting high quality embryos and procedures for enhancing embryo viability," he said. "This will lead to reduced numbers of embryos transferred per cycle, reduced multiple pregnancy rates and healthier animals and people."

Keeping Abreast of Mammary Health

Another area of reproductive health receiving increased attention is mammary biology.

Plaut and MAES large animal scientist Lorraine Sordillo are expanding their research on preventing diseases such as mastitis to optimize the way in which cows take up and utilize nutrients.

"We've always been interested in the mammary vascular system and inflammation," said Sordillo, who also serves as Meadow Brook Chair in Farm Animal Health and Well-Being at MSU. "Now we're trying to build upon our expertise in that arena to ask new questions — the breast cancer piece is brand spanking new."

One of the components that Sordillo studies in the mammary gland is the supportive tissues where all the nutrients from the blood supply go that form the building blocks of milk.

"There has to be a healthy vascular system in order to maintain milk synthesis and secretion," she said. "But if that system goes awry, it is also a wonderful way to provide nutrients that support tumor growth and the spread of diseases such as cancer from one part of the body to another. So understanding how we can control these processes for health and disease is very important."

"The supportive tissues are one component of the structure of the mammary gland," Plaut said. "You also have the epithelial cells that make milk or, in the case of breast cancer, grow and proliferate as cancer cells. They all work together, so we're studying different aspects of these components to better understand the whole system and determine what controls or interventions might be most effective."

Sordillo is looking at the process of angiogenesis — the growth of blood vessels that act as a plumbing system to deliver nutrients to cancer cells and provide a drain to remove the waste.

"Understanding how to turn the 'faucet' off so the tumor cells don't get the nutrients they need and finding ways to prevent the removal of the toxic waste from the tumor so it ends up killing itself are key," she said.

Plaut and MSU colleagues from animal science and engineering are also collaborating with computer science and engineering researchers in London and Spain on an innovative project to build mathematical models that describe this switching process using software programs developed to operate cars.

"The switching process, in the case of the car, gets the car moving; in the case of the cow, it gets the nutrients flowing," Plaut explained. "Our goal is to find the on and off switches to the signaling pathways so we can manipulate them in a way that maximizes production efficiency and minimizes disease," Plaut said.

"In other words," Sordillo added, "when you want a cow to produce milk or when a mom is breast-feeding and you want to ensure she doesn't get mastitis, you want to turn the switch on to support those functions; when breast cancer cells are present, you want to turn the switch off. Understanding how to turn these switches on and off is what this research is all about."

Putting it All Together

History shows that, since the time of the Greeks and Aristotle, animal research has played a critical role in keeping both animals and people healthy.

"People ask me all the time what I'm doing in animal science when most of what I do is applied to human medicine," Cibelli said. "But if you look back to the early days in mammalian embryology, every breakthrough came from the animal world. Many of the things we know today about human health and disease were first described in animals. And many of those were actually domestic animals, such as sheep, pigs and cow."

The recent landmark sequencing of the entire domestic cattle genome reveals that the human genome is closer to the bovine genome sequence than to those of mice and rats, providing researchers with a valuable tool that could lead to important new findings about health and nutrition and a better understanding of animal and human diseases and their related treatments.

"This research framework is exciting because it's a way to link animal science and biomedicine like we've never had here at MSU," Ireland added. "It may be one of the major initiatives of its kind in the United States. The bottom line is that healthy people and animals will be more fertile and live longer. In the next 10 to 15 years, we'll learn a lot more about the mechanisms involved in reproductive biology."

"This research framework is exciting because it's a way to link animal science and biomedicine like we've never had at MSU. It may be one of the major initiatives of its kind."

The new robotic milking machines at the W.K. Kellogg Biological Station pasture-based dairy were the second such installation in the state. The new dairy anchors education and outreach programs showing how ecological, social and economic principles can be evaluated on a small scale.

Smith believes the expanded depth and breadth of the animal science faculty opens a whole new avenue in the clinical application of the department's work.

"MSU has made a tremendous investment in building one of the top programs in reproductive biology by hiring a group of people who are like-minded, have similar interests, work collaboratively and critique each other's ideas," he said. "We all have our independent programs, but the synergism that exists between faculty members is a big reason why we've been as successful as we have so far."

Although reproductive biology is an integral part of the department's research portfolio, Plaut emphasizes that reproduction research alone is not what puts the MSU animal science department in a leading-edge position.

"In the end, it's a complex system with many pieces," Plaut said, "so we're trying to do more research and bring expertise from all different areas together and then go from bench to field and field to bench and back again. It's a circle with many inputs into the circle. The new focus areas — health, environment and welfare — position us well as a department and put MSU in a leadership role in these areas."

—Val Osowski

Research *in the news*

Scientists Land $14.4 Million Grant to Improve Fruit Quality

Hungry to make fruit better for longer, Michigan State University scientists will lead a four-year, $14.4 million grant-funded research project. The grant is the largest awarded by the U.S. Department of Agriculture's Specialty Crop Research Initiative since its inception in 2007.

MAES horticultural scientist Amy Iezzoni heads the RosBREED project, aiming to combine emerging DNA sequence and research findings to improve the quality of apples, peaches, cherries and strawberries — key species in the globally important botanical family *Rosaceae*.

The project involves scientists from 11 U.S. institutions, including several land-grant universities such as MSU, Washington State University and the University of Minnesota; USDA labs; and six international partners from the Netherlands, South Africa, New Zealand, Chile, France and the United Kingdom.

Selective breeding of most rosaceous species during the past 6,000 years has made today's varieties bigger and juicier than their wild cousins. Worldwide consumption is increasing, but producers remain under pressure from international competition, costs, pests and disease.

"This is a watershed year for *Rosaceae*, with the peach, apple and strawberry genomes being sequenced," Iezzoni said. "Yet a huge gap exists because this DNA-based information is rarely applied to improve plant breeding for the development of new fruit cultivars. These crops provide vital contributions to human health and well-being, and the associated production and processing industries collectively make up the economic backbone of many U.S. rural communities."

The project is part of the USDA's National Institute of Food and Agriculture program, which funds multiyear, multi-institutional collaborative projects. RosBREED follows earlier genomic, genetic and breeding programs focused on rice, wheat, barley, conifers, potatoes and tomatoes.

"RosBREED is rooted in our vision that the common ancestral origin of this diverse plant family can be harnessed to leverage knowledge and resources across commodity boundaries," Iezzoni said. "This project exploits similarities among the genomes of three fruit-bearing species of *Rosaceae* — *Malus* (apple), *Prunus* (peach and cherry) and *Fragaria* (strawberry) — to develop practical applications. Collectively, these three lineages represent the majority of the fruits produced and consumed in the United States."

Mobile Lab Allows MAES Researcher to Study Air Quality, Health Effects

A new mobile air research laboratory will help a team of researchers led by an MAES scientist better understand the damaging health effects of air pollution — particularly, why certain airborne particles emitted from plants and vehicles induce disease and illness.

Jack Harkema, university distinguished professor and MAES pathobiology and diagnostic investigation researcher, will deploy the 53-foot, 36,000-pound lab — dubbed "AirCARE 2" — throughout southern Michigan, including metropolitan Detroit.

"The mobile laboratory allows us to analyze 'real-world' pollution in communities that may be at risk," he said. "We can study why certain ailments, such as asthma, cardiovascular disease and even obesity, may be more pronounced after exposure to particulate air pollution."

With about 450 square feet of indoor laboratory space, the $400,000 center helps researchers study fine and ultrafine particles in air pollution. These small particles have been found to increase mortality and morbidity among susceptible people with preexisting health conditions such as heart disease.

Housed in a converted semitrailer, the mobile laboratory pulls air from the surrounding atmosphere through an air-particle concentrator, allowing the scientists to selectively collect the particles and analyze for chemical components that may be responsible for damaging health effects.

Researchers can study the subtle effects of controlled particle exposure on both laboratory animals and human subjects, looking for clues on why and how pollutant particles are so harmful to the heart and lungs. Harkema works closely with environmental and biomedical researchers from the University of Michigan on the projects.

"We know particles in the air can exacerbate preexisting respiratory and cardiovascular disease in people," Harkema said. "We need to understand why. There are many different components to air pollution, and we want to determine which of these are most harmful and where they come from."

The addition of the new mobile laboratory allows Harkema and U-M collaborators Robert Brook, a cardiologist, and Gerald Keeler, an atmospheric scientist, to conduct a new study funded by the Environmental Protection Agency. As part of the project, Harkema, Brook and Keeler will deploy AirCARE 2 in rural southeastern Michigan to study the cardiovascular health effects of transported air pollution originating from distant emission sites in Michigan or adjacent states.

Miscounting Bionergy Benefits May Increase Greenhouse Gas Release

A fixable error in the way carbon is counted in current U.S. climate legislation and in the Kyoto Protocol could undermine efforts to reduce greenhouse gas emissions by using biofuels, says a premier group of national environmental and land use scientists.

"The promise of biofuels made from biomass is huge, from both climate mitigation and economic perspectives," said Phil Robertson, MAES crop and soil scientist and one of the authors of the paper "Fixing a Critical Climate Accounting Error" published in the Oct. 23 issue of the journal Science. "But the promise could come up short if we don't pay attention to the details. One of the most important details is how the benefits of carbon capture are tallied. If we miscalculate the carbon benefits, we may find out later that our policies and practices are counterproductive — that they don't have the positive impact on climate that we want them to have."

Robertson also is a member of the Great Lakes Bioenergy Research Center, a partnership between Michigan State and the University of Wisconsin-Madison 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.

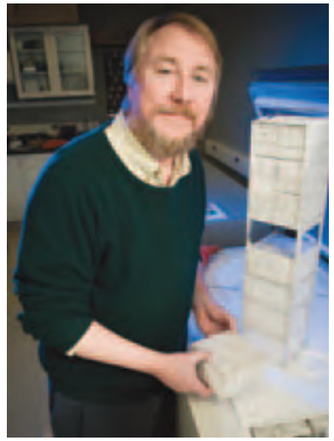
The paper authors point out that the greenhouse gas consequences of bioenergy can vary widely, depending on where the plants used to produce the energy are grown. For example, fast-growing biofuel crops grown on abandoned farmland can capture more carbon than existing plants and so reduce greenhouse gas emissions. This would happen because the biofuel crop absorbs more carbon from the atmosphere than would otherwise be stored. But if existing forests are cut down and replaced with bioenergy crops, the carbon released from the soil and mature trees, plus the loss of future carbon storage, is greater than the carbon captured by the bioenergy crops.

Current carbon accounting measures mistakenly exempt all the carbon dioxide emitted from bioenergy, regardless of the source. According to a number of studies, including one by the U.S. Department of Energy, applying current carbon accounting measures globally could lead to the loss of most of the world's natural forests.

"The error is serious but readily fixable," said Tim Searchinger, of Princeton University, lead author of the paper. "The solution is to count all the pollution that comes out of tailpipes and smokestacks, whether from coal and oil or bioenergy, and to credit bioenergy only to the extent it really does reduce greenhouse gas emissions."

"To avoid environmental regret later and protect both private and public investments, we need to get the carbon calculations correct from the start," Robertson added. "Michigan is particularly well positioned to benefit from correct carbon accounting practices. As the market grows for cellulosic biofuels, Midwest producers will benefit by growing biofuel crops on land not now being used for food production. Correctly crediting our carbon from the start will help to ensure the long-term market value for these fuels, protecting early investments by farmers and refiners."

Time in a Bottle: Scientists Watch Evolution Unfold over 40,000 Generations



A 21-year MSU experiment that distills the essence of evolution in laboratory flasks not only demonstrates natural selection at work but could lead to biotechnology and medical research advances, researchers said.

Charles Darwin's seminal *The Origin of Species* laid out the case for evolution exactly 150 years ago. Now, MAES microbial ecologist Richard Lenski and colleagues document the process in their analysis of 40,000 generations of bacteria, published in the Oct. 19 issue of the international science journal Nature.

Lenski, a John A. Hannah distinguished professor, started growing cultures of fast-reproducing, single-celled *E. coli* bacteria in 1988. If a genetic mutation gives a cell an advantage in competition for food, he reasoned, it should dominate the entire culture. Though Darwin's theory of natural selection is supported by other studies, it has never before been studied for so many cycles and in such detail.

"It's extra nice now to be able to show precisely how selection has changed the genomes of these bacteria, step by step over tens of thousands of generations," Lenski said.

Lenski's team periodically froze bacteria for later study, and technology has since developed to allow complete genetic sequencing. By the 20,000-generation midpoint, researchers discovered 45 mutations among surviving cells. Those mutations, according to Darwin's theory, should have conferred some advantage, and that's exactly what the researchers found.

The results "beautifully emphasize the succession of mutational events that allowed these organisms to climb toward higher and higher efficiency in their environment," noted Dominique Schneider, a molecular geneticist at the Université Joseph Fourier in Grenoble, France.

Lenski's long-running experiment itself is uniquely suited to answer some critical questions – such as whether rates of change in a bacterium's genome move in tandem with its fitness to survive.

"The coupling between genomic and adaptive evolution is complex and can be counterintuitive," Lenski concluded. "The genome was evolving along at a surprisingly constant rate, even as the adaptation of the bacteria slowed down a lot. But then suddenly the mutation rate jumped way up, and a new dynamic relationship was established."

A mutation involved in DNA metabolism arose around generation 26,000, causing the mutation rate everywhere else in the genome to increase dramatically. The number of mutations jumped to 653 by generation 40,000, but researchers surmise that most of the late-evolving mutations were not helpful to the bacterium.

Gene mutations involved in human DNA replication are involved in some cancers. Many of the patterns observed in the experiment also occur in certain microbial infections, "and cancer progression is a fundamentally similar evolutionary process," observed collaborator Jeffrey Barrick, microbiology and molecular genetics postdoctoral researcher. "So what we learn here can help us better understand the course of these diseases."

Thousands of generations later, the MSU experiment continues to evolve.

"Like a lot of science, our study answers some questions but raises many others," Lenski said.

Research *in the news*

Reaching Out: Program Aids Foster Care Youth during College Years

The numbers paint a dismal picture. Though some 75 percent of the nation's foster care children say they'd like to attend college, just 13 percent actually enroll — and of those, only 4 percent graduate.

Michigan State University, a national leader in foster care research and outreach, has launched an innovative program to attack the problem.

Foster Care Alumni Services is a comprehensive initiative that offers assistance to MSU students in an effort to help them remain in school and ultimately graduate. Services include community mentoring, scholarships, care packages and help lining up everything from student employment to housing to financial aid.

There's even a summer camp for foster care children still in high school on what to expect in college.

"The MSU foster camp provides young people in the foster care system a chance to have new experiences, learn new skills, meet new friends and dream about a brighter future than the often dismal past that many have experienced," said John Seita, MAES scientist and associate professor of social work.

During the 2008-09 academic year, MSU identified and contacted former foster care youth attending the university, inviting them to register for services on a newly created Web site. Each student who registered was then contacted by a representative of the requested service provider.

In all, 209 former foster youth were identified and contacted. The program will continue annually as MSU reaches out to new students who indicate that they were in foster care on their federal financial aid forms.

MSU was the first university in the state to offer foster care alumni scholarships, and the program has grown to include an array of services. Foster Care Alumni Services is offered through several university departments, primarily the School of Social Work and researchers Seita and Angelique Day, both foster care alumni who now work to reform the foster care system.

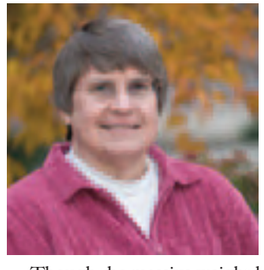
Because Day lacked family support during her college years, she said she "just kind of jumped in blindly and figured it out as I went along."

"This program is designed to ensure that young people interested in coming to MSU don't have to accept that challenge blindfolded," said Day, a research specialist in social work. "Young people coming out of foster care don't have parents or stable adults in their lives that they can go to when they are frustrated or overwhelmed in college — and at that point they may make the decision to drop out."

Other participating MSU departments are the Office of Financial Aid, the Center for Service-Learning and Civic Engagement, MSU Extension, University Housing and the Department of Residence Life.

External support comes from the Capital Area United Way, Learn and Serve America, Michigan Campus Connect and the Comcast Foundation.

MAES Scientist Studies Links between Gastric Bypass, Immune System



Though the massive weight loss associated with gastric bypass surgery has many benefits, some patients may face malnutrition, poor wound healing and infection as their immune systems adjust to the extreme decrease in food consumption, an MAES researcher reports.

Pam Fraker, MAES biochemistry and molecular biology scientist, is working with MSU surgeon Pandu Yenumula at Sparrow Hospital in Lansing to monitor the health of patients undergoing gastric bypass surgery and see what effects the surgery has on the immune system and inflammation.

"The immune system is a very large and complex system, replenishing billions of new cells each day," Fraker said. "A modest depletion in nutritional intake can have a significant impact on the immune system's ability to defend the body."

Patients undergoing gastric bypass surgery, Fraker said, often see reduced inflammation and improved metabolic status as they lose weight.

"We also are trying to find out if there are any adverse effects of morbid obesity on certain facets of immune defense, and then determine if bypass surgery has beneficial effects," she said.

Using mass spectrometry — which analyzes the elemental composition of blood tissue samples and measures trace metals to monitor patients' nutritional status — Fraker works with patients who are part of the Sparrow Weight Loss Clinic. Her team provides a progressive assessment of the patient's immune defense and measures changes in metabolic profiles and inflammatory factors before and after surgery.

Yenumula, who performs about 20 weight-related surgeries each month, said having Fraker as part of his team provides valuable insight into a patient's health as he or she recovers from surgery.

"When it comes to the morbidly obese, we have lot of research and studies that show the benefits that surgery can have on problems such as diabetes, hypertension, high cholesterol and other issues," he said. "But we need to better understand how the immune system functions and adapts as patients lose weight."

Fraker's work with gastric bypass surgery is funded by the National Institutes of Health and MSU. Though she is working with morbidly obese patients, her research also can be applied to the overweight, which make up 60 percent of all Americans.

Fraker and several other professors at MSU, known as the MSU Metabolic Disease Group, are looking at a group of disorders and avenues of research associated with obesity.

"Our immune system has such an impact on so many facets of our bodies that we need to know what sort of impact the obesity epidemic is having on our immune defense system," Fraker said. "Do viruses survive longer in overweight or obese people? Do normal vaccination levels work effectively? How does obesity affect stem cell biology and bone marrow growth? These are just some of the questions we need to address."

John Baker
Associate Director, Michigan Agricultural Experiment Station
Professor of Large Animal Clinical Sciences
109 Agriculture Hall
517-355-0123
baker@anr.msu.edu

Adrian Blow
Assistant Professor of Family and Child Ecology
3B Human Ecology Building
517-432-7092
blowa@msu.edu

Holly Brophy-Herb
Associate Professor of Family and Child Ecology
3F Human Ecology Building
517-355-3397
hbrophy@msu.edu

Robin Buell
Associate Professor of Plant Biology
S320 Plant and Soil Sciences Building
517-353-5597
buell@msu.edu

Jose Cibelli
Professor of Animal Science
B270 Anthony Hall
517-432-9206
cibelli@msu.edu

Brad Day
Assistant Professor of Plant Pathology
104 Center for Integrated Plant Systems
517-353-7991
bday@msu.edu

Stuart Grandy
Assistant Professor of Crop and Soil Sciences
516 Plant and Soil Sciences Building
517-355-0271, ext. 1244
grandya1@msu.edu

J. Ian Gray
Vice President for Research and Graduate Studies
232 Administration Building
517-355-0306
gray@vprgs.msu.edu

Jim Ireland
Professor of Animal Science
1230C Anthony Hall
517-432-1384
ireland@msu.edu

Ning Jiang
Assistant Professor of Horticulture
A330 Plant and Soil Sciences Building
517-355-5191, ext. 1381
jiangn@msu.edu

Jason Knott
Assistant Professor of Animal Science
1230 Anthony Hall
517-432-5446
knottj@msu.edu

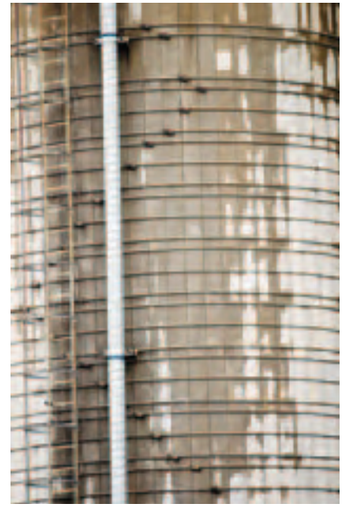
Karen Plaut
Chairperson, Department of Animal Science
1290G Anthony Hall
517-355-8383
kplaut@msu.edu

Steve Pueppke
Director, Michigan Agricultural Experiment Station
Director, MSU Office of Biobased Technologies
109 Agriculture Hall
517-355-0123
pueppke@msu.edu

J. Richard Pursley
Professor of Animal Science
1230G Anthony Hall
517-432-6178
pursleyr@msu.edu

Elizabeth Quilliam
Assistant Professor of Advertising, Public Relations and Retailing
317 Communication Arts and Sciences Building
517-432-7076
quilliam@msu.edu

Gemma Reguera
Assistant Professor of Microbiology and Molecular Genetics and Crop and Soil Sciences
6190 Biomedical and Physical Sciences Building
517-884-5401
reguera@msu.edu



George Smith
Professor of Animal Science
1230D Anthony Hall
517-432-5401
smithge7@msu.edu

Lorraine Sordillo
Meadow Brook Endowed Chair in Farm Animal Health and Well-being
G300 Veterinary Medical Center
517-432-8821
sordillo@msu.edu

Kathy Stansbury
Associate Professor of Family and Child Ecology
3E Human Ecology Building
517-432-8038
stansbu2@msu.edu

Kim Wilcox
Provost
429 Administration Building
517-355-1524
kwilcox@msu.edu

April Zeoli
Assistant Professor of Criminal Justice
436 Baker Hall
517-353-9554
zeoli@msu.edu

MICHIGAN STATE UNIVERSITY

109 Agriculture Hall
Michigan State University
East Lansing, MI 48824

NONPROFIT
ORGANIZATION
U.S. POSTAGE
PAID
GRAND RAPIDS, MI
PERMIT NO. 1

ADDRESS SERVICE REQUESTED

maes research

11-09 4 M