MSU today

RESEARCH AND CREATIVE ACTIVITIES

NEWS FOR MICHIGAN STATE UNIVERSITY ALUMNI AND FRIENDS

WINTER 2007

TEAM RESEARCH

Partnerships—local, regional, national, and global—thrive at MSU.

Conducting research and other scholarly activities responsibly and with integrity requires following established rules and regulations. But it also requires thinking broadly and deeply about the ethical challenges of research. Advances in genetics, in particular, often raise thorny ethical questions: think of cloning, stem cells, and gene therapy.

In this issue of *MSUToday* (see page 7), we tell you briefly about a new committee to help our scholars think about the ethics of conducting research. This group represents a small part of our total effort to comply with—and exceed—research regulations. Our goal at MSU is for all researchers—faculty, staff, and students—to understand the importance of conducting all their scholarly activities with integrity.

J. Ian Gray
Vice President for Research and Graduate Studies

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MSU today
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NEWS FOR MICHIGAN STATE UNIVERSITY ALUMNI AND FRIENDS

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Scientists harvest answers from genome of grain fungus

The genome sequence of a serious fungal plant pathogen is showing scientists a way to combat the pathogen that infects wheat and barley crops, rendering them unusable.

Fusarium graminearum causes Fusarium head blight, which reduces grain yields and taints grain with mycotoxins that have been found to be detrimental to human and animal health.

Frances Trail, associate professor of plant biology and of plant pathology, and Jonathan Walton, professor in the MSU–Department of Energy (DOE) Plant Research Laboratory, joined scientists around the world in picking over the inner workings of the fungus.

Frances Trail: Understanding the genome sequence begins the process of curtailing a fungal pathogen.

Fusarium begins its blighting ways as pinprick-sized pods that spit spores into the air. The spores float over grain fields, landing on flowering wheat and barley and colonizing the wheat flowers. The often cool, wet weather of the Midwest provides an ideal environment for the fungus to take hold. The result: fields of blight, identified by withered, bleached heads of grain. At harvest, many of the grains are shrunken and white and harbor the mycotoxins.

The fungal plant pathogen has some 14,000 genes sequenced. Trail says the roles of some of them are understood, including those that help form the spores or help produce toxins. The team figures there are 2,000 genes dedicated to making the spores.

"Those spores have to get out to cause the new disease cycle," she says. "If we can figure out that whole mechanism, it's likely that we can figure out a way to control it."

Understanding the genome sequence is the first step in the process. From there, the task is to understand the makeup of the genes—where they're strong and organized, where they're unstable and ready to change strategy. For instance, Trail wonders if the flexibility in the pathogenic-holding parts of the chromosome is the reason this fungus can produce so many different mycotoxins. One of them, zearalenone, can mimic sex hormones in mammals, including possibly people, and potentially cause developmental and reproductive problems.

Some parts of the chromosomes, where many switches for disease and toxins reside, are unstable. Other areas of the chromosomes, where basic metabolism and other vital functions dwell, are stable.

"Those unstable areas are places where the organism is ready to evolve," Trail says. "In those genes there's a lot of mutation. They can change a lot without killing the fungus. The genes that are involved in basic metabolism can't change without killing the fungus. We're starting to see this kind of a pattern as genomes have been looked at. It tells us something about what makes a pathogen a pathogen."

Walton's lab helped annotate the completed genome—that is, inspect a subset of the 14,000 gene sequences for accuracy and then compare them to genes in other organisms. In this way, they identified genes that *Fusarium* has that are lacking in related fungi that aren't pathogenic on plants. This gives additional clues as to what *Fusarium* needs to be a pathogen, which the team hopes will lead to new strategies to control the disease.

The project was supported by the National Research Initiative of the U.S. Department of Agriculture Cooperative State Research, Education, and Extension Service. Related research is supported by the Michigan Agricultural Experiment Station. The sequencing was performed at the Broad Institute at the Massachusetts Institute of Technology.

New tool measures speeding nuclei

An international collaboration at the National Superconducting Cyclotron Laboratory (NSCL) demonstrated a new technique for studying particles traveling at one-third the speed of light.

In the study, NSCL users from the Institute for Nuclear Physics of the University of Cologne in Germany and Central Michigan University teamed with MSU researchers for a first-ever measurement of the rare isotope germanium-64 (Ge-64). Specifically, the researchers gauged the amount of time it takes for an excited, high-energy version of the isotope to decay into a lower energy state—information crucial to nuclear scientists seeking to characterize shape and structure of rare isotopes.

"To make this experiment happen, you need to bring together all the top elements you have available in the lab and from our users," says Krzysztof Starosta, NSCL assistant professor. "You need everything to be optimized, and it happened for this particular experiment."

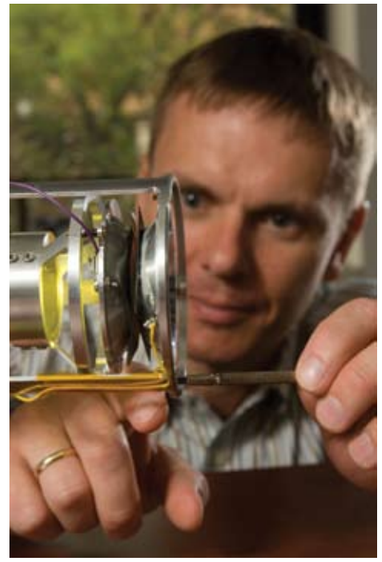
All nuclei are made up of protons and neutrons, and the stable form of Ge-73, relatively abundant on Earth and commonly used as a semiconductor in the computing industry, has 32 protons and 41 neutrons. Ge-64, in contrast, has an equivalent number of protons and neutrons—32 of each—an exceedingly rare combination for this element.

Physicists are interested in isotopes like Ge-64 with mirror-image sets of protons and neutrons that fall within a specific mass region—heavier than nickel and lighter than tin. It is a nuclear neighborhood marked by strange phenomena, including nuclei that rapidly change from being round to cigar- or pancake-shaped. The broad theoretical outlines of shape-shifting behavior are well understood, yet until now, precise experimental observation has been difficult to achieve, according to the researchers.

NSCL studies isotopes by fragmenting beams of nuclei traveling at more than 62,000 miles per second. This fast-beam method holds certain advantages over alternative means of producing rare isotopes, allowing physicists to study nuclei at the extreme edge of existence.

But studying such speeding nuclei is rife with challenges, too, such as filtering and purifying the beam and having the right equipment to detect the few sought-after isotopes from the many billions of billions of other particles in the beam.

"Until now, such challenges hindered the success of lifetime measurement experiments at fast-beam facilities," Starosta says. The experimental result is only the second time a precise lifetime measurement has been made in the mysterious portion of the nuclear landscape where unusual proton-neutron ratios may cause strange behavior.



Krzysztof Starosta: First-ever measurement of the rare isotope Ge-64 occurred at MSU.

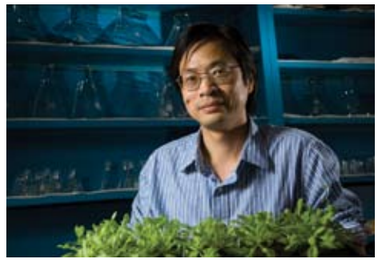
The research was supported by the U.S. National Science Foundation and the Gesellschaft für Schwerionenforschung in Germany.

MSU researchers JAZ (zed) about plant resistance discovery

While scientists have known for years that a common plant hormone, jasmonate, plays a crucial role in plant development and function, the steps that convert the hormone's signal into genetic and cellular action have remained elusive. MSU scientists Sheng Yang He and Gregg Howe were part of two back-to-back discoveries that solved the mystery, described last summer in the online journal *Nature.*

Jasmonate is the last major plant hormone to have its signaling process revealed. Initial research by Washington State University (WSU) researchers identified the family of proteins—dubbed JAZ proteins—that are critical to plants receiving and responding to the jasmonate signal.

"In a healthy environment, these JAZ proteins are doing their job—they're blocking all the defenses and signals, because they are not needed," says Howe, professor of biochemistry and molecular biology. "But when a plant becomes stressed by an insect or pathogen, the plant needs to respond very quickly if it's going to be successful in warding off the attacker."



Sheng Yang He: Protein interactions enable plants to defend against insects and pathogens.

Independent of the WSU work, Howe and He used *Arabidopsis,* a common lab plant, and tomato plants to determine how the JAZ proteins work. Their experiments showed that the jasmonate signal causes direct interaction between JAZ proteins and a second protein complex, SCF^{COI1}, that works to eliminate the JAZ protein so that the plant can mount a defense response.

Based on the research findings, there is strong evidence to suggest that Howe and He might have identified the SCF^{COI1} protein complex as the receptor for jasmonate.

"We found that when jasmonate is present the COI1 and JAZ proteins bind together," says He, professor of plant biology, plant pathology, and microbiology and molecular genetics. "This opens the way for the plant to turn on the necessary genetic or cellular response."

As part of their research, Howe and He have proposed a model for how this interaction works.

"Now that we know what the active signals are and have identified the key regulatory proteins—the JAZ proteins—involved, the hope is to either genetically modify plants or develop compounds that mimic the jasmonate hormone," Howe says. "The research may help scientists engineer plants for increased resistance to insects and pathogens."

The research was funded by the National Institutes of Health and the U.S. Department of Energy and supported by the Michigan Agricultural Experiment Station.

Background check system goes national

A Web-based informatics system that integrates the databases of several registries provides a mechanism for conducting criminal history checks on prospective employees, current employees, independent contractors, and those granted clinical privileges in facilities. MSU researchers partnered with several state agencies to develop and implement Michigan's Workforce Background Check Program as one of seven pilot programs funded by the U.S. Department of Health and Human Services.

Since the system went into effect for the state of Michigan in 2006, nearly 4,000 of approximately 163,000 applicants were deemed unemployable because of records of abuse or criminal histories discovered during the background check process.

Because of its success, the system is now being used as a model for the rest of the country in legislation introduced in the U.S. Senate last summer. Of the pilot programs, Michigan's is statewide and the most comprehensive in terms of systems and cost–benefit analysis.

"This system gives peace of mind to Michiganders with family members in long-term care, potentially saving lives and reducing injuries," says Lori Post, assistant dean for research in the College of Communication Arts and Sciences, who was in charge of developing the system.

"In addition, our incremental background check system has created a significant cost savings to taxpayers. And for every crime prevented, we save the family, the facility, and the taxpayer money by reducing hiring and training charges, criminal justice investigations, and social service support needed to recover from crimes," Post says.

The system that MSU and the partner agencies developed gives long-term care providers online access with a secure login and password, allowing them to check multiple registries. If no matches are found, applicants are sent to an independent vendor for a digital scan of their fingerprints, which are sent to the Michigan State Police (MSP) and to the FBI. If disqualifying information is found, notice

Lori Post: MSU's background check system increases safety and decreases costs.

is sent to either the Michigan Department of Community Health or the Michigan Department of Human Services for staff analysts to examine the applicant's criminal history. An appeals process also was enacted to provide a fair system.

In addition, Michigan employs a "rap back" system by the MSP that notifies state agencies of changes in a history including arrests, charges, and convictions. The agencies, in turn, notify the employers.

The federal legislation would replicate a similar system nationwide.

Fuel from fiber: pretreatment is key

"Put a tree in your tank." Fuel companies aren't touting that slogan. At least not yet.

But thanks to research done in part by Bruce Dale, professor of chemical engineering and materials science, making fuels from poplar trees and corn stalks is becoming more efficient and cost-effective.

Dale is internationally known for his 30 years of research on making ethanol from plant biomass—the stems, leaves, stalks, and trunks of plants and trees usually discarded as waste after a crop is harvested. He's developed a patented pretreatment process for biomass, ammonia fiber expansion (AFEX), which makes the breakdown of cellulose—the most difficult part of making ethanol from plant biomass—more efficient.

"In time, we can expect to completely replace gasoline and diesel with cellulose-derived biofuels that are cheaper, better for the environment, and much better for national security than petroleum-derived fuels," Dale says.

Making fuels from poplar trees and corn stalks is becoming more efficient and cost-effective.

And, he adds, using cellulosic materials instead of corn grain for ethanol eliminates the fuel vs. food debate—the concern that diverting corn grain to make ethanol will lead to food shortages.

Dale used life cycle analysis tools, which include agricultural data and computer modeling, to study the sustainability of producing biofuels from renewable resources. As the country moves toward large-scale cellulosic ethanol production, the yield of so-called energy crops—grasses and woody materials grown for their energy content—also will increase dramatically.

"This will reduce pressure on our land resources," says Dale, who also is associate director of the MSU Office of Biobased Technologies. "We'll be able to get more raw material out of one acre of land."

Dale notes that many of these energy crops will be grown on land that isn't prime agricultural acreage. "The evidence indicates that large-scale biofuel production will increase, not decrease, world food supplies by making animal feed production much more efficient," he says.

Dale's research is supported by the National Science Foundation, the U.S. Department of Agriculture, the U.S. Department of Energy, Natural Resources Canada, DuPont Biobased Materials Inc., and the Michigan Agricultural Experiment Station at MSU.

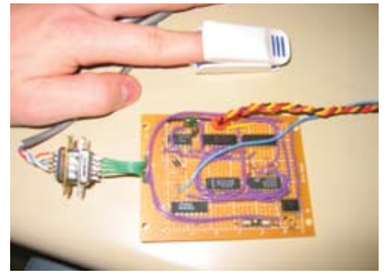
Students design medical diagnostic device

A team of engineering students has designed and developed a medical diagnostic device that would allow patients in developing countries like China to be inexpensively screened for a variety of medical problems.

Faculty facilitator Tongtong Li, assistant professor of electrical and computer engineering, and students Joe Hines, Janelle Shane, Kevin Scheel, Thomas Casey, and Kurtis Hessler teamed up with students from China and Italy on the project.

"The goal of the project was to develop a low-cost, low-maintenance, user-friendly medical device that can perform multiple biomedical measurements for patients in rural areas," Li says. "The free screening tests can provide immediate medical diagnosis for the patients and help them to determine whether further medical assistance needs to be pursued," she explains.

Affordable health care in China is an important issue as health-care costs are major contributors to poverty. Although China's health-care system is in a state of reform, lack



Students' device allows patients in developing countries to be screened inexpensively for a number of diseases.

of health insurance, especially in rural areas, prevents many Chinese people from seeking medical care. Available for free use in rural hospital lobbies, the device is designed to be simple and safe enough to be operated by trained volunteers or even by patients themselves.

The device performs a number of diagnostic measurements: blood pressure, blood oxygen saturation, temperature, glucose level, and electrocardiogram. An additional online database system for patient records and a wireless infusion bottle monitoring system will be useful to doctors and other hospital workers.

For its originality and quality of product, the design team was selected one of 30 finalists for the Mondialogo Engineering Award 2007. The five-member team was nominated to proceed to the finals of the worldwide engineering contest by DaimlerChrysler AG and the United Nations Educational, Scientific, and Cultural Organization. About 3,200 engineering students from 89 countries participated in the competition.

Projects advanced to the finals on the basis of creativity and quality, feasibility, and pursuit of the UN Millennium Development Goals. The intensity of intercultural dialogue and the exchange of knowledge between the trainee engineers also played a crucial role in the assessment.

When food makes pets sick

When contaminated pet food was being recalled early this year, the question veterinarians and others asked was this: How do we know for sure that a pet has been sickened or died from eating contaminated food?

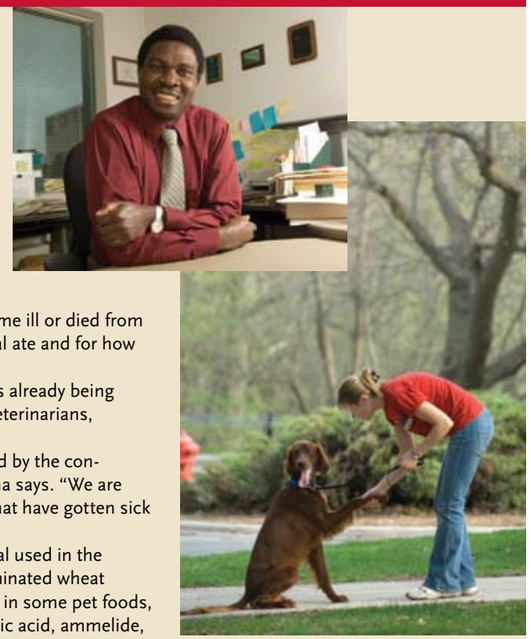
The problem is that dogs and cats are subjected to many contaminants, toxins, and other such things in the course of their daily lives. "Some animals, for example, drink antifreeze," says Wilson Rumbeiha, associate professor in MSU's Diagnostic Center for Population and Animal Health. "Those same animals could have eaten contaminated food. We stay busy here because animals eat things they shouldn't."

Rumbeiha, working with the American Association of Veterinary Laboratory Diagnosticians and pathologists from the University of Guelph, designed a Web-based survey for pathologists, veterinarians, and others to get to the heart of the matter and figure out just how many animals became ill or died from eating bad food. The survey collects data about what kind of food the animal ate and for how long, what the symptoms were, and whether it survived.

Within a week of posting the survey last spring, valuable information was already being collected, Rumbeiha says. Follow-up interviews are being conducted with veterinarians, pathologists, and others who responded to the survey.

"In addition to getting a handle on how many animals have been affected by the contaminated pet food, there is also an analytical component to this," Rumbeiha says. "We are developing a test that can tie the contaminants in the food to the animals that have gotten sick or died."

The U.S. Food and Drug Administration found that melamine, a chemical used in the manufacturing of plastic utensils, fertilizer, and other products, had contaminated wheat gluten, a filler used in certain pet foods. Rice protein concentrate, also used in some pet foods, also was found to contain melamine. Other contaminants, including cyanuric acid, ammelide, and ammeline, also were found in wheat gluten. "It's not clear which of these contaminants is responsible for the kidney injury pets experienced," Rumbeiha says. "It's possible there may be an interaction between the contaminants."



Was it the food or something else? Wilson Rumbeiha (top) is looking for answers.

FACULTY ELECTED TO NATIONAL ACADEMIES


Pamela Fraker

A nutritional immunologist is the latest MSU faculty member to be elected to the prestigious National Academy of Sciences (NAS). Pamela Fraker, professor of biochemistry and molecular biology and of food science and human nutrition, was one of 72 U.S. scientists elected at the 144th annual meeting of the academy. Eighteen associates from 12 other countries also were elected. Seven other MSU faculty are active members of the academy.

Membership in the NAS recognizes distinguished and continuing achievements in original research. Fraker studies the impact of zinc and other nutrients on immune systems. She found that a deficiency of zinc—a global dietary problem and a side effect of chronic diseases like AIDS, Crohn's disease, and sickle cell anemia—causes the body to increase production of glucocorticoids, the steroid hormones that regulate carbohydrate metabolism. That in turn accelerates the death of developing white blood cells needed to fight infection. Her research is supported by the National Institutes of Health. This fall she was honored as the Jean Andrews Centennial Visiting Professor at the University of Texas–Austin.

NAS is a private organization of scientists and engineers dedicated to advancing science and its use for the general welfare. It was established in 1863 by a congressional act to serve as an adviser to the federal government in any matter of science or technology.

One of the sixteen educators elected to the prestigious National Academy of Education this year is Robert Floden, professor of teacher education and associate dean for research in the College of Education.

Floden studies the character and effects of teacher education, teachers' mathematical knowledge, and the connections between education policies and practice. He serves as director of the Institute for Research on Teaching and Learning.

He is coprincipal investigator on the Teachers for a New Era project, funded with grants from the Carnegie Corp. and the Ford and Annenberg foundations. He is also a principal investigator on a National Science Foundation grant, Knowing Mathematics for Teaching Algebra, and a senior staff member for Promoting Rigorous Outcomes in Mathematics and Science.

The National Academy of Education consists of 162 U.S. members, including three others from MSU, and 12 foreign associates who are elected on the basis of outstanding scholarship or outstanding contributions to education.

NOBEL LAUREATE IS MSU ADJUNCT PROFESSOR


Albert Fert

Albert Fert, who shared the 2007 Nobel Prize in physics with a German colleague, has strong collaborations with MSU physics professors Jack Bass, Bill Pratt, and Peter Schroeder, all of whom have worked for years with Fert on giant magnetoresistance.

Fert, a professor at the Universite Paris-Sud, Orsay, France, and director of the Unite mixte de physique CNRS in Orsay, has been an adjunct professor in MSU's Department of Physics and Astronomy for 10 years.

In 1988, Fert and Germany's Peter Grunberg discovered that weak changes in magnetic fields can generate larger changes in electrical resistance in magnetic multilayers consisting of alternating layers of magnetic and nonmagnetic metals, each layer only a few atoms thick. This effect has led to sensitive tools for reading the information stored on hard disks and recently made it possible to miniaturize hard drives.

The MSU team's ability to make high-quality magnetic multilayers led to the collaborations with Fert.

"We had a mutual interest in developing ideas and better understanding the physics underlying what he had discovered," Bass says. "We also found a way to measure something that was complementary to what he had originally measured—giant magnetoresistance with current flowing perpendicular to the plane of the multilayers."

MSU's pioneering measurements of perpendicular current flow fit together well with Fert's model of how the giant magnetoresistance should change in this case. Bass and Schroeder have spent sabbaticals working in Fert's lab in France. MSU faculty and Fert and their students have traveled to each other's laboratories to make samples, conduct measurements, and share scientific ideas. The collaboration has led to several scientific publications with Fert and his students.

"We've worked in two different directions," Bass says. "One is a direct outgrowth of original discoveries—another is in a different direction. Both are very productive for understanding the physics of giant magnetoresistance."

"The result has been a very dynamic collaboration," says Wolfgang Bauer, University Distinguished Professor and chairperson of the Department of Physics and Astronomy.

GRAZING COWS WILL YIELD MORE THAN MILK

A $3.5 million development grant from the W. K. Kellogg Foundation will establish a pasture-based dairy facility and composting program at MSU's W. K. Kellogg Biological Station (KBS) in Hickory Corners, Mich.

The initiative will help researchers determine best practices for raising animals on pasture and develop an improved supply chain—processing, distribution, and marketing programs—for pasture-raised animals. Results will provide farmers with information on dairy management options for moderate to small operations that focus on sustainability from production through consumption.

"Expanding production options that improve the viability of these farms will help strengthen healthy rural economies and communities," says Mike Hamm, C. S. Mott Chair for Sustainable Food Systems at MSU.

"This program will provide a unique opportunity to evaluate how an animal production system operates in the context of other aspects of the landscape—agricultural, managed, and natural," adds KBS Director Kay Gross. "KBS is well-suited for this type of work because of the strong programs in ecology and sustainable row crop agriculture that we have here."

The conventional dairy operation currently operated at KBS will be converted to a pasture-based program over the next two years. A 120-cow milking herd will be maintained on an intensively managed rotational grazing system and on a replicated plot-based pasture system.

"The development of a pasture-based dairy at KBS allows us to expand our portfolio of production alternatives for farmers and to develop new research and outreach programs that fit with interests and needs of diverse farm stakeholders," says Karen Plaut, chair of the Department of Animal Science.

RESEARCH ETHICS: ADDRESSING THE ISSUES

"MSU responds effectively to federal requirements for research through its policies and regulatory offices," says Terry May, interim conflict of interest information officer. MSU has invested in infrastructure to assure that regulations are followed, he adds, citing the Office of Regulatory Affairs and its new export controls unit, its successful efforts to achieve accreditation for human subject protection programs and animal care programs, and its support of environmental certifications for campus units.

"These efforts are important and help researchers navigate the regulations," May adds, "but they don't always address the open-ended questions that remain about the role of science in public policy and the ethical matters associated with scientific issues." He notes debates that surround some research and technologies in areas like biotechnology, nanotechnology, and genetics.

A new Research Integrity Council will focus on those broader issues. Its activities will include

- Identifying issues of responsible research conduct requiring heightened awareness and educational efforts
- Serving as an advisory body for policy issues of ethics and integrity in research and scholarship
- Promoting a greater presence for research ethics and integrity across disciplines
- Encouraging the infusion of issues of research ethics and research integrity into student-focused programs

"A council like this will give MSU a way to address research and education questions that arise about issues like the role of scientific uncertainty in public policy and the benefits and burdens associated with new technologies," May says. "It won't have any official regulatory responsibility or have any oversight of units charged with carrying out regulatory functions. It will engage in serious conversations on sensitive issues of broad import that cross regulatory boundaries."

FACULTY NAMED AAAS FELLOWS

Two MSU faculty are among this year's 471 new fellows of the American Association for the Advancement of Science recognized for efforts to advance their areas of science.

George Garrity, professor of microbiology and molecular genetics, was honored for his outstanding contributions to bacterial systematics. He served as editor in chief of *Bergey's Manual of Systematic Bacteriology* from 1996 to 2006 and currently is vice chairperson of the Judicial Commission of the International Committee on Systematics of Prokaryotes. A fellow of the Society for Industrial Microbiology, Garrity is a cofounder of NamesforLife, LLC, an MSU spin-off company that is commercializing a proprietary semantic resolution technology for tracking and managing dynamic life-science terminologies.

Jack Preiss, University Distinguished Professor of biochemistry, was honored for distinguished contributions to biochemistry, particularly for his work on the synthesis of glycogen in bacteria and of starch in plants, with special emphasis on the structure–function relationships of the enzymes involved. Preiss leads the Starch Biochemistry and Design Research Group and is codirector of the Center for Structural Biology. He has received many awards, including the Guggenheim Memorial Fellowship, and he was recognized as a Fulbright Scholar.

The American Association for the Advancement of Science is the world's largest general scientific society and publisher of the journal *Science.*

MSU IGNITES RESEARCH IN STRUCTURAL FIRE ENGINEERING


Venkatesh Kodur

Fire claims 4,000 lives, injures about 100,000 individuals in the United States and accounts for more than $50 billion in total losses each year. Yet structural fire safety has been one of the least developed research areas in the United States. MSU's College of Engineering has set out to change that in a new Structural Fire Testing Facility, the first such facility in a U.S. university setting.

The new facility is led by Venkatesh Kodur, professor of civil and environmental engineering and one of the world's leading experts on the effects of fire on materials and structural systems.

The Structural Fire Testing Facility features a natural gas-fueled test furnace capable of reaching temperatures in excess of 2,200 degrees Fahrenheit. The furnace will simulate the temperatures, heat transfer, and loads endured by structures in an actual fire.

In the facility, researchers will be able to test beams up to 13 feet long—two at a time—while an 8-foot-long section of each beam is exposed to the fire. Slabs measuring 8 by 10 feet and columns about 8 feet tall also can be tested as can connection systems or portal frames.

Several projects are already under way or slated to begin soon in the new facility.


MSU President Lou Anna K. Simon (center) helps dedicate a facility that doubles previous space available for energy and automotive research.

RESEARCH IN NEW FACILITY TO TACKLE ENERGY AND AUTOMOTIVE PROBLEMS

A new $10 million, 29,000-square-foot research complex will enable researchers to identify ways to realize greater fuel efficiency, determine how to collect waste heat and convert it to electricity, and work to develop new biobased fuels.

The Energy & Automotive Research Laboratories house a dynamic new center for synergistic research and development, bringing together in one facility the leading engineers and scientists working to solve problems important to the energy and automotive fields.

The new research complex features a powertrain lab and two engine test cells—one of which can accommodate a large SUV or small military vehicle. The complex also will have a cold room to test engine turnover in temperatures as low as minus 40 degrees Fahrenheit.

"These facilities will allow for further development of hybrid technologies, the creation of more efficient combustion engines and the pursuit of biobased fuels," says Eann Patterson, chair of the Department of Mechanical Engineering.

"Activities within the new energy labs will complement research programs taking place elsewhere on campus, at other universities, and within industry," says Satish Udpa, dean of the College of Engineering. "This new facility will bring together some of the world's top plant scientists, agricultural economists, chemists, forestry experts, and engineers to develop innovative solutions."

The new facility, which more than doubles the previous space for energy and automotive research, represents an investment in infrastructure and research that will allow the College of Engineering to continue to draw the world's best researchers.

Nearly half of the financial support for the Energy & Automotive Research Laboratories was provided by individual and corporate donors.

"There is no problem or issue, domestic or global, which does not require an interdisciplinary definition and an interdisciplinary solution. We will cut across boundaries—disciplinary, geographic, and political—to tackle the real problems society faces." – MSU President Lou Anna K. Simon

TEAM RESEARCH

Written by Jamie DePolo, Sue Nichols, Tom Oswald, and Janet Rohler

Wayne Dyksen (left) and Mark Kornbluh link computer science and humanities scholarship.

They're sometimes called silos, the discrete departments that make up the colleges that make up a university. And they sometimes have the intellectual equivalent of a silo's tall, thick walls that confine the contents.

But whatever its value for storing grain, the silo concept doesn't work very well when there are complex problems to solve, or when one field of study needs the expertise of another to advance.

MSU has departments, of course. But a remarkable number of them have homes in more than one college—sometimes in more than two. The Department of Microbiology and Molecular Genetics, for example, resides in three colleges: Human Medicine, Natural Science, and Osteopathic Medicine. The food science and human nutrition department has homes in both the College of Agriculture and Natural Resources and the College of Natural Science.

The list goes on and extends to individual faculty, many—perhaps most—of whom are appointed in multiple departments and often in other program units as well.

These administrative complexities can be hard to fit on a business card, but they're ideal for the business of advancing knowledge. And MSU is determined to keep that interdisciplinary activity flowing as freely as possible. Society's problems require it.

Here are four stories of research projects that stitch diverse disciplines and cultures together to create meaningful results.

QUILTS AND COMPUTERS

"Humanities" and "computing technology" are words not often seen together. Perhaps "quilts" and "technology" are even less likely companions, since many quilts are made with nothing more technical than thimble and needle. But MATRIX has demonstrated the value of linking such disparate concepts.

MATRIX, the Center for Humane Arts, Letters, and Social Sciences Online, has carved out a unique role as a leader in applying advanced information technology to scholarship on human thought, expression, and behavior. The integration is apparent in the center's leadership: Director Mark Kornbluh, who is chair of the Department of History, has appointments as a professor of both history and computer science and engineering. One of the associate directors of the humanities-based center, Wayne Dyksen, is a professor of computer science and engineering.

Access to information is basic to humanities research, Kornbluh points out. But even if the information has been digitized and added to an Internet site, finding it and organizing it often remain daunting tasks, he adds. MATRIX links people who understand arts and humanities scholarship with people who know how to design sophisticated electronic search and management tools.

One MATRIX tool, MediaMatrix, enables users to find, segment, annotate, and organize text, images, video, and sound. With this online tool, teachers can collect media from the Web for classroom use, students can incorporate media into their assignments, and scholars can use media found online the way they've traditionally used texts in libraries.

Project Builder, an online repository now in its second generation, organizes digital library collections. It allows users to manage and deliver different kinds of digital collections using the same software system, and that simplifies cross-collection searching.

The Quilt Index is one collection built on that software. Begun with a grant from the National Endowment for the Humanities and the Institute for Museum and Library Services (IMLS), it is rapidly becoming the primary digital repository for information on quilts, quilt makers, and quilt making. MATRIX staffer Justine Richardson and Marsha MacDowell, professor of art and art history and folk arts curator at the MSU Museum, captured the essence of the project at a conference on Museums and the Web in a presentation called "Bits & Bolts to Bits & Bytes."

The Quilt Index (**quiltindex.org**) organizes quilt images and information from both public and private collections. Scholars—or anyone interested in quilts—can search by patterns, individual quilters, themes, techniques, and more. A recent grant of more than $900,000 from IMLS will support adding new materials relevant to quilt studies, including bibliographies and online tools that help researchers locate hard-to-find primary materials.

A joint project of MSU and the Alliance for American Quilts, the Quilt Index has won four large national grants totaling nearly $2 million. "This innovative work demonstrates that one can build a national, standards-based, cross-institutional digital repository of related materials," Kornbluh says. As a result, MATRIX is in discussions about building similar repositories for other types of cultural artifacts, including Native American baskets, outdoor murals, and rural agricultural buildings.

MATRIX also is working to develop tools for searching very large text archives to find all documents similar or related to a given document. But that's not as easy as it sounds, Dyksen says. He lists some of the challenges:

Scholars interested in quilts can search the digital Quilt Index built with software developed at MSU.

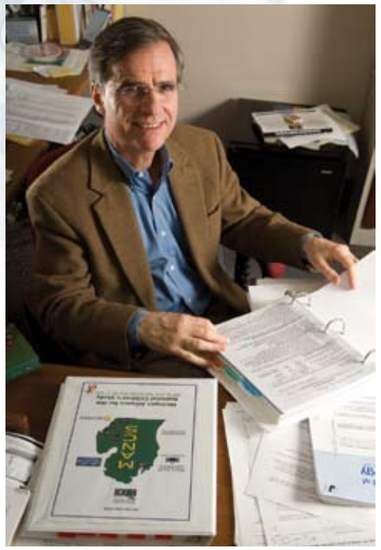
- Defining and measuring similarity
- Handling really short and really long documents
- Processing a million documents, repeatedly
- Presenting the results in ways that are meaningful to a variety of users

For this project MATRIX has begun collaborating with Bill Punch, associate professor of computer science and engineering and director of the High Performance Computing Center where many standard processors are clustered to provide fast, high productivity computing resources—the kind of resources essential when scholars generate a lot of data and need to reduce it, validate it, modify it, or organize it.

MATRIX is committed to fostering this kind of collaborative, interdisciplinary research. "We identify potential projects that are mutually beneficial and externally fundable," Dyksen says. "Then we identify potential collaborators. That's a process of strategic and personal networking," he adds.

"And then," he says, "we make potential collaborators an offer they can't refuse." It might be funding for travel or a research assistant; it might be programming or Web hosting services. It's always significant help with proposal writing and submission. "We identify funding opportunities and ask our collaborators to brainstorm the project ideas with us and provide their piece of the technical content for the proposal," Dyksen says. "And we lead the rest, the writing, editing, formatting, and administrative tasks required to submit a completed proposal to an agency."

"This kind of collaboration is transforming the way we do humanities research," Kornbluh says.



Nigel Paneth leads the Michigan team participating in a large, national study of children's health issues.

KIDS AND HEALTH

An alliance of Michigan's top three research universities, two leading health care systems, and state and local health agencies is part of a national research project to study how the environment affects the health and development of children.

The National Children's Study will monitor more than 100,000 children nationally from before birth to age 21. In Michigan, researchers will recruit and monitor approximately 1,000 participants in Wayne County in the initial phase of the study, which is funded by an $18.5 million research contract from the National Institutes of Health (NIH). In all, Congress appropriated $69 million for the study in fiscal year 2007.

MSU will lead Michigan's role in the project, which is believed to be the most ambitious children's health study of its kind in the nation. Nigel Paneth, professor of epidemiology and pediatrics and human development, is directing the Michigan project.

"No children's health study of this size or scope has ever been undertaken," Paneth says. "The results should provide critical information about environmental influences and their effects on the health of children. Environmental influences are broadly defined. We will examine the effects of environmental toxins, nutrition, and family and societal structures.

"By studying children through several phases of growth and development, including their development before birth, we will be better able to understand the role of these factors on health and disease."

The idea for the study stems from a task force on children's health and the environment established by President Bill Clinton in 1998. In 2000 Congress authorized planning for the study. Paneth, an expert on infant and children's health issues, was invited to serve as cochair of the study design working group.

Knowing that the national study was on the horizon, Paneth enlisted partners from a wide range of disciplines and institutions to form the Michigan Alliance for the National Children's Study in 2002 and begin planning for the project. They met in person every four months and added conference calls between meetings.

"We have fabulous collaborators," he says. "They represent the biomedical and scientific strength of the state." Each person and institution comes with unique skills, from prenatal epidemiology to survey expertise to data analysis capabilities.

They also responded quickly when NIH put out the request for proposals last March with 45 days to respond. "We sent about 150 pounds of proposal documents to NIH," Paneth recalls. The package contained multiple copies of six 400-page volumes outlining the scientific and business plans for the research.

Each partner will play a specific role in the study:

- The University of Michigan will be responsible for enrolling and interviewing study participants and assessing postnatal child development.
- Wayne State University will oversee the assessment and care of pregnant women.
- Children's Hospital of Michigan will serve as the repository for biological samples.
- Henry Ford Health System will serve as the repository for environmental samples, perform medical examinations of children, and coordinate community engagement efforts.
- MSU will coordinate the overall work of the study and house the project. MSU Extension will help develop community support for the study.
- Michigan Department of Community Health will provide information related to live birth characteristics and locations in Wayne County.

"Our members of Congress were important allies," Paneth adds. "There was bipartisan support for the study. And we can't leave out the important collaboration of the participants. To learn what causes diseases like asthma, diabetes, seizure disorders, and cerebral palsy, we need to have data from a lot of children over a long time period." The study will take some time and effort on the part of the mothers, he says, but it won't cause them or the children any harm.

"It's important that Michigan be a part of the largest and most comprehensive national study of child health ever mounted," Paneth says. "But we also expect that issues especially important to the health of Michigan children will be addressed, leading to new ways of treating and preventing disease in our children and to new public health programs in our state."

PLANTS AND ENERGY

Renewable energy for American industry is the focus of a major Midwest research center funded by the largest federal grant exclusively for research endeavors in MSU's history.

MSU will partner with the University of Wisconsin–Madison in establishing the Great Lakes Bioenergy Research Center (GLBRC), one of three such centers the U.S. Department of Energy (DOE) funded last summer. The center, based in Madison, will receive $125 million over five years. MSU will use approximately $50 million for basic science research aimed at solving some of the most complex problems in converting natural materials to energy.

Ken Keegstra, University Distinguished Professor of plant biology and of biochemistry and molecular biology, and Tim Donohue, professor of bacteriology at the University of Wisconsin (UW), led the initiative to bring the center to the Great Lakes region. Keegstra will be the executive director, splitting his time between East Lansing and Madison.

"This is a great partnership that uses Michigan State's comprehensive and powerful plant sciences to shape a green future in renewable resources," says Steve Pueppke, assistant vice president for research and director of MSU's Office of Biobased Technologies. "This matches some of the world's best plant science with industry needs. The work will create momentum; these activities bring on more activities. This is how things start to happen."

Steve Pueppke (top) and Ken Keegstra are part of a national team exploring how plants can be used for energy.

Wisconsin, Michigan, and the Great Lakes region will be a hub for research efforts aimed at clearing the technological bottlenecks that prevent plant biomass from being used efficiently as a source of energy. The DOE estimates the United States will need to process one billion tons of biomass per year as a source of renewable energy to meet the goal set by President George W. Bush to make cellulosic ethanol cost competitive with gasoline by 2012.

Research at the GLBRC will be done by a dream team of scientists from Wisconsin; Michigan State; Lucigen, a Madison-area biotechnology company; the Pacific Northwest and Oak Ridge national laboratories; and the University of Florida, among others.

The research focus: breeding new varieties of bioenergy plants, developing new processing techniques and agents from microbes for breaking down cellulose, improving the microbial and chemical processes that convert biomass to energy products, providing an environmental and economic framework for sustaining the biomass-to-fuel pipeline, and integrating new technologies—including genomics and new computational methods—into bioenergy research.

Keegstra says the two universities' complementary expertise—from agriculture sciences to microbiology to chemical engineering—combined with knowledge from the rest of the partners forms a team designed for progress and action.

"If we're going to start using plants in significant ways beyond food, there are a lot of issues that come into play that we need to figure out," Keegstra adds. "Sustainability, competition for food, environmental issues—our universities already have a head start in studying these from many angles. There is tremendous compatibility between UW–Madison and MSU, and we have assembled with others a strong and dynamic partnership."

Michigan State brings

- Some of the world's most renowned plant scientists. MSU professors are leading three of the center's five research focus areas.
- Strong links between plant and agriculture sciences and the agriculture industry as part of its land-grant tradition, made stronger with its Michigan Agricultural Experiment Station.
- Twenty years of research at the national Long-Term Ecological Research site (LTER) at Kellogg Biological Station, the only LTER site in the nation that focuses on agriculture.
- Connectivity with and proximity to the auto industry. The GLBRC plans to craft research projects to solve key problems identified by the industry.
- The Office of Biobased Technologies, which identifies and supports research opportunities, forges public–private sector partnerships, and supports research.

NATURE AND SOCIETY

An international group of 16 natural scientists and social scientists called for the wedding of natural sciences and social sciences in a paper published in the journal *Science* last fall. In addition to three members from MSU, the interdisciplinary team came from Sweden, Canada, and China, as well as seven other U.S. universities.

"In the past, natural scientists such as ecologists often excluded humans from considerations, while social scientists usually ignored the impact of natural systems on the humans, although humans and natural systems interact with each other as coupled systems," says Jianguo "Jack" Liu, lead author of the paper and Rachel Carson Chair in Ecological Sustainability at MSU's Center for Systems Integration and Sustainability. "As the world is becoming increasingly connected in various ways, there is an urgent need to integrate natural sciences and social sciences to understand global challenges and develop feasible policies for effective solutions to complex problems."

The paper uses six case studies from around the world. They represent urban and rural areas; developed and developing countries; and various ecological, socioeconomic, political, cultural, and geographic settings. They provide information for comparing and contrasting complex aspects of systems on five continents—Africa, Asia, Europe, North America, and South America.

All of the example systems are faced with pressing environmental and human challenges: In Kenya, forests give way to croplands, cropland soil degradation causes more poverty, and more poverty leads to more deforestation. In China, tourism, residents, and pandas vie for real estate. In Washington state's Puget Sound, single-family housing crowds rich bird habitats. In Wisconsin's Northern Highland Lake District, recreation affects sensitive fish habitats. In tropical Altamira, Brazil, crop changes and recent deforestation take a toll. In Vattenriket, Sweden, land-use choices made several hundred years ago continue to affect a wetland of international importance.

The researchers turn the case studies on all ends, looking not only at landscape patterns, wildlife habitat, and biodiversity but also at socioeconomics, policies, governance, and social networks. They examine complex ecological and socioeconomic patterns and processes over time and across space. They analyze why policy often didn't produce the expected outcome.

William Taylor (top), Jack Liu (right), and Thomas Dietz worked with 13 other natural and social scientists to analyze the links between human and natural systems.

All the studies show that the path from cause to effect is often not a straight line and in some cases takes decades to emerge.

Modern life has raised the stakes, Liu says. The global neighborhood is more crowded.

"Government agencies have recognized for a number of years the need for researchers who can cross the boundaries between the social and natural sciences, because they have to confront real-world problems where the ecological and social systems interact," says Thomas Dietz, paper coauthor and MSU assistant vice president for environmental research and director of the MSU Environmental Science and Policy Program. "Some approaches, like those we review in this study, are focused on local systems. Others, like many studies of climate change, compare nations or look at the global system. We need all these approaches."

"The future of a sustainable environment demands that scientists and policy makers understand the coupling of human and natural systems," adds William Taylor, another paper coauthor and chair of the MSU Department of Fisheries and Wildlife. "Without such understanding and systems thinking, we are doomed to degrading environments, reduced biodiversity, social instability, and an overall decline in the quality of life. I am optimistic that the approach of coupling human and natural systems will provide the road map for enhancing our abilities to develop governance systems to ensure a socially and ecologically sustainable future."

Olympic athletes in Beijing will play on a field designed by MSU turf researchers, led by John Rogers (top).

Turf research goes to the Olympics

Olympic athletes in Beijing this summer will play on a portable field designed by MSU turf researchers. Within 48 hours of the opening ceremonies, the team led by John N. "Trey" Rogers, professor of crop and soil sciences, will install thousands of interlocking 4-foot-square sections of turf, each weighing more than 1,000 pounds.

They've done this before. In 2004, they replaced acres of asphalt in Athens, Greece, with turf sturdy enough for the Olympic soccer games and other field events. In 2002 they worked closer to home: Spartan Stadium. Rogers' team started the switch from artificial turf to natural grass by planting grass in 6,000 trays at the MSU Hancock Turfgrass Research Center. They used 4,800 of them to create the playing field.

In 1994 it was the Pontiac Silverdome near Detroit where the World Cup soccer games were played. A trial game in 1993 marked the first time soccer was played on natural grass indoors.

In each case, the researchers designed root zones and explored different varieties of grass to find the one best suited to the climate and the purpose.

Along with developing turf for the Beijing Olympics, Rogers and his colleagues have developed a joint education program on turfgrass management with four Chinese universities.

New MRI unit will advance malaria research

Soon Terrie Taylor won't have to rely so heavily on autopsy studies to identify how cerebral malaria affects the brain. Early in 2008 the University Distinguished Professor of internal medicine expects to have a new MRI unit installed at the Queen Elizabeth Central Hospital in Blatyre, Malawi. She spends the rainy season—January through June—there each year conducting research on the disease that kills as many as 3 million children in sub-Saharan Africa every year.

A gift from the General Electric Corp. (GE), the magnetic resonance imager will be the first in Malawi and also will serve the neighboring nations of Mozambique and Zambia.

"This will help in so many ways," Taylor says. "We will use it for the research we do; we'll be able to use it for everyday patients that come through the hospital, and it will help to attract and retain more doctors to Malawi."

In MRI, or magnetic resonance imaging, radio waves and a powerful magnet linked to a computer are used to create detailed pictures of areas inside the body. Among other things, these images can show the difference between normal and diseased tissue.

With the MRI, Taylor and her colleagues will be able to look at much of the brain activity while the patient is still alive. "What this will do," she says, "is allow us to follow the process as it happens in the brain. It's a huge advantage."

So far, one of the most significant findings from Taylor's autopsy study of children presumed to have died with cerebral malaria is that about one-quarter of them actually died of completely unrelated infections or diseases. "This calls into question a lot of the work that's been done on severe malaria to date," she says. "The studies might have included patients who were not suffering from malaria at all, because the researchers were using case definitions that lacked precision."

Taylor's autopsy study was funded by a grant from the National Institutes of Health (NIH). The NIH also is providing support for the MRI project, including funds to cover some operating costs and the high-speed Internet connection that will allow Malawi's single radiologist—Sam Kampondeni—to send images to MSU for further assessment and evaluation.

MSU's College of Osteopathic Medicine, where Taylor, an osteopathic physician, is on staff, is donating more than $400,000 for construction of a building to house the MRI. James Potchen, University Distinguished Professor of radiology and chairperson of the department, worked with GE to arrange for the gift.

New imaging technology in Malawi will help Terrie Taylor (center) treat children with cerebral malaria and learn more about how the disease affects their brains.

Study of tropical insects informs rain forest conservation

New research findings suggest that plant-eating insects in tropical forests feast on a broad menu of foliage and can be consistently found across hundreds of miles of tropical forestland. Anthony Cognato, assistant professor of entomology, and graduate student Jiri Hulcr were part of an international team that conducted the groundbreaking research.

"Tropical rain forests are home to a rich diversity of plants, birds, insects, and other animals," says Hulcr, an entomology doctoral student working with Cognato and coauthor of the report. "They also play an important role in our global climate and provide aesthetic, recreational, and medicinal benefits. For these reasons and others, it is critical that we understand how these forests generate and sustain their diversity and what we can do to help conserve them."

The study included approximately 500 species of caterpillars, beetles, and fruit flies from common plant-eating families and 175 species from four diverse plant groups across 28,950 square miles of contiguous lowland rain forest in Papua, New Guinea. Cognato and Hulcr contributed expertise on the biology and ecology of the bark and ambrosia beetle family, a group composed of 6,000 species worldwide, and one common to tropical rain forests.

"What we found was that the composition of the community of beetles does not change with distance as long as the environment is stable," Cognato says. "Even communities hundreds of miles apart are the same. And if there are differences, they seem to be random and not caused by any environmental change." Findings were similar for the butterfly and fruit fly species examined in the study.

Cognato and Hulcr expect similar patterns in other tropical lowland rain forests that are comparable to the study area in New Guinea. They are currently conducting research in other areas—including Borneo, Ecuador, Guyana, Ghana, and Thailand—to confirm the New Guinea findings.

"If we want the stability of these forests, especially given how much they are threatened now, we need to understand how to best set up conservation areas," Cognato says. "And it's not just about the flashy species; it's about the whole thing."

"This and additional research will allow conservation managers and policy makers to base decisions on data rather than on theory so that we can preserve as much diversity as possible," Hulcr adds.

Cognato and Hulcr's work was funded by the National Science Foundation, National Geographic Society, and MSU's Michigan Agricultural Experiment Station. The research team included scientists from Australia, the Czech Republic, the United Kingdom, New Guinea, and the United States. Their results were published in the online edition of the journal *Nature* last August.

Better water from better technologies

Volodymyr Tarabara and Tom Voice are leading an international partnership of environmental engineers and scientists that will create new membrane-based technologies to purify the world's waters.

"Membrane-based technologies selectively remove things such as chemicals and particles from water," says Voice, professor of civil and environmental engineering. "They are analogous to filters except they remove things that are smaller and separate on the basis of chemistry and size. Our project is looking at developing new types of membranes and membrane systems that perform better in water-treatment applications."

Membranes can produce ultrapure water, removing almost everything. "They are used in some places to turn sea water into fresh water," Voice adds. "The challenge is to do this cost effectively, and we seek to do this by improving their performance." Development of robust membranes is a significant opportunity to enhance the quality of water and, ultimately, public health, especially in developing countries.

A $2.5 million grant from the National Science Foundation (NSF) funds the team, which comes from two U.S. research universities, two research centers in France, and three institutions in Ukraine and Russia. The team's strength, Tarabara says, is that each institution brings something unique to the table.

"For example, research to develop stronger hollow fiber membranes will unite the renowned expertise in carbon nanotube composites at Duke University with the knowledge of hollow fiber membrane manufacture and optimization at France's National Polytechnic Institute of Toulouse," he says.

"Development of high-flux membranes to remove heavy-metal contaminants will include the group in Kiev, which is heavily involved in this work due to local environmental contamination, along with a group from MSU, which is developing high-flux membranes that reject large molecules," he adds.

"One premise of our partnership is that students are powerful catalysts for research collaboration," Tarabara says. "Our research will be organized in international teams in which at least one doctoral student from a foreign institution will be teamed with a student from a U.S. institution."

When the nonrenewable, five-year grant expires, Tarabara says, the project will live on.

An international team aims to improve water around the world.

"We are working with industrial partners in the United States and abroad to ensure that the project is sustained after the NSF funding is over."

Early social skills and learning are linked, research shows

A child's social skills at age 3 could predict his or her future social and academic performance, according to MSU researchers. Important social skills in early childhood include emerging abilities to manage feelings and behaviors, recognize social cues from others, and engage in positive interactions with peers.

"Early intervention is an important tool for enhancing and supporting early development," says Holly Brophy-Herb, associate professor of family and child ecology, who led the research team. "But we must also focus on how interventions work, whether they are curricular interventions or comprehensive early intervention services, such as Early Head Start, under what circumstances, and for whom."

Early Head Start (EHS), a national intervention and support program for income-eligible families, provides comprehensive services to families prenatally until the child is 3 years old. Brophy-Herb and colleagues are working with EHS providers in six Michigan counties to evaluate an infant/toddler curriculum targeting early social and emotional development that was developed by the MSU team and its EHS partners. The project is funded by the U.S. Department of Health and Human Services.

The MSU research team also is part of a National Early Head Start Research and Evaluation Consortium, which has been engaged in a study of EHS-eligible children and their families since 1996. This research was conducted at 17 sites across the country with 3,001 families participating.

Findings reported by the national consortium reflect the long-term impacts of EHS:

- Overall, EHS children performed better on measures of cognition, language, and social–emotional functioning than their peers at age 3. In addition, they were less likely to be in the "at risk" category of cognitive and language functioning. By age 5, children who had received EHS programming as infants and toddlers continued to show fewer behavior problems and more positive approaches to learning.
- Parents of EHS children were more supportive of their children's emotional, cognitive, and language development when their children were 3 years old and also when the children were 5 years old.
- When impacts were examined by race and ethnicity, African American children showed the greatest benefits. They were more likely to be enrolled in formal programs following EHS than those children not in EHS.

These findings have boosted the long-held belief that early childhood intervention is key to helping children who are at risk of behavior problems, poor developmental health outcomes, decreased school readiness, and higher dropout rates. Brophy-Herb and colleagues, with the EHS Consortium, are conducting a grade five follow-up of the children and families.

Grant will grow heredity lessons for fifth and sixth graders

Michelle Williams

Plants are already part of the fifth-grade curriculum, and the scientific principles underlying heredity show up in sixth grade. But thanks to an MSU faculty member's grant from the National Science Foundation (NSF), teachers in East Lansing, Mich., schools will have some new tools for those lessons and will learn what impact those tools have on teaching and learning.

Michelle Williams, assistant professor of teacher education, received a prestigious NSF CAREER grant this fall to support the study. She already has gathered a team of teachers from local schools and enlisted the support of the school superintendent and the district's curriculum developer. "We have buy-in at every level," she says. "The teachers and administrators are excited about merging research with practice."

The project will explore how fifth and sixth graders come to understand concepts of heredity. This is a subject area where the American Association for the Advancement of Science (AAAS) identified benchmarks for student learning from kindergarten through high school, Williams notes.

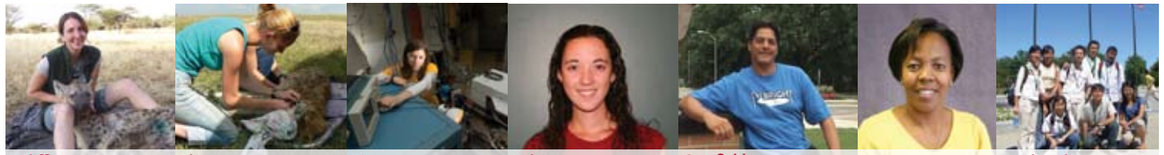
"We'll have the fifth graders grow several varieties of Wisconsin Fast Plants and identify different traits that show up in the plants," Williams says. "Fifth graders are using microscopes," she adds, "so they'll look at cells to help them understand the plant's structure."

By sixth grade, students begin learning how physical traits are passed from parent to offspring. "Over two generations of plants, the sixth graders will see phenotypes come and go," Williams says. "They'll learn to figure out a parent's trait by looking at characteristics of the offspring."

In addition to these greenhouse experiments, students will use the Web-based Inquiry Science Environment (WISE) to see other kinds of cells and make comparisons. The program, developed at the University of California–Berkeley, offers students a way to visualize and analyze scientific evidence. Williams and her team of undergraduate and graduate students will work with the teachers to design modules that will help students make connections between experimental and virtual environments.

And all through the five-year project, Williams and her students will assess the progress of those fifth and sixth graders and get feedback from their teachers.

"We'll do multiple comparisons," Williams says. "We'll look at the effect of the intervention as a whole, but we'll also look at specific mechanisms within the intervention to determine which ones do the most to facilitate learning." Those mechanisms include both the WISE system and the direct efforts of teachers. "Teachers are really looking forward to using this approach," she says. "They've been wonderful advocates."



Califf | Shaw | Pinter | Kalcic | Cranfield | Louw | Do (kneeling, center)

Student researchers win fellowships

MSU students—both undergraduates and graduate students—regularly win prestigious national and international scholarships. Here's a sampling.

NSF fellows

In 2007, the National Science Foundation (NSF) awarded 920 fellowships to graduate students or prospective grad students around the country. Eight of them are now graduate students at MSU; five more were MSU undergrads who received fellowships.

Two doctoral students working with Kay Holekamp, zoology professor, are among recipients of the prestigious fellowships this year. **Katy Califf** is comparing the genetics of spotted and striped hyenas in Kenya. **Kate Shaw** will likely explore the evolution of intelligence and social cognition in Kenya's hyena communities.

NSF fellowships support three chemistry students. **Jill Pinter** is in her third year as a Ph.D. student in nuclear chemistry, working with Paul Mantica, chemistry professor at the National Superconducting Cyclotron Laboratory.

She studies one property of nuclei, the magnetic moment, to get information about how the nucleus is formed, how it is structured, and how its protons and neutrons interact. "It's basic research," she says, "but it has medical applications, and that's appealing because it applies the basic science to help people."

Jeff Gour is a third-year Ph.D. student in chemistry, working with Piotr Piecuch, University Distinguished Professor of chemistry, to develop and implement new quantum mechanics methods for studying atoms and molecules. He began working with Piecuch as an undergraduate at MSU.

Another chemistry student, **Christine Kalcic**, is working with Marcos Dantus, chemistry professor, and proposes to develop a gluten sensor that is already the subject of an invention disclosure. She plans to pursue a career in instrument design and development.

MSU's NSF fellows are in good company: two of the scientists who shared the 2004 Nobel Prize for Physics were NSF Graduate Research Fellows. So was Google cofounder Sergey Brin.

International fellowships

Among international students with fellowships to support their studies at MSU are two from Cape Town, South Africa. **Corvell Cranfield**, in the second year of a Ph.D. program in the Division of Math and Science Education, worked at the University of Cape Town for eight years in the Schools Development Unit, the last five managing the testing program that assessed 35,000 students. That work helping teachers upgrade their qualifications, along with his 19 years as a secondary school teacher, prompted his application for a Fulbright Fellowship. He was one of 18 selected for the fellowship from more than 500 applicants in South Africa.

"MSU's strong international center and staff were very helpful as I was getting settled here with my family," he recalls. The diverse graduate student body is a plus, too. He cites a class of seven students representing six different countries.

"The faculty challenge us to be individual thinkers," he adds. "I'm learning to put a theoretical lens on things I've done in practice." His research will be a longitudinal study tracking growth in math competence in students from grade three to grade eight.

Julia Louw began her Ph.D. program in rehabilitation counseling this year, with a Ford Foundation International Fellowship. Attending the University of the Western Cape part time over 10 years, Louw earned bachelor's and honors degrees in psychology and a master's degree in research psychology. She taught general science and history in sixth and seventh grades in Cape Town for 15 years.

For her dissertation research, Louw is considering a study of how HIV/AIDS programs are taught to sixth and seventh graders. Specifically, she is interested in teachers' views and perceptions about gender roles. "Our culture rewards men for having multiple partners," she explains. "What is the impact of these gender stereotypes on teachers teaching HIV/AIDS programs to their learners? That's the area I'm thinking of exploring."

Dat Thanh Do began his Ph.D. program in physics this year with a Vietnam Education Foundation (VEF) Fellowship. The U.S.-funded program aims to enhance relations between Vietnam and the United States and improve science and technology capabilities in Vietnam.

Do is one of 40 new VEF fellows at 27 U.S. universities this fall. A native of North Vietnam, he earned his undergraduate degree at Vietnam National University.

The U.S. National Academy of Sciences identifies scientists to interview VEF fellowship applicants. MSU was one of five universities the oral examiners recommended to Do. He plans to focus his research on nanotechnology and nanoscience.

Do wants to return to Vietnam to teach in a university there. "Education philosophies are different in the United States and Vietnam," he notes. "In the United States, professors are less directive; students work more independently." Vietnam wants to move toward that model, he adds, and he wants to be part of that change process.

Goldwater Scholar

Chen

Edwin Chen is part of a generation of students becoming scientist doctors who are getting research head starts early in their college careers.

Now in his fourth year at MSU, he has worked on projects to discover new drugs that inhibit the growth of cancerous cells and studied cellular targets of ansamycins, a chemical class of compounds that are in clinical trials with high therapeutic potential in treating tumors. He also has worked on development of a new generation of antiparasitic treatments.

His research mentor at MSU is David Wenkert, associate professor of physiology.

Chen is pursuing a dual bachelor of science/master of science in physiology and a bachelor of arts in chemistry.

Named in honor of former Sen. Barry M. Goldwater, the scholarships encourage outstanding students to pursue careers in mathematics, natural sciences, and engineering. Chen is one of three MSU students named Goldwater scholars in 2007. A total of 317 scholarships were awarded nationwide.

MSU today

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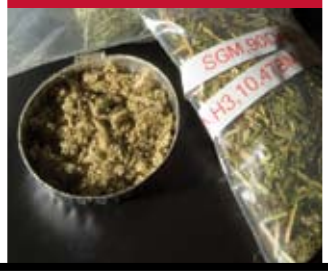

THEN & NOW

Entomology was first taught at MSU in 1858 by Henry Goadby, a physician from Detroit, in a course called Animal and Vegetable Physiology and Entomology. He also wrote an entomology textbook that was one of the first in the nation. Albert John Cook, professor of zoology and entomology from 1869 to 1893, pioneered insecticides to protect crops from pests like the codling moth. The first U.S. professor to teach beekeeping, he persuaded the Postal Service to reverse its ban against shipping queen bees after discussing the matter with President Rutherford B. Hayes. The Department of Entomology was established in 1906.

Albert John Cook pioneered studies of bees and the use of insecticides for protecting crops.

Today, entomology faculty win grants not only from the U.S. Department of Agriculture and commodity groups but also from the National Science Foundation, the U.S. Agency for International Development, and the National Institutes of Health. This funding reflects the quality of studies at the molecular and cellular levels, as well as studies of the role of insects in diseases. Global projects include eradicating mosquitoes that transmit malaria in eastern Africa and investigating the role of aquatic organisms in the transmission of Buruli ulcer disease in Africa.

Richard Merritt, professor and chair of entomology, explores whether biting water insects grow the Buruli ulcer bacterium and pass it to humans and whether water quality affects the process.