New Iowa State Center Develops Biorenewable Energy Sources

The conversion from a petrochemical economy to one based on biorenewables requires new thinking and new partnerships. Iowa State University is uniquely suited to provide the intellectual and entrepreneurial resources required for this important effort as evidenced by a major federal grant to establish a National Science Foundation (NSF) Engineering Research Center for Biorenewable Chemicals (CBiRC). The new center is funded by a five-year, $18.5 million award from the NSF Generation Three Engineering Research Center Program. It has assembled a team of researchers who are charged with developing the fundamental knowledge and technology as well as the academic and industrial partnerships needed for a renewable resource-based industry.

Rather than attempting to create one biorenewable chemical at a time for each petrochemical end product, CBiRC is undertaking a larger vision of creating a generalized framework for producing carbon molecules that will be useful in creating a whole range of chemical products created from biologically feedstocks.

“I am extremely pleased to be able to work on a project that has so many pieces working together for a high impact common objective,” said Brent Shanks, professor of chemical and biological engineering and CBiRC director. “It also is a wonderful opportunity for students because they get to interact with faculty and students from different departments at ISU, faculty and students at other universities and industrial researchers.”

An important premise of the CBiRC biorenewables research is Life Cycle Assessment, which evaluates whether or not a specific biorenewable chemical is truly sustainable by assessing its broader impacts, such as economic viability and environmental effects. Development of life cycle assessment tools will be an overarching research area for the center.

Industrial members are an important aspect of the CBiRC mission. Four companies, Poet, a regional ethanol producer; Novozyme, a leader in bioinnovation; Grain Processing Corporation, a leading manufacturer of corn-based products; and Chevron-Phillips, a chemical producer, work closely with the scientists and can influence the direction of the research in order to ensure that the results will be commercially viable. In return for their practical guidance, the companies are allowed first rights to commercialize the technology when it develops, and also are given access to the students who will be trained in the use of the new technology.

There are three major goals of the research in CBiRC. The first two are heavily dependent upon the biotechnical capability of ISU plant and microbial researchers, while the third will require the skill of chemical catalysis specialists. The project is unusual, not only in its scope, but also in the type of scientists that will be working together.

The plant scientists will be working to exploit the fatty acid and polyketide biosynthesis pathways of plants to produce new precursor molecules of 10 carbon atoms or less. The precursor molecules will offer flexible biochemical conversions that can iteratively generate alkylchains, which carry different chemical functionalities at specific positions on the molecules. Identification of key enzymes suited to carry out the biocatalytic action producing the smaller precursor molecules is the major focus of this area of research.

With only two months of project work completed, the researchers are already working on an enzyme, acetyl-CoA synthetase, which is essential for fixing carbon into the new pathway being built. They have cloned a gene from Arabidopsis and have modified it so that it can be expressed in E. coli and yeast.
The microbiologists will use metabolic engineering scientists to develop efficient microbial strains that produce the precursor molecules in an economically viable manner. They will incorporate the pathways discovered by the plant scientist, and amplify the plant-derived catalysis for use in microbials. The goal of the research is to produce molecules at high yields, high rates and high product titer.

The role of the scientists dealing with chemical catalysis will be to use the resultant precursor molecules developed by the microbiologists to develop and optimize new catalytic reactions for the production of chemical products. The ISU researchers currently are developing experimental procedures and analytical methods for the project. They have initiated collaborative projects with CBiRC colleagues at the University of Wisconsin and the University of New Mexico.

“This project is very different than any other I have worked on — mainly because of its scope. We are re-engineering an entire biosynthetic pathway in order to convert it to a mechanism for producing industrial chemicals,” said David Oliver, professor and associate dean of the college of liberal arts and sciences. “This requires people with a very broad range of skills, from basic biochemists to microbiologists to metabolic engineers and catalyst specialists. Keeping all of our research projects coordinated and working together is a major job.”

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**Biotechnology News**

**ISU Office of Biotechnology Helps Jump-start New Faculty Research**

Based on a news release by Glenda Webber, Office of Biotechnology, Communications

Iowa State University’s Office of Biotechnology has awarded $550,000 to newly-hired biotechnology faculty scientists to help them establish their research programs at Iowa State.

The seven awards were made through the faculty recruitment program begun by the Office of Biotechnology in 1986. To date, the office has provided more than $13.8 million to more than 127 new scientists in 25 academic departments. By obtaining additional funds from external granting agencies, these scientists have brought millions of dollars to Iowa State.

“The Office of Biotechnology is pleased that the funds have helped to recruit innovative biotechnology faculty to Iowa State University,” said Walter R. Fehr, Charles F. Curtiss Distinguished Professor in Agriculture and director of the Office of Biotechnology. The research projects of this year’s seven new faculty recipients are summarized below.

**Nicholas Gabler**, animal science, utilizes molecular approaches to study how nutrients are metabolized in cells and at the whole animal level in swine. His work could lead to new technologies for the swine industry and may be applied to human nutrition.

**Laura Jarboe**, chemical and biological engineering, focuses on the analysis and simulation of bacterial regulatory networks. What she learns about how microbes function at the cellular level could result in improved fermentation technologies for the conversion of biorenewable feedstocks to commodity products.

**Peter Nara**, biomedical sciences, is a veterinary comparative scientist, immunologist and entrepreneur whose molecular research involves the technology of Immune Refocusing to learn how to steer the immune system to better protective responses. His work could lead to more effective vaccines for viral, bacterial, and parasitic diseases, including some cancers, and the production of newly developed vaccines in animal and human health.

**Jason Ross**, animal science, is conducting research on identifying and understanding the molecular mechanisms controlling early pregnancy in pigs. Discoveries from this research could result in increased production efficiencies for swine producers and understanding of fundamental biological processes also affecting human health and fertility.

**Matthew Rowling**, food science and human nutrition, investigates vitamin A and D metabolism and the cellular events controlled by it. His work could open up new avenues in breast cancer research. Rowling is affiliated with the College of Human Sciences and the College of Agriculture and Life Sciences.

**Joshua Selsby**, animal science, is using molecular approaches to better understand the mechanisms underlying muscle function. Selsby’s discoveries could lead to new therapies to maintain muscle tissue threatened by disease or inactivity.

**Olga Zabotina**, biochemistry, biophysics, and molecular biology, is studying plant cell wall structure and metabolism at the molecular level. What she learns could contribute to new technologies for cellulosic fuel production.

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**New Confocal Microscope Expands Research Horizons at ISU**

A state-of-the-art confocal microscope, which offers technology not previously available at ISU, will allow researchers to dramatically enhance their research projects. The microscope, installed in late January 2009, has faster scanning, higher resolution and increased sensitivity relative to other available microscopes. It can be used in fluorescent mode when spatial distribution of cellular structures is desired, and can generate a stack of images for 3D-reconstruction, view structures in thick tissue and remove background and cross-talk fluorescence from other structures that obscure viewing of the desired structure.
“The instrument’s high resolution of a wide fluorescence spectrum and its live cell imaging capabilities will provide excellent images of a variety of cell types,” said Mark Ackermann, one of the investigators who was integral in securing funding for the equipment.

The system has a white light laser. This laser is a new feature that frees researchers from the limitation of the usual three or four lasers at three or four fixed wavelengths. The white light laser can be tuned to any wavelength between 470 and 670 nm, which has the effect of having 200 lasers and 200 wavelengths. This allows researchers to select the excitation wavelength that is best-suited to their samples and avoid autofluorescence. Additionally, the system has an acoustic optical beam splitter that allows the precise definition of emission wavelengths. The combination of these technologies helps to separate fluorescence signals with close excitation or emission spectra.

“The white laser of the new confocal microscope is amazingly versatile,” says Jorgen Johansen, who has been using the new microscope for his studies on chromatin protein. “The white laser allows us to image DNA dyes that could not be visualized very well on our previous confocal system. This allows us to triple labelings to follow more proteins simultaneously.”

This system is also equipped to allow researchers to work with live cells over an extended period. Live cell equipment includes a heated stage with microcontainment system, active gas regulation, cell cultivation chamber and microinjection system.

“This technology allows us to image with minimal photodamage, so we have been able to observe multiple rounds of nuclear divisions within the embryo to get a complete picture of the protein’s distribution throughout the cell cycle,” says Johansen.

For capturing images of fast-moving samples or events that occur in a fraction of a second, the resonant scanner enables video rate scanning with speeds up to 16,000 lines per second. In addition, the system has FRET, FRAP, timelapse, and hyperspectral signal separation software, 3D imaging, colocalization, deconvolution, ROI (Region of Interest) scanning, brightfield and DIC capabilities. A 405 laser provides UV excitation and an Argon laser provides CFP excitation and extra power for bleaching. The system also has an X-Y scanning stage and automatic composition software to capture high-resolution images of samples that are too large to fit within one field of view.

The $730,000 system was funded by a Shared Instrumentation Grant (SIG) from the National Institutes of Health and a grant from the Roy J. Carver Charitable Trust. The SIG program specifically aims to help fund high cost equipment that will be used by a large number of researchers at an institution. The equipment is available for use by on- and off-campus researchers and is located in 117 Molecular Biology. Further information is available on the web at www.biotech.iastate.edu/service_facilities/confocal_microscopy.html or by contacting Margie Carter at (515) 294-1011 or mcarter@iastate.edu.

New ISU Biotechnology Directory Released

This year’s edition of the biotechnology directory, Research in Biotechnology 2009, encompasses 330 Iowa State University faculty who are conducting research in some aspect of biotechnology and includes information on the 27 biotechnology service facilities on campus that support their research.

Research in Biotechnology serves as a valuable resource that helps new and established biotechnology researchers at Iowa State develop contacts with their colleagues in 30 departments with similar areas of research. The publication also is used to showcase the university’s strength in biotechnology to prospective graduate students and faculty, as well as industry leaders around the country. Information provided for each researcher includes department affiliation, office location and contact information, education, Web site, areas of interest and research description.

The online version of the document can be viewed at www.biotech.iastate.edu/Current_Research/. Free printed copies can be obtained by contacting Camie Stockhausen at camstock@iastate.edu or (515) 294-7356.

Faces and Places

Steve Carlson joined the Department of Biomedical Sciences in August 2007 as an associate professor and director of graduate education. He is also a member of the Interdepartmental Neuroscience Graduate Program. He earned a D.V.M. at Iowa State and worked as a large animal veterinarian. Carlson later earned his Ph.D. with an emphasis on molecular pharmacology at the University of Iowa, where he completed a postdoctoral fellowship in molecular microbiology. Prior to joining ISU, Carlson served as a veterinary medical officer for the U.S. Department of Agriculture where he studied the genetics of Salmonella virulence and antibiotic resistance.

Work in his laboratory at ISU is focused on the characterization of relationships between Salmonella and protozoa that engulf the bacterium. Investigation of the intra-protozoal environment as a site for Salmonella virulence gene upregulation and antibiotic gene acquisition from other bacteria is a major focus of his research.

Carlson can be contacted by telephone at (515) 294-0912 or email at stevec@iastate.edu. His office is located in 2028 Veterinary Medicine, and his lab is in 1039 Veterinary Medicine.
Research Update

The following are a subset of the grants recently awarded for biotechnology-related research at ISU. For more information about establishing research relationships with ISU biotechnology researchers, please contact Lisa Lorenzen at llorenze@iastate.edu.


Cianzio, S., Bhattacharyya, M. Agronomy. Application of new genetic resources to the improved control of soybean sudden death syndrome. United Soybean Board


Shanks, B. Chemical and Biological Engineering. PIRE: Molecular engineering for conversion of biomass-derived reactants to fuels, chemicals and materials. University of New Mexico.

Shogren-Knaak, M. Biochemistry, Biophysics and Molecular Biology. Histone modification and higher-order chromatin structure. National Institutes of Health

Vollbrecht, E., Brendal, V. Genetics, Development and Cell Biology. Genetic mechanisms regulating inflorescence architecture in maize and related cereals. University of California – Berkeley

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