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Teaching, Research and Outreach in the Division of Agriculture, Forestry and Veterinary Medicine

Undergraduate Research: Honors College Provides Opportunities

Mississippi State University chemical engineering alumni Bobby Shackouls and his wife, Judy, of Houston, Texas, donated $10 million to the university in 2006 to establish an honors community for undergraduate students pursuing academic excellence.

The university used their generous endowment to create an honors college that would provide opportunities for undergraduate research fellowships, study-abroad scholarships and expansion of programs for visiting scholars and guest speakers. Administrators set aside more than $3.3 million specifically to fund the undergraduate research fellowships awarded through the Shackouls Honors College.

More than 2 years later, the first Shackouls undergraduate research fellowships were awarded to 15 students in spring 2008. Four students with academic pursuits within the Division of Agriculture, Forestry and Veterinary Medicine received fellowships. Their research projects are as varied as their majors, personalities, scientific approaches and career goals.

Bahamas' Rock Iguana Intrigue Lures Johnson into Laboratory

June Johnson

The islands of the Bahamas hold appeal as a great vacation spot, but this Caribbean archipelago also draws the attention of scientists who seek clues to apply to their theories about natural perpetuation of the species.

June Johnson, a biological sciences major with a concentration in preveterinary medicine at Mississippi State University, became interested in such an opportunity when her biology professor Mark Welch mentioned his work with a conservation study involving the genetic analysis of different groups of Turks and Caicos rock iguanas (*Cyclura carinata*) that live on these particular islands. The reptile is one of eight endangered species of iguanas belonging to the genus *Cyclura* found in the Bahamas.

The MSU junior from Helena, Ala., used her research fellowship to contribute to the study of comparing iguana genetics among groups of islands. She, along with Welch and another undergraduate, Angela Mason, presented the research at the Southeastern Population Ecology and Evolutionary Genetics Conference in Eatonton, Ga.

Turks and Caicos iguana populations, which are found only on the Turks and Caicos islands, are among the healthiest in the Caribbean. These islands represent the southeastern extreme of the Bahamian Archipelago. When humans began bringing cats and dogs, they introduced predators that have decimated the population. This predation has reduced the range of these iguanas to less than 5 percent of what it once was.

"About 15,000 years ago, the Bahamas were part of a large land mass, but once the oceans rose, many species became isolated on different islands," Johnson said. "If we understand how these iguanas have evolved within their surroundings, we can apply this knowledge to other cases in which species have become isolated or fragmented."

Johnson conducted her research while working in the biological sciences laboratory this summer at MSU. She worked with Welch, who had taken 280 blood samples from the rock iguana population. Johnson's task involved manipulating DNA she extracted from the blood.

"We operated on the hypothesis that there is no genetic difference between the rock iguanas living on the eastern islands in the Turks and Caicos area and those living on the western islands," she said. "We extracted DNA to test this hypothesis."

Johnson treated each DNA sample with different enzymes to cut, or mark, the genetic material in a specific area. After marking all samples, Johnson then injected the DNA into a gel and applied an electrical current. By using this technique, known as gel electrophoresis, Johnson was able to photograph the gel under UV light and see the cuts.

"We recorded cut sites and where they were located," she said. "We noted most of the DNA samples from the iguanas living on the western islands did not have cut sites. This revealed a significant degree of difference in the genetic material between the iguanas living on the western islands and those living on the eastern ones."

Johnson's results reflected Welch's previous research findings of significant genetic differences within a smaller sampling of the rock iguana population. Johnson said she hopes her involvement in the study will motivate other students to consider conservation research.

"As human beings, we should realize that every single organism on this planet has a purpose," she said. "We have had to deal with problems caused by extinction of many species and the overpopulation of other species. We need to think about the consequences of our actions and how they affect the environment."

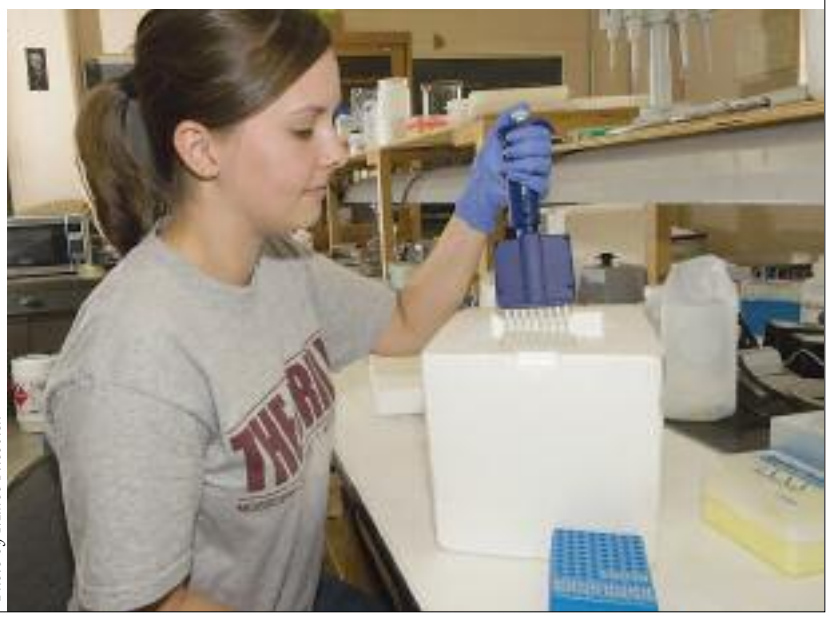

Photo by Marco Nicovich

Masters Takes Stock of Distillers' Grains

Melissa Masters

Nutrition is a big issue for beef producers who want to market animals at their optimal weight. Producers are as finicky about feed as cattle are because they know their production performance depends upon feed intake and digestibility. Researchers and nutritionists are constantly investigating new ingredients and processing techniques to make feed that maintains animal health and promotes good finish.

Mississippi State University senior Melissa Masters used her research fellowship to assist beef nutritionist Brian Rude and graduate student Jonathan Green of the MSU Department of Animal and Dairy Sciences in their performance study to incorporate dried distillers' grains into cattle feed. Rude and Green are completing their analysis of the results for publication.

"The producer is paid according to the weight of the animal," said Masters, a Louisville senior majoring in animal and dairy sciences. "If the animal is 500 pounds underweight from what it should be at the time of sale, the producer stands to lose money."

Distillers' grains are a dry, powdery byproduct of the fermentation of corn into ethanol. The substance is essentially the discarded protein, fat and carbohydrate particles of corn kernels. It also can contain fiber and sulfur, both of which can cause digestive problems in some animals. Because corn already is a key component of many livestock feeds, some nutritionists believe distillers' grains might be a good alternative if the corn supply becomes limited or more expensive to purchase.

Ethanol manufacturing in the United States has not been standardized, so the proportion of protein, fat, carbohydrate and fiber in the distillers' grains may vary from plant to plant. Researchers will need to examine the factors that affect the content of distillers' grains and to establish manufacturing standards.

"Distillers' grains are used for animal feeds in the Midwest," Masters said. "There are piles of it everywhere. But, all distillers' grains are not equal in terms of content."

For her research, Masters analyzed the content of distillers' grains with fractionation, a separation process in which a certain quantity of a mixture is divided into smaller quantities, thus

Photo by Marco Nicovich

changing the composition. Radhakrishnan Srinivasan of the MSU Department of Agricultural and Biological Engineering developed a process that separates distillers' grains particles based on bulk density and supplied the material for the project.

Some of these fractions may vary in the quality of the nutrients, thus reducing the digestibility when fed to cattle. Masters used particle size as a separation standard for some rations and combined various particle sizes for other rations. She then used specific tests to measure protein, fat and carbohydrate proportions in each ration.

"The smaller the particles of the feed, the more digestible they are to the animal," she said. "I noted the similarities and differences that will help formulate rations and assess digestibility in an upcoming feeding trial with distillers' grains."

During a break in school this spring, Masters traveled to the Midwest in hopes of gaining additional insight into the cattle industry. She spent a week working in the Nebraska sandhills, an area profuse with feedlots, dairies and cattle ranches.

"There were dirt roads for miles and miles with cattle everywhere," she said. "I was able to talk with beef producers about their nutritional needs and concerns. They also stressed the importance of comparing the money spent on feed with the value the feed may or may not bring."

Dulaney, Pote Help Team Lay Waste to Lignin Problem

Caleb Dulaney

Sam Pote

Some researchers think biomass, or plant waste, offers an unlimited supply of raw material for biofuel production. The problem that stands in the way of accessing these materials is lignin, a biopolymer that gives plant cells their structure and resistance to degradation.

If plants did not have lignin in their cells, they would not be able to stand. The cellulose and hemi-cellulose would be nothing but loose fibers. However, cellulose and hemi-cellulose are materials that can be converted to sugar for making fuel such as ethanol.

Many manufacturers are unwilling to perform the process needed to break down lignin in biomass because it is costly and complex. While some food crops, such as corn, soybeans and sugar cane, provide materials for making ethanol and other biofuels, the diversion of these important commodities to make biofuel puts a strain on the world's food supply.

Mississippi State University biological engineering undergraduates Caleb Dulaney and Sam Pote are determined to help the world rethink biofuel materials "one cell at a time."

"The problem with the current way of making ethanol is that resources are limited," said Dulaney, a senior from Collinsville. "The plant matter left over after harvesting can provide an almost unlimited resource for biofuel manufacturing."

The complexity of industrial breakdown of lignin arises from the requirement of harsh chemicals. This only adds to the constant waste disposal problems that industries face.

"If an accelerated biological process to break down lignin were possible, there is less of a problem for the environment," Dulaney said.

Dulaney used his research fellowship to work with Pote, a junior from Starkville, on a project with the MSU Synthetic Biology Team to isolate an enzyme-producing gene that helps degrade lignin.

The students' project received the bronze award in the 2008 International Genetically Engineered Machine (iGEM) competition sponsored by the Massachusetts Institute of Technology. The student project is being directed by biological engineering professor Filip To and biochemistry professor Din-Pow Ma.

"Dr. To heard about this competition 4 years ago, and he talked with several students before he went to MIT to observe," Pote said. "He brought back several ideas and after a great discussion, we decided to research alternative material sources for biofuel."

The white-rot fungus, often noticed on rotting wood, contains a peroxidase enzyme that contributes to lignin breakdown. Two other enzymes complete the process.

"We chose lignin-degrading peroxidase because it initiates the breakdown," Dulaney said. "The other enzymes break away the lignin from the plant material and further break up the material."

Marco Nicovich

The first step of the research was to isolate the enzyme-producing gene. The second was to introduce the gene into Escherichia coli bacteria, popularly known as E. coli, to reproduce it. Dulaney and Pote enlisted the help of graduate students Robert Morris and Meng-Hsuan "Victor" Ho to accomplish this goal.

"We were looking for a natural and environmentally friendly way to break down the lignin at a faster rate," Pote said. "Our work on the project allowed us to isolate the gene, slice out the DNA and basically have the bacteria eat the lignin."

The students said they enjoyed the research because they were able to focus on the engineering of a biological process, a concept both wanted to master.

"Our research project is definitely an indication that science and industry are giving more thought to moving away from petroleum-based energy," Pote said. "We feel like we have taken our first step to make people aware of the possibility."

TNT Breakdown Study is Dynamite for Knott

Erika Knott

TNT's impact when first used is immediate and forceful, but the explosive's long-term effect on the environment as it breaks down is unknown.

Mississippi State University junior Erika Knott used her summer research fellowship to work with a university laboratory conducting a comparative study of TNT degradates in organ tissue and body fluid.

Knott decided to major in biochemistry/forensic sciences because she enjoyed science in high school. She investigated several schools in the Southeast with such programs, including Louisiana State University, before choosing MSU.

"The Department of Biochemistry at MSU placed great emphasis on the chemistry component, which was what I wanted," she said. "When I visited Mississippi State, I loved the beauty of the campus, and I was offered a scholarship because of my scholastic achievements."

TNT, or 2, 4, 6-trinitrotoluene, is a yellow, odorless industrial compound classified as a secondary explosive. This hazardous material not only contaminates groundwater and soil, but at high doses, it also can cause serious health problems, such as anemia, liver dysfunction, skin irritation and cataracts. Microbes in the soil break down the compound into substances known as TNT degradation products. Little is known about the toxicity of these products.

Knott discovered that the toxicology laboratory at the University of Louisiana at Monroe was conducting a TNT degradation study funded through the U.S. Department of Defense and the U.S. Army Corps of Engineers. The location was advantageous for Knott, a Monroe native, who also hoped to find a summer job in her hometown.

"This opportunity allowed me to gain considerable experience in a laboratory and learn the basic investigative techniques that must be followed to ascertain what may be happening," Knott said.

The project supervisor, Sharon Meyer of ULM's Department of Toxicology in the College of Pharmacy, wanted Knott to have a good educational experience. She assigned Knott to assist with taking samples of liver, kidney and spleen tissue and blood. Knott then helped prepare the samples for analysis under the microscope.

"In taking a tissue sample, my first step was to preserve the extracted organ in paraffin," Knott said. "Then, I precisely cut slivers of tissue at small, specialized intervals on the organs for mounting onto glass slides."

She also mastered the technique of "H&E staining," which enhances visibility of cell content. This technique involves the applications of hematoxylin to delineate the cell nucleus and eosin to view the cell membrane.

"Once we stained the cells, we could examine the tissues for damage and correlate that with the presence of TNT degradate," Knott said.

Through these studies, Knott has shown that the TNT degradation products appear to be less hazardous to the environment than the parent TNT.

Knott hopes to enjoy a career as a forensic scientist with the Federal Bureau of Investigation. She said she wants to use scientific knowledge and analytical skills to help solve problems.

"Science is continually discovering how substances in the environment can affect living organisms," Knott said. "This knowledge will help us understand how to effectively remove these substances from the environment before they can do harm. It's our responsibility to use what we have to make a contribution to our world and make it better for others."

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