Continued from page 11

supercapacitors, with a carbon material derived from inexpensive biochar.

Using his background in chemistry and industrial coatings, Jin is investigating different methods of converting biochar to nanostructured carbon materials that can hold more energy. His dissertation will focus on developing biochar-based carbon materials for supercapacitors.

For a lithium battery, the carbon must have a relatively high graphene content, however, for use on the electrodes of a supercapacitor, “the carbon must have well-developed hierarchical pores,” Gu explained. The two devices can be used in combination—supercapacitors to capture the energy from wind turbines, for instance, and lithium batteries to provide stable, long-term storage.

The United States now imports most of its activated carbon from Asia—including Japan, Thailand and China—to manufacture these storage devices, according to Gu. “With America’s abundance of wood-based biomass and agricultural residue as raw materials, we can use those materials as biofuel so the U.S. does not have to depend heavily on petroleum, and at the same time, generate good active carbon to export.”

For a description of other SDSU technologies available for licensing, go to www.sdstate.edu/research/tto/technologies/index.cfm.

More technical information is available through Wili Aylor, director of technology transfer—wili.aylor@sdstate.edu or (605) 688-4752.
Exploring gene expression

In November 2008, scientists at Washington University in St. Louis, Mo., completed sequencing the corn genome, a mixture of 25,800 genes within 10 chromosomes. It is the third cereal-based crop for which this has been done.

Clay and her team use a method known as microarray analysis to document how environmental stressors change the ways in which genes are expressed. The researchers process and then tag the genetic material from the control and experimental groups with different fluorescent colors, so that they can identify which gene expression increased or decreased, according to Clay. These variations affect plant growth and yield.

Identifying these differences can mean sorting through anywhere from 60,000 to 100,000 possibilities. One graduate student and two research associate work on the project. Clay's husband, David, is the sole expert on the team.

Growing better among corn

To figure out how corn and weeds affect each other's gene response, Clay and her team planted plots of velvetleaf alone, corn with weed and control plots of velvetleaf and corn kept weed-free. The researchers saw an entirely different response when velvetleaf was grown with both corn and control versus corn planted alone.

The research team compared the corn's growth and yield in response to weeds, lack of nitrogen or shade. In all cases, Clay and Morrow found that genes were differentially expressed compared with nonstressed plants. Moreover, each stress resulted in very different expression patterns.

Traditionally, weeds have been thought to reduce crop yield and yield due to competition for water, nutrients and light. This study, however, indicates that weed-crop interactions are much more complex than researchers have thought.

When grown with weeds, genes that control the major facets of the corn plant's metabolism were decreased or down-regulated, according to Clay. These included its response to light, stimulus, the amount of chlorophyll it produces and its ability to convert raw materials into energy.

In short, these changes in gene expression adversely affect the plant's ability to grow and reproduce.

Having long-term impact

When the researchers started taking weeds out of the corn at early points, such as when the corn had as few as two and four leaves, they still see differences in gene expression when compared to corn without weeds. However, Clay pointed out, the amount of biomass—the stem and leaves—was not significantly different.

"The genes never recovered," said Clay, even after the weeds were removed. "The impact is long term," she added, which further builds the case for controlling weeds early.

These changes in gene expression can help explain instances in which the yield is unaltered, but a slight reduction has taken place in the plant which scientist cannot presently.

Now, the researchers looked at the effect of water stress on gene expression using corn planted on high and low ground. The growth of the water-stressed corn on the top of the field was down-regulated in terms of photosynthetic uptake, Clay explained.

In addition, the circadian rhythm, the internal clock that controls the operation of the plant's cells, was affected as well. This, in turn, affected the plant's wound response to make it more susceptible to pest injury.

Essentially, the water-stressed corn was getting older, faster," Clay said.

The researchers now "have a clearer idea of how that stress is affecting the plant," she explained. "We didn't have that ability before we had the genome sequence."

Refocusing on early control

The increasing emergence of herbicide-resistant varieties of weeds has refocused attention on weed control, according to Clay. For the last 20 years, glyphosate has provided an inexpensive, yet efficient, means of controlling weeds.

"Because we had such an easy control method, no one put money into research," said Clay, pointing out that the newest herbicides were developed decades ago. "My bet is that is going to change because we need new tools to get weeds out of the way we thought, where and when they need it."

And that, Clay explained, means "delicately using all the tools in our toolbox." Like many people in agronomy, she considers herself an environmentalist. "I want to help producers do the best job they can with the smallest footprint."

By understanding how weeds and environmental stress affect gene expression, scientists will have one more piece of the puzzle that will improve weed control and decrease crop damages.
Outlook

Research in South Dakota

Innovative research yields practical results for South Dakota

...Innovative research yields

In which to build bridges and test new building materials that withstand efficient ways to filter wastewater not only to provide for the needs of the nationwide obesity epidemic. South Dakota is one of five states in the nation with the highest obesity rate in preschoolers. With resolve and persistence, we can help keep this tide has begun to turn for some kids. This is the goal of the TO-P graduate certification program, which began in 2011, is supported by a five-year, $4.1 million grant from the U.S. Department of Agriculture and Food Research Development of the TO-P graduate certification program emphasizes the complexity of the obesity problem. "Our students learn with awareness and understanding of childhood obesity that is bigger than their own lives," said Montgomerie. Building the value of collaboration among disciplines early in their careers will help these young professionals take a difference in the lives of these children and their families.

Graduate research targets childhood obesity

"Although obesity remains epidemic, the tide has begun to turn for some kids in some states."

—Tom Friedman, director of the Centers for Disease Control and Prevention

A mercury contaminant in the air is a known to threaten children’s health, according to the American Heart Association. The National Collaborative for Childhood Obesity Research showed that obesity increases a youngster’s risk of developing arthritis by 60 percent. In addition, 30 percent of obese 5- to 17-year-olds have two or more risk factors for cardiovascular disease.

South Dakota was one of five states in which the childhood obesity rate decreased by 1 percent—which is 0.2 to 1.2 percent—between 2008 and 2011, according to the Centers for Disease Control and Prevention. As of 2017, South Dakota had the highest obesity rate in preschoolers. With resolve and persistence, we can help keep this epidemic, the tide has begun to turn for some kids. The program encourages children to eat healthier and be more active in order to reduce obesity.

"We are committed to childhood obesity rates that have been on the rise," saidquette. "We want to make sure that children have access to healthy foods and activities that can help them maintain a healthy weight.

"The TO-P graduate certification program focuses on training students to improve the health of children who are overweight or obese and to prepare them for careers in the field of childhood obesity," said Christiansen. The students are surprised at how much sugar a common sports drink contains. Below from left: Mid-schooler Emma Todey takes the treadmill test as doctoral student Corey Selland, undergraduate James Nordstrom and doctoral student Emily Huber help adjust the equipment that will determine the fitness level of Berg, center.

For more: Mid-schooler Emma Todey takes the treadmill test as doctoral student Corey Selland monitors her progress. The test is called "the gold standard." She completed the test in September and is currently serving as a student intern in the South Dakota Dietetics Program. The students are surprised at how much sugar a common sports drink contains. Below from left: Mid-schooler Emma Todey takes the treadmill test as doctoral student Corey Selland, undergraduate James Nordstrom and doctoral student Emily Huber help adjust the equipment that will determine the fitness level of Berg, center.

Research targets childhood obesity

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A merican parents cite obesity as the No. 1 threat to their child’s health, according to the American Heart Association. The National Collaborative for Childhood Obesity Research showed that obesity increases a youngster’s risk of developing arthritis by 60 percent. In addition, 30 percent of obese 5- to 17-year-olds have two or more risk factors for cardiovascular disease.

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Transmammary drug delivery system for early-stage breast cancer may reduce side effects

The 5-year survival rate for women with early-stage breast cancer is nearly 100 percent. More than 95 percent of breast cancer originates in the milk ducts.

One of every eight women in the United States will develop breast cancer that has spread beyond the ducts and lobules of the breast. Though the incidence of breast cancer began decreasing in 2010, it is still the second-leading cause of cancer death in women.

Better screening techniques, increased awareness and improved treatments have increased the 5-year survival rate to nearly 100 percent for women with early-stage cancer. In 2013, an estimated 176,000 women were diagnosed with carcinoma in situ, a noninvasive breast cancer that affects the milk ducts and lobules of the breast, according to the American Cancer Society.

While nearly everyone diagnosed at this stage can be cured, professor Om athanu Perum al, head of the pharmacological sciences department, pointed out that the side effects from the drugs used to combat this disease are pretty significant.

He and doctoral student Kaushal Kumar Dave are developing a new method to deliver cancer-fighting drugs directly to the milk ducts, where more than 95 percent of breast cancer originates. The protein-fueling technology has been licensed to Transderm Solutions, a Brookings-based start-up company. Perum al is the company’s chief scientific officer.

This method promises to reduce side effects and to deliver large doses of medication directly to the affected tissue. The research has been supported by the Translational Cancer Research Center, one of the Governor’s Research Centers. It provides seed money for high-risk, high-reward research.

Using this data, Perum al has teamed with researchers and clinicians from Johns Hopkins University and Mary Clinic to apply for an $800,000 Department of Defense grant.

Delivering drugs through milk ducts

Anticancer drugs, such as tamoxifen, are normally administered via oral tablet, so the medication must travel through the bloodstream before reaching the breast tissue, explained Perum al.

Side effects of tamoxifen, for example, include increased risk of uterine cancer, cutaneous, stroke and cardiovascular disease. Patients diagnosed with precancerous cells or lesions may take tamoxifen anywhere from three months to five years.

These significant side effects may be mitigated through a more direct, localized drug delivery method, according to Perum al.

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“Validating the model

Feedback from a proposal submitted to the National Institutes of Health confirmed that the researchers needed to use human breast tissue to prove the feasibility of the pig model.

“Animal skin is usually thinner and more permeable than human tissue,” Perum al explained. “We need repeatability.”

Pigs have an average skin-to-scan pair of mammary glands, but the team would need at least three pairs of human breasts—at a cost of more than $1,000 per set—to validate the model.

Fortunately, Perum al was able to obtain the human breast tissue he needed free of charge through the Lions Eye and Tissue Bank in Sioux Falls. Director Marcy Dimond said her organization provides tissue to qualified researchers and tissue banks, such as the one at the Lions Eye and Tissue Bank.

Not everyone can be a transplant donor, so this is a way those patients who truly want to be donors can contribute to research.

The donation of breast tissue was integral to advancing the project.

“Without them, we wouldn’t have made a lot of progress,” Perum al said. Having local access to tissue was “a big help to move things forward.”

Documenting similar trends

Comparing the absorption rate of the nipple with the surrounding breast skin, twice the amount of drug can be delivered through the nipple, Perum al explained. “It’s a direct port of entry. Plus, the medication does not enter the bloodstream.

Through different drug quantities are absorbed, pig and human breast tissue show similar trends, Perum al explained.

As a result, the researchers can now use pig tissue to optimize and test various drug formulations. Dave, who will finish his dissertation within a year, has already begun some animal studies. He recently received a grant from Women and Giving at the SDSU Foundation to support his work.

A variety of compounds show promise in fighting the many types of breast cancer. Perum al points to a natural compound—developed by former colleague and distinguished Professor Emeritus Chandrashankar Dey and the Lions Eye and Tissue Bank in Sioux Falls. Dey was awarded a grant from Women and Giving at the SDSU Foundation to support his work.

Top left to right: Compounds now used in the treatment of early-stage breast cancer and novel compounds developed at SDSU are being tested using pig breast tissue on this setup for side effects. The labs are repeated four times.

Doctoral student Kaushal Kumar Dave puts a buffer solution in the receiving vial.

Bottom left to right: The pig nipples are placed on the top of the receiver. The receiver skin is usually thinner and more perm edable than human tissue, “The researcher proposes applying a medication-containing gel to the nipple. The drug will then be absorbed through the openings in the nipples directly into the milk ducts.

When the project began, Perum al thought that breast anatomy was well understood, “but it’s not,” he explained. The number of openings in the nipple varies based on the individual, but the range is usually 10 to 15 openings per nipple. The number of openings gives the scientists an indication of how much drug can be delivered.

Next, the researchers looked at which molecules could be delivered. To do this, they used pig breast tissue. Surprisingly, they found that even large molecules, such as protein, can be transported through these openings, making a wide range of medications deliverable.

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Multiple hosts and pathogens

In addition, Yen must find out where the signal is coming from and how the fungus suppresses the gene expression. Only then can she research further how to prevent the disease from becoming epidemic.

Quantum head blight results from close interactions between the fungus and the host. We need to understand how this interaction is occurring and identify which step is the most susceptible to manipulation or control, he explained.

That will then allow researchers to determine how to rewire the fungus’s genes to prevent it from spreading and reducing its yield potential.

Scab resistance

Rice

The research is important because it may lead to resistance in our wheat varieties would not only prevent losses and reduce quality discounts, but also would save farmers billions of dollars and time invested in treating the disease, said S.D. Wheat Commission Chairman Clint Yen. "Fusarium spores survive winter in the plant debris. Two of the three genes are directly involved in the gene expression. These genes are functionally and structurally similar. However, they have different regulatory functions. They make the disease tough to control."

Researchers are working to develop resistant strains of grain, alter tillage practices and apply fungicides in the spring, vietnam, and how the fungus suppresses the gene expression. Only then can she research further how to prevent the disease from becoming epidemic.

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Palliative care improves quality of life for chronically ill patients

Nearly 90 million Americans are living with serious illness and end-of-life care. A number is predicted to double in the next 20 years. Seventeen percent of deaths in this country are caused by chronic conditions. In South Dakota, 45 percent of all deaths in 2011 were due to heart disease and cancer.

A palliative health care system can improve quality of life and significantly reduce healthcare costs for patients suffering from a range of conditions, including chronic disease. A study by the American Cancer Society, National Coalition of Hospice, Home Care and Pain Relief Organizations, reported that palliative care systems can significantly reduce Medicare costs by levels as high as 40 percent for high-risk patients.

In addition, the National Coalition for Hospice, Home Care and Pain Relief Organizations, reported a significant decrease in healthcare costs among patients facing end-of-life care. The study showed that patients in palliative care are more likely to have lower costs of care, with a decrease of 40 percent in medical costs per patient per year compared to those not in palliative care.

The researchers also found that palliative care systems can improve the quality of life for patients and their families. Palliative care systems can help patients manage symptoms, reduce stress and anxiety, and improve overall quality of life. In addition, palliative care systems can help reduce hospital readmissions and length of stay, which can result in significant cost savings for healthcare systems.

In conclusion, palliative care systems can improve the quality of life for chronically ill patients and significantly reduce healthcare costs. Palliative care systems should be considered an essential component of any comprehensive healthcare system.

Mary Hinton
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