Scientists to study plant 'switchboards'

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A new four-year, $3.72 million grant to North Carolina State University will allow researchers to shed light on an important mystery - how genes impact the type and amount of "glue," known as lignin, produced in trees. Understanding the role of lignin, which binds fibers together to form wood, has significant implications in the production of paper products, biofuels and construction materials.

The National Science Foundation Plant Genome Research grant will spur the most comprehensive analysis of lignin regulation ever undertaken. By triggering genetic "on/off switches" in more than 10,000 trees, researchers will determine how each of the 33 lignin-producing genes impact the type and amount of lignin in wood of the model tree species, black cottonwood.

"Additional lignin creates an even stronger wood, so having lots of lignin can be advantageous in developing construction materials or wood-burning energy. To create products like paper or to produce bioethanol, however, lignin needs to be removed from wood," says Dr. Vincent Chiang, Jordan Family Distinguished Professor for Natural Resource Innovation, co-director of NC State's Forest Biotechnology Group and the study's principal investigator. "Removing lignin to make paper products is the basis of a $300 billion global industry, and the efficient conversion of plant biomass to ethanol is largely determined by the lignin.

"To produce bioethanol from wood, lignin needs to be broken down by expensive chemical pretreatment," Chiang continues. "When we reduce

the lignin by modifying the genes, we can eliminate chemical pretreatment, which is typically 35 percent of the cost of producing ethanol from any lignin containing plant biomass."

To develop a more comprehensive understanding of the lignin biosynthesis pathway, researchers will eliminate each pathway gene, one at a time. Then the team will determine the role each gene plays in producing a specific type and amount of lignin. Finally, the information will be turned into a mathematical model to create equations that determine how to create specific types and levels of lignin suited for any particular end use.

"We're starting with lignin biosynthesis, but this 'systems approach' could really be used for any biological process in any plant," Chiang says. "It could guide strategies for improved plant productivity for materials, energy and food."

Working with Chiang is a group of 37 researchers, including co-principal investigators Dr. Ronald Sederoff, Distinguished University Professor and co-director of the Forest Biotechnology Group at NC State, Dr. Joel Ducoste, associate professor of civil, construction and environmental engineering at NC State, Dr. Fikret Isik, research associate professor of forestry and environmental resources at NC State, and Dr. John Ralph, professor of biochemistry at the University of Wisconsin-Madison. Graduate and postdoctoral education and training in systems biology is a major emphasis. Six graduate students will conduct part of the proposed research for their dissertations. In addition, outreach and education efforts will focus on under-represented groups at the university and high school levels. The Kenan Fellows Program for Curriculum and Leadership Development will develop curricular materials to bring cutting-edge plant genomics and systems biology to high school classrooms.

"This project represents the efforts of a group of people getting together and trying to develop systems biology by integrating individual work that has been carried out over a lifetime," Sederoff says. "We are using systems approaches that are typical of engineering, but that bring together biology from the perspective of developing predictive models. The integration of genomic and proteomic science to molecular biology to biochemistry to chemistry to statistics to wood products to predictive modeling makes this research really unique. This 'switchboard' approach will establish a new strategy for many future studies of biological processes in plants."

Source: North Carolina State University (news : web)