

The iPlant Collaborative

Taking plant biology into cyberspace

By Janni Simner and Susan McGinley



Richard Jorgensen, lead investigator and director of the iPlant Collaborative, surrounded by petunias used in gene expression studies.

The National Science Foundation (NSF) has awarded a University of Arizona–led team \$50 million to create a global center and computer cyberinfrastructure to answer plant biology’s grand challenge questions, which no single research entity in the world currently has the capacity to address.

The project will unite plant scientists, computer scientists and information scientists from around the world for the first time to provide answers to questions of global importance and to advance knowledge in all of these fields.

Dubbed the iPlant Collaborative, the five-year project is potentially renewable for a second five years for a total of \$100 million.

“This global center is going to change the way we do science,” says UA plant sciences professor and BIO5 Institute member Richard Jorgensen, who is the lead investigator and director of the iPlant Collaborative. “We’re bringing many different types of scientists together who rarely had opportunities to talk to one another before (see sidebar). In so doing, we’ll create the kind of multidisciplinary environment that is necessary to crack the toughest problems in modern biology.”

These problems, called “grand challenges,” go beyond regular scientific investigations because solving them requires huge increases in knowledge, along with major advances in technical capability.

Categories of grand challenges that the community might choose to focus on include, but are not limited to, questions such as how plants grow from a single cell into complex, multi-cellular organisms; how and to what extent plants can adapt to

environmental changes; how plants have evolved in the past and their potential to evolve in the future; and how plants live together with other organisms in ecosystems.

iPlant’s team of plant biologists, computer scientists, information scientists, mathematicians and social scientists will set about building a “Discovery Environment”—a cyberinfrastructure—to answer those questions in partnership with the community’s grand challenge teams.

The iPlant center will be located in and administered through the UA’s BIO5 Institute in Tucson. BIO5 was founded to encourage collaboration across scientific disciplines, accelerate the pace of scientific discovery and develop innovative solutions to society’s most complex biological problems. The iPlant Collaborative will create both a physical center and a virtual computing space where researchers can communicate and work together as they share, analyze and manipulate data, all while seeking answers to plant biology’s greatest unsolved mysteries.

Solving grand challenges in plant biology is crucial, Jorgensen says, because plants affect every aspect of our lives.

“Everything’s connected,” he explains. “As our climate changes and our environment changes we need to have a deep understanding of the biology of plants from the molecular to the ecosystem level in order to understand and mitigate the problems that will arise – to adapt as best we can and to focus our efforts on saving the organisms and ecosystems that are most important to save.”

The collaborative is designed so that any research team from any consortium of institutions or disciplines can propose a grand



challenge question. iPlant will facilitate the identification of such questions by the plant biology community (two to four the first year) and develop the iPlant cyberinfrastructure to help scientists answer those questions.

Their approach will rely heavily on computational thinking, a form of problem-solving that assigns computers the jobs they're most efficient at, and in doing so frees up humans to spend more time on the creative tasks that humans do best. The iPlant cyberinfrastructure will serve as a model for solving problems in fields outside of plant biology, too.

One feature of iPlant that will be developed is the ability to map the full expanse of plant biology research in much the way that Google Earth physically maps our planet through a series of zoom features. Users of iPlant may one day be able to zoom in and out among various levels of plant biology, from individual cells and molecules to entire organisms and ecosystems.

For example, a researcher might zoom in to analyze the carbon fixed, oxygen produced and water utilized by individual leaves, then zoom out to analyze how all of these might affect large-scale changes in ecosystems and how that could in turn affect air quality and climate.

Because collaboration among disciplines is central to iPlant's mission, the cyberinfrastructure also will have a strong social networking component (similar to Facebook), for facilitating communication among researchers from different fields as they work and for researching the effectiveness of social networking in iPlant and in the plant and computer and information sciences generally.

All iPlant projects will include a full range of school curriculum components as well, which are co-funded by NSF, BIO5 and Science Foundation Arizona. Students, teachers and the public will have access

to iPlant's resources and data, as well as to educational tools designed to help them understand that data and develop inquiry-based learning modules for K-12, undergraduate and graduate science education.

"The learning activities that will evolve from the iPlant collaborative will bring the challenges of real-world problem-solving and discovery to the classroom for both students and teachers. Science Foundation Arizona's investment will ensure that Arizona students are engaged from day one," says William C. Harris, president and CEO of Science Foundation Arizona.

BIO5 Director Vicki Chandler, also a lead investigator, explains, "Because of the Internet and cyberinfrastructure, this is the first time in the history of science that everyone can access the same data at the same time using the same tools as the researchers generating that data. The exciting challenge is to produce tools that students and teachers can readily access."

Each proposed grand challenge question will have practical applications and societal implications. For a field like plant biology, those implications are many and far-reaching. "Human existence on this planet is absolutely dependent on plants," Chandler says. "Our houses, our food, our atmosphere – everything about the quality of human life depends on plants." ★

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Institutions working with the UA's BIO5 Institute on the iPlant Collaborative include Cold Spring Harbor Laboratory (CSHL) in New York, Arizona State University, the University of North Carolina at Wilmington and Purdue University. The project's board of directors will be chaired by Robert Last, from Michigan State University.

About 79 percent of the \$50 million grant—the largest NSF grant in Arizona history—will stay at the UA, with CSHL receiving approximately 16 percent, ASU four percent, and UNCW and Purdue a combined one percent.

UA participants in the iPlant Collaborative include BIO5; the College of Agriculture and Life Sciences' Department of Plant Sciences; the College of Science's Departments of Computer Science, Mathematics, and Ecology and Evolutionary Biology; the Eller College of Management's Department of Management Information Systems; the College of Engineering's Department of Electrical and Computer Engineering; the Arizona Research Lab's Biotechnology Computing Facility; and University Information Technology Services.

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