Using every tool in the kit: a story of diversification enabling innovation

JENNIFER NEMHAUSER

Professor, 2016 HHMI Faculty Scholar, Department of Biology, University of Washington

Jennifer Nemhauser is interested in plant growth networks, and in particular in the small-molecule triggered signaling pathways that integrate information from the environment, developmental programs and metabolism. Jennifer started her research career as a technician in Eric Lander’s lab (then at the Whitehead Institute)—an experience that imprinted her with a love for science that draws together new technology, quantitative approaches, and questions about how genotype is translated into phenotype. As a graduate student at the University of California with Pat Zambraski, Jennifer got hooked on the big question of how cells figure out where they are during development. She discovered that the plant hormone auxin played a pivotal role in relaying this type of information in a highly context-dependent manner. Her postdoctoral work with Joanne Chory at the Salk Institute allowed Jennifer to use first-generation genomic tools to begin to build an organismal, integrated view of plant hormone signaling, environmental responses and development. This adventure continued when she began her own lab in 2006, and took a surprising turn when her group, in collaboration with UW Electrical and Computer Engineering Professor Eric Klavins, recreated auxin signaling in yeast. A major focus of Jennifer’s lab today is to use plant parts to program core signaling functions in yeast, and then to use this information to rationally engineer crops. In the process, she hopes to learn a great deal about the principles shaping cell signaling networks and how evolution has re-wired these programs. Alongside her research questions, Jennifer is investigating how social and institutional systems shape the way scientists frame, analyze and disseminate their findings.

The Evolution of G Signaling

ALAN JONES

Kenan Distinguished Professor, Department of Biology, University of North Carolina at Chapel Hill

Alan Jones’ expertise is signal transduction with emphasis on plant cells. He introduced the genetic model Arabidopsis to the G protein field in 2001 with two high impact papers showing the role of G signaling within a biological context (Science 292:2066 and Science 292:2070). Remarkably, even after 30 years of G protein research and 10 Nobel Laureates in this field by the time those two papers were published, nearly all G protein research had been done with simple cells (ex vivo) or with yeast; there was no multicellular context to place the function of G proteins. The knock-out mouse was not yet routine by 2001 therefore Jones’ rationalization was to use Arabidopsis, particularly since the G protein repertoire
was vastly simpler than in the mouse. Two major discoveries came soon after. Jones Lab discovered that plants had a self-activating G protein (PNAS 104:17317) and a receptor RGS (Science 301: 1728). Jones Lab later showed that signaling through this system architecture was not threshold based, rather dependent on both dose and duration of the signal (Cell 156: 1084).

**Do plants feel pain?**

**SIMON GILROY**

*Distinguished Professor, 2018 Emil H Steiger Awardee, Department of Botany, University of Wisconsin-Madison*

Simon Gilroy received a Ph.D. in Plant Biochemistry from the University of Edinburgh, U.K. followed by postdoctoral research at the University of California-Berkeley. In 1993 he became an Assistant professor in the Biology Department at Penn State and in 2007 moved to the University of Wisconsin-Madison, where he is currently a professor in the Department of Botany. Prof. Gilroy’s research program is focused on defining the cellular and molecular machinery that plants use to sense the world around them and then how these signaling networks trigger adaptive responses. His team has studied plant sensory systems related to stimuli as varied as touch and the direction of gravity, to pathogen attack and wounding. The work on wounding in particular has led to a new understanding of how internal cellular signals related to changes in calcium propagate throughout the plant to preemptively trigger defenses. He is also leading a team of researchers evaluating how plants respond to the uniquely stressful environment of spaceflight. His group has sent several experiments to the International Space Station to assess how plants can be adapted to factors such as the lack of gravity and increased radiation in space. These findings are helping space agencies such as NASA define how plants react to spaceflight and so how they might be incorporated into life support systems for long-duration space missions.

**Chemical signaling in plant defense**

**PRADEEP KACHROO**

*Professor, 2014 Noel Keen Awardee, Department of Plant Pathology, University of Kentucky*

Prof. Pradeep Kachroo received a Ph.D. in Microbiology from the University of Baroda, India. A portion of his dissertation research was conducted at the University of Wisconsin, Madison, through a graduate fellowship from the Rockefeller Foundation. He then moved to be a post-doctoral scholar at the Swiss Federal Institute of Technology (ETH) in Zurich, the Waksman Institute of Microbiology at Rutgers University, and the Boyce Thompson Institute at Cornell University. He joined the faculty of the University of Kentucky in the Department of Plant Pathology in 2002, where since 2013, he is a full professor. His work has significantly contributed to our understanding of signaling pathways regulating host-pathogen interaction. His group uses Arabidopsis as a host model and to study molecular, genetic and biochemical mechanisms governing response to infection by various different microorganisms.
His work made multiple advances that are foundational to our understanding of plant disease resistance. He is a recipient of the Noel T. Keen Award for Research Excellence in Molecular Plant Pathology.