Robert (Rob) L. Last

How did you spend your career?

After receiving a bachelor's degree in organic chemistry and organismal biology at Ohio Wesleyan University, I conducted predoctoral research on baker's yeast pre-mRNA splicing mutants and proteins in John Woolford's group at Carnegie Mellon. My plant biology research career began in 1986 in Gerry Fink's group at the Whitehead Institute for Biomedical Research at the Massachusetts Institute of Technology (MIT). Those were the early days of using the "awesome power of genetics" with *Arabidopsis thaliana,* and my approach was to apply the experimental philosophies of microbial biochemical genetics to this plant. The tryptophan pathway was the focus of this research, because—in addition to being an essential amino acid—the pathway contributes to biosynthesis of auxins and specialized metabolites that defend plants from biotic stress and are important in medicine.

In 1989, I started an independent career at the Boyce Thompson Institute (BTI) at Cornell, where my focus expanded to understanding metabolic networks that protect plants from the environment. This included UV-B avoidance and repair mechanisms (phenolics and DNA damage repair) and the antioxidant ascorbate (Vitamin C) biosynthetic pathway.

By the mid-1990s, genomics technologies were revolutionizing biology, and I wanted to get involved. Starting in 1998, I assumed a science director position at Cereon Genomics LLC, the emerging genomics discovery and technology arm of Monsanto. We developed a large collection of randomly generated mutant families, which we screened for a wide variety of phenotypes, including tocopherol (Vitamin E) defects, glucosinolates, and stress tolerance mutants, identifying the underlying genes by map-based cloning.

After a 1.5-year stint as a program officer at NSF, I took my current position at Michigan State University (MSU). I brought the philosophy of screening a massive mutant collection to MSU, where a group of collaborators screened thousands of homozygous T-DNA mutants for qualitative and quantitative phenotypes associated with plastid biology (the Chloroplast 2010 Project). In parallel, the laboratory developed a strong collaborative project beginning with Eran Pichersky at University of Michigan and Dan Jones at MSU. This work focused on specialized metabolism in trichomes across the whole Solanaceae family (nightshades). We no longer work on a model species using induced mutations, but rather a model family and evolutionary diversity across >50 million years of evolution.

What do you consider to be your most important contributions to plant science?

The first response that comes to mind is application of genetics, biochemistry, and genomics to understand how plants use metabolism to survive in a hostile environment and secondarily provide benefits to humans. At MIT I identified the first sexually transmitted amino acid auxotrophic mutants of any plant, and at BTI we used these mutants and molecular biology to understand the tryptophan biosynthetic pathway and its regulation in response to stress. We were among the very first to take genetic approaches to dissect plant abiotic stress tolerance. For example, we broke with convention and showed that flavonols are not particularly good UV-B protectants, whereas hydroxycinnamates are. We dissected Vitamin C biosynthesis by identifying ozone-sensitive mutants and then used these ascorbate-deficient mutants to understand the crucial roles of Vitamin C in protection of plants against biotic and abiotic stress.

My groups have also contributed to technology development and early adoption. At Cereon we did the first shotgun sequencing of a plant genome by achieving a whopping 1.5-fold coverage of

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Arabidopsis Landsberg *erecta* using Sanger sequencing. This was the first use of this now very common resequencing strategy. Thanks to the leadership of Steve Rounsley and others, Monsanto made the polymorphic markers available to the community, supercharging map-based cloning in hundreds of labs around the world. It may be difficult for those who did not work in the pregenomics era to believe that until recently, mapping experiments were marker limited (rather than recombination limited)! At Cereon and MSU, our early adoption of what is now called phenomics transformed the way we did forward and reverse genetics.

These days we are back to the philosophy that intensive dissection of a single biosynthetic pathway can be used to study many themes in biology. In fact, we are taking it one step further, studying a single pathway (biosynthesis of protective acylated sugars) in one cell type, the apical cell of glandular trichomes. These metabolites are on the plant surface, simplifying phenotyping, and trichome transcriptome analysis greatly enriches for the enzymes that we are studying. Rather than using a single model organism, we take advantage of the phenotypic and genetic diversity along with experimental tools available in the Solanaceae to reconstruct the evolutionary history of acylsugar metabolism. Working on a phenotypically diverse metabolic network in a plant with a well-developed taxonomy and great structural and functional biology tools allows us to derive information about enzyme structure and function along with metabolic pathway evolution over hundreds of thousands to tens of millions of years of evolution. We are still having fun!

When did you become a member of ASPP/ASPB?

In the 1990s.

How did the Society impact your career, and what was your motivation for becoming a Founding Member of the Legacy Society?

The Society has been central to my professional identity and development since I began studies of plants in the late 1980s. Publishing in the journals and attending the annual meetings and some smaller ASPB-sponsored conferences provided early opportunities to communicate our science and have our work become known to a wider community. Volunteering for varied committees, including the Publications and Science Policy Committees, expanded my view of the broader professional ecosystem in which plant biology operates. Service is important to me, and ASPB enables members to serve our community while promoting high-quality science.

My primary reason to donate generously to the Legacy Society and more broadly at ASPB is to enable good works that benefit early career community members and professionals from groups underrepresented in science. I have lived a privileged life and now have the means to be charitable: what better way to give back than to pay forward? The Legacy Society endowment income will be used to help ASPB continue doing good works beyond my career and life. I am especially enthusiastic about supporting travel awards for young people to attend the annual meeting through travel grants and funding for undergraduates to perform authentic research at their home institutions.

What important advice would you give to individuals at the start of their career in plant science?

You are really lucky: this is a career in which you can still be challenged and happy to go to work more than 40 years after your training began. That kind of longevity of happiness requires that you choose questions and problems that you find very interesting and that you be willing to change topics and approaches over time. It helps to be trained broadly, and not only in the hot new technology of today, which will become a cooled-off fad next year or in a decade (e.g., microarrays and gene chips were transformative and now are historical). Although we cannot each be an expert in all topics, it is crucial to have a firm grounding in fundamental biology, including areas of microbial and animal biology. Go to seminars and read papers in areas that you did not know about, and talk to your friends about what you liked and would have done differently. This goes for both the substance of the work and the style of communication that was used: *how* you communicate is nearly as important as *what* you communicate. Try to make your science writing and verbal commu-

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nication understandable and exciting to first-year PhD students: if you do this, you are teaching rather than just listing results.

Some other advice:

1. Create and maintain a vision for where you wish to be in one, three, five, and 10 years. Think big, and act toward your goals one step at a time. An annually updated individual development plan, developed with mentors and friends, is one way to do this.
2. Pay attention to what the crowd is doing, and focus your energy on cool stuff that others do not know about or are ignoring.
3. Volunteer to participate in activities that will extend your experiences, take you in directions that move you toward your goals, and benefit the local and broader community.
4. Do not be afraid of change: you could learn more in the first six months of a brand-new job or research project than during the next five years in the same one.
5. Do activities that promote your physical and emotional well-being, including taking time off to recharge, staying physically fit (believe me, this gets harder every year), and helping others achieve their goals.

Academic Family Tree

https://academictree.org/chemistry/tree.php?pid=98275