Jerry D. Cohen

How did you spend your career?

My research career began early, as I was lucky enough to explore undergraduate microbiology studies at the University of California, Riverside, by working in labs and in the field. My undergraduate adviser, E. Crellin Pauling, and mentor, John A. Moore, provided an early introduction to science through asking seemingly unanswerable questions. Research experience in neurobiology, chloroplast function, and field botany gradually converted me from a microbiologist to a biochemist with interests in plants.

Finding a place that would accept both my wife and me led to an MS degree on acid growth and cell walls with Ken Johnson and David Rayle at San Diego State University. They encouraged me to pursue a PhD, and I was fortunate to be accepted at Michigan State University (MSU), where, after rotations with Derek Lamport and Ken Nadler, I joined Bob Bandurski's lab. MSU in general, and Bob's lab in particular, were exciting places to be in the 1970s as the combination of advances in analytical methods and mass spectrometry, coupled with exciting developments in molecular biology, would come together to define my career. After finishing my PhD in 1979, and the birth of my son Aaron shortly thereafter, I decided to stay at MSU as a postdoctoral scholar supported by the U.S.–Israel Binational Agricultural Research and Development Fund to continue working with Bob and help with expansion of the mass spectrometry facility.

By 1981, I had decided to move on and accepted a postdoctoral position with Clinton Ballou at UC Berkeley, using mass spectrometry to study complex molecules. However, fate intervened when Bob and Mark Brenner dined with Morris Lieberman from USDA–ARS during the ASPP/CSPP meeting at Université Laval in Quebec. They discussed the newly formed USDA Plant Hormone Lab, and I was soon offered a permanent USDA–ARS position. Tragically, only two months after I arrived in Beltsville, Maryland, Morris passed away, and what had seemed like a well-mentored path soon became one with unwelcome challenges. Nevertheless, fueled by some wonderful colleagues I was able to attract to the program, over the next few years my vision of the lab's scientific future began to come together. First, Morris had brought Krystyna Bialek-Kalinski to the Plant Hormone Lab, and she soon joined my program. Next, Janet Slovin took on the challenge of joining our lab, bringing molecular biology, modern genetics, and a love of model systems to a federal system not ready for any of them. Both Janet and Krystyna had years of prior experience, and together we worked as a trio, with Krystyna pushing ahead on the analytical front and Janet developing new molecular approaches. USDA–ARS Beltsville did not have a strong relationship with our neighbor, the University of Maryland, but I was fortunate to become an adjunct faculty member in the Botany Department (later Plant Biology and eventually Cell Biology and Molecular Genetics). Largely through a close relationship with Todd Cooke, I was able to educate seven PhD students who benefited from the experiences offered at the two institutions.

Scientifically, this was a wonderful adventure, in which we were developing new stable isotopic methods and applying them to measure metabolic flux in novel mutants. This pushed us into new ways of approaching auxin biochemistry. We had a level of independence through solid grant support from NSF, DOE, and later USDA. Methods we pioneered drew attention from colleagues around the world, and we developed collaborations that have endured. We made significant progress in studies on auxin conjugation and in the then-new area of auxin biosynthesis. USDA–ARS Beltsville, however, was not a happy place, and this impacted our stress level, our

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creativity, and our ability to expand our vision.

So when I was accepted into a "midlevel" scientific management program by USDA in the early 1990s, I took some time away from the lab, which turned out to be an important step in my science policy education. In 1998, I was granted a one-year leave to pursue a management experience, and with Machi Dillworth as my guide, I was able to join NSF as a program director for cell biology. After six months, I was promoted to deputy director for the Division of Molecular and Cellular Biosciences, and NSF arranged an extension of my leave from USDA. This management experience taught me many important lessons, the most important of which was that although I truly loved doing the important work of NSF, my passion remained with bench science and education of the next scientific generation.

On the first day of January, 2000, I moved to the University of Minnesota and accepted the Gordon and Margaret Bailey Endowed Chair in the Department of Horticultural Science. I didn't forget NSF, however, and returned there twice over the next few years. Those NSF experiences were critical for the next step in my scientific career, as I could see that the mass spectrometric approaches we had developed to study plant signaling systems could be applied more universally to investigate protein and metabolic flux. As I was making these realizations, the same ideas were developing at the University of Minnesota, and new colleagues with proteomics and metabolomics experience and interests joined the faculty. My decision to move to the University of Minnesota has been a happy one, and the capstone to my career.

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

My PhD research resulted in some advances in analytical methods and the isotopic labeling necessary to make progress in understanding the biochemistry of indole-3-acetic acid (IAA) ester conjugates. The fusion of chemistry and biology, no matter whether you call it biological chemistry or chemical biology, was important for taking advantage of the progress in molecular biology and, later, genomics. Thus, I would say that on the analytical side, our development of stable isotope dilution mass spectrometry methods and compounds (such as [$^{13}C_6$]IAA, [^{13}C]IBA, and labeled conjugates), improvements in solid phase extraction, microscale analysis, and measurement of metabolic flux were significant. More recently, high-resolution mass spectrometry methods, stable isotope methods in proteomics and metabolomics, and the design and use of chambers for growing plants in [^{13}C]CO_2 are quite important.

These chemical advances facilitated a number of discoveries in auxin biochemistry. In the 1980s, we began to form collaborations with geneticists, hoping to find mutants that would help replicate the advances seen with gibberellins. This paid off in our collaborations with Gerry Neuffer, Allen Wright, Gerry Fink, and Jennifer Normanly. Together with our metabolic flux measurements in *Lemna,* use of the maize Orp tryptophan auxotroph, and use of tryptophan synthase mutants in Arabidopsis, we showed via in vivo and in vitro measurements that plants unable to make tryptophan were able to make IAA. Nevertheless, it was clear that tryptophan was an important auxin precursor, and solutions to how it was alternatively synthesized required genetic and analytical studies. Yunde Zhao, in Joanne Chory's lab, had an interesting activation tagged line, YUCCA, that looked to be an IAA overproducer, and we were able to confirm that by isotope dilution analysis. How YUCCA fit into the IAA pathway, however, required additional information that was provided in a collaboration with Paula McSteen, and together we showed that *vanishing tassel2,* a tryptophan amino transferase, was part of the same pathway as the maize monooxygenase *sparse inflorescence1*. This finding was quickly confirmed by several labs working with Arabidopsis.

During my PhD studies, I developed a "double standard" approach to IAA analysis that resulted some years later in the discovery by gas chromatography mass spectrometry that indole-3-butyric acid (IBA) was actually a naturally occurring auxin-related compound. Collaborations over my career with, for example, Ephraim Epstein, Jutta Ludwig-Müller, Gary Gardner, Bonnie Bartel, and Lucia Strader, as well as graduate students in my lab, have shown that IBA is present in numerous plant species, has its own transport mechanism, and is primarily active

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only after it is converted to IAA *in planta*. Finally, we have identified multiple amide auxin conjugates native to plants, including IAA and 4-Cl-IAA proteins, and we showed that a number of these, including IAA-aspartate and IAA-glutamate, are sources of IAA *in planta*.

When did you become a member of ASPP/ASPB?

I became a member of ASPP in 1974, when I attended the annual meeting at Cornell University. I was there with my MS adviser, Ken Johnson, who had prepared me well for my talk. Nevertheless, when I went to my session and the slide projector stopped working, I started to worry. It was repaired in time, luckily. Ken had paid my way to the meeting with lab funds, but we lacked funds to pay for his travel as well. I was concerned about this, but Ken simply said that when I had students, I should remember the example. I most certainly do.

How did the Society impact your career, and what motivated you to become a Founding Member of the Legacy Society?

ASPB has had a major impact on my career as my primary professional society. It provided me with an early introduction to senior colleagues, a forum for presentations, and the opportunity to serve on the editorial board for *Plant Physiology* and on the Executive Committee. Most importantly, ASPB's congressional advocacy has been critical to solidifying grant support at the federal level. Thus, I was pleased to become a member of the Legacy Society.

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

If you complete a PhD in science, you have already worked hard, and no matter what track your career takes, you will always need to keep working hard, hopefully at something you will love more each year. My advice is to follow your love for science where it takes you and to remember that you have two main goals: discovery of new knowledge and education of a new generation. Many people can do experiments, but the real goal should be to design each study both to be excellent science and to have that special beauty of creativity that makes everyone appreciate the work you have done.

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