ASPB Pioneer Member

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How did your career get started?

Born in East LA! I begin my biography with the title of this movie and song by Cheech Marin because it describes my origins, and my background has had a major impact on my life and career.

I grew up in East Los Angeles and attended Garfield High School. Garfield High is what used to be called an inner-city high school, characterized by a student population that was greater than 90% Chicano/Chicana, reading scores that ranked in the bottom 25% of high schools in the nation, and a greater than 50% dropout rate. Not surprisingly, the quality of my secondary education largely reflected this environment. However, I would be remiss to note that long after I graduated, Garfield High School became famous for an academic achievement because of a math teacher and the movie "Stand and Deliver". The movie describes the efforts of Jaime Escalante, who taught Advanced Placement Calculus so effectively that all 18 students who took the AP exam passed. However, because the students were from Garfield High, the Educational Testing Service did not accept the test scores and required 14 of the students to retake the exam - and all of the students passed the exam again. Not bad for kids from Garfield High.

For college, I applied to and somehow managed to be accepted to UCLA. Although UCLA was only about 20 miles from Garfield High, it was, seemingly, thousands of miles away academically. I am a first-generation college graduate, although not the first in my family to attend college - that milestone belongs to my older brother, Michael, who also went to UCLA. When I arrived at UCLA, Mike told me, "This place is so hard - be happy if you get C's in your classes." So as not to disappoint my brother, I did receive lots of C grades, mainly because I spent my first couple of academic quarters reading remedial textbooks to try to learn all of the things that I did not learn at Garfield High. I eventually realized that I did not have to get C's. Once I caught up, I reasoned that if I actually studied and worked harder than the other students, something I rarely did at Garfield, I could learn and earn A grades. The experience that taught me resilience.

When I entered UCLA, I knew I was interested in biology, but without role models nor ready exposure to potential career tracts, my path forward was unclear - until I took a biochemistry class. I recall sitting in class listening to my professor, Dr. Charles A. West, and coming to the realization that much of life could be explained simply as directed chemistry. This epiphany was so striking that I went to Professor West's office hours - the first time I ever met with a professor - to confirm that this revelation was correct. After asking how I could learn more about biochemistry, he invited me to conduct undergraduate research in his laboratory. And I was hooked!

Professor West's research focused on diterpene metabolism in plants, and my project was to synthesize an affinity chromatography column to isolate a biosynthetic enzyme. Although I did not complete the project successfully, I learned to use the literature to research topics, to conduct experiments in the laboratory, and to live the life of a graduate student, including attending lab meetings, meeting with the "boss", and working late into the night. This experience helped me to decide to apply to graduate school in biochemistry to learn more about the discipline and to work to improve my grades so I would have a chance to be accepted into graduate school. I even managed to graduate from UCLA with honors - not bad for a kid from Garfield High.

I applied to graduate schools in biochemistry and chose to enroll at the University of Washington at Seattle. My primary rationale was that I thought UW would provide me with the best training in biochemistry. One reason was that UW emphasized a broader biological interpretation of biochemistry as compared to other graduate programs which were often more chemistry oriented. The second was that many of the programs offered at UW Biochemistry were geared to student training, including laboratory rotations and classes to teach incoming students how to read research articles critically.

I chose Dr. David R. Morris as my

major professor, and he provided me with excellent training in conducting research. I learned how to design experiments, including the importance of controls and standards, how to interpret experimental results critically, and how to draw appropriate conclusions from the results. I also learned how to disseminate scientific findings effectively, both in written and oral presentations. I note that I studied the control of cell proliferation in mammalian cells and not a topic in plant biology as a graduate student. I often discuss my career pathway with students to emphasize that what you study in graduate school does not have to be what you study for the rest of your life. Rather, the most important outcome of my graduate school career was that I learned how to "do" and communicate science rigorously and effectively, and this outstanding training allowed me to transition readily into a different discipline - plant biology.

As I approached the completion of my Ph.D. research, I needed to make a decision about my career path. I enjoyed conducting laboratory research, but I was not sure of the venue at which I should conduct research - academic, industrial, government, or others. I also enjoyed my experience as a teaching assistant, so classroom teaching was also attractive. I decided that obtaining a postdoctoral position would allow me to gain further research experience and to consider different career options.

With apologies to the Fifth Dimension, this point in time was the "dawning of the age of" molecular biology; scientists were first learning how to clone and analyze genes. Given my experience with plant biochemical research with Professor West at UCLA and my interest in this emerging discipline, I decided that I wanted to study plant molecular biology. I chose Professor Robert B. Goldberg's lab, in part, because I was told it was one of the best plant molecular biology labs in the world. But also, Bob was at UCLA, and I would be able to return to California.

Being in Bob's lab was the best learning experience of my life. Although I had excellent technical training in conducting scientific experiments, I learned to focus on designing, conducting, and interpreting experiments to answer biological questions. This training has served me well throughout my career. Bob is a master communicator, and my writing and speaking skills were enhanced immensely under his mentorship. These skills have been instrumental in advancing my career. And the science was exciting! We studied the molecular basis for storage protein accumulation in developing soybean seeds. We were among the first to clone plant genes, to show that plant genes have introns, without DNA sequencing, to demonstrate that storage protein genes are regulated at the transcriptional level, to characterize gene families, and to demonstrate physical linkage among gene family members.

When it came time for me to find a "real" job, I knew that I wanted to continue conducting cutting-edge research, but I needed to decide on the venue. I explored opportunities at biotechnology companies and universities and ultimately decided to pursue an academic career. Although the resources and expertise available in companies are amazing, I wanted to dictate the topic and direction of my research. Of equal importance, I wanted to have the opportunity to teach in the classroom.

Molecular biology at this time was a "hot topic", and universities, particularly those with an agricultural emphasis, were interested in hiring a plant molecular biologist. As one of the few postdoctoral scholars with training in plant molecular biology, I had several offers. Although my pathway was serendipitous, I have often suggested to my students that they employ a similar strategy, particularly those interested in academic careers. That is, within the area of their research interests, I encouraged them to obtain training as a postdoctoral scholar in the topics and/or experimental approaches that were likely to be a "hot topic" in five years or so. This approach has the potential to place them in a favorable position to obtain a position at the end of their tenures as postdoctoral scholars.

I ultimately selected UC Davis for three reasons. First, collectively, the UC Davis faculty possess tremendous depths and diversity of expertise in plant biology and agricultural sciences. Given that I did not have a strong background in plant biology, I knew that having ready access to this expertise would be helpful. Second, the Department of Botany to which I was recruited is one of the top ranked units in the country, and it had and has an excellent reputation with many excellent faculty. Third, the "C" in UC Davis is an abbreviation for California, and it was my strong preference to remain in the state.

UC Davis and the Department of Botany, now the Department of Plant Biology, provided an extremely supportive environment. They were generous in providing the resources needed to set up my laboratory,

especially given that most of the equipment needed for molecular biology experiments was not available, and to establish my research program. UC Davis also had and created research facilities that allowed faculty to conduct studies using state-of-the art experimental approaches. However, what turned out to be the most valuable resource were my colleagues, both within and outside of my department. There is a very strong tradition of collaboration, both formal and informal, among UC Davis faculty in different departments and colleges. Many, many individuals who served as collaborators, mentors, role models, and friends were instrumental in helping to guide me through my career. Ultimately, all of this resulted in a 38 year career at UC Davis doing a job that I loved - at least most of the time. Not bad for a kid from Garfield High.

What do you consider your most impactful contribution to plant science research?

I believe strongly that it is for others to judge my most impactful contribution to science. I will, however, discuss three broad professional areas about which I am passionate and for which I have tried to make contributions that advanced the scientific community.

The first area is my research which focused on seed development. A major reason for my passion to study seed development is because it is an elegant developmental system. The seed is comprised of three different regions with distinct genotypes, embryo, endosperm, and seed coat, and each region is further compartmentalized into tissues and cell types. Ultimately, growth of the seed requires the coordinated development of these different compartments. Seeds development is also divided temporally into two phases. During the early morphogenesis phase, regional specification and the establishment of domains, tissues, and cell types occurs. This is followed by the maturation phase during which storage reserves accumulate to massive amounts and the embryo becomes tolerant of desiccation. My overarching goal has been to obtain a mechanistic understanding of the processes that underlie the spatial and temporal development of the seed. A second rationale is that seeds are a key to agriculture, providing the majority of calories consumed by humans. My hope is that information derived from my studies of seed development may contribute to strategies to improve crop plants.

As a postdoctoral scholar, I studied processes that occur during the seed maturation phase by studying the organization and expression of soybean β-conglycinin storage protein genes in Bob Goldberg's lab. We showed that members of this complex gene family are differentially expressed and regulated at the transcriptional and posttransciptional level, and that they are physically linked in the genome.

When I started my lab at UC Davis, I studied the transition from embryogenesis to seedling development. A major emphasis was to examine the processes that govern the conversion of unspecialized peroxisomes to glyoxysomes, organelles that play major roles in the metabolism of storage lipids into sugars after seeds germinate. Using the experimental approaches of molecular and cell biology, we showed that the onset of glyoxysomal function is dictated by the transcriptional activation of glyoxysome-specific enzymes and not by the selective import of these enzymes into peroxisomes.

The next phase of my research program involved a collaboration with Professors Bob Goldberg, Robert L. Fischer of UC Berkeley, and Gary N. Drews of University of Utah known as the Seed Institute. Collectively, we used molecular genetic approaches to identify and analyze genes that are required for embryo and seed development. My lab focused on the *LEAFY COTYLEDON* genes, *LEC1* and *LEC2*. We cloned these genes and showed that encode transcription factors that are key regulators of seed development, particularly in regulating the transition from the morphogenesis to the maturation phase. For example, LEC1 acts combinatorially with different sets of transcription factor to regulate distinct processes during seed development, including the transition from the morphogenesis to the maturation phase. We also made the unexpected discovery that *LEC1* and *LEC2* greatly enhanced totipotency, causing tissues overexpressing either transcription factor to promote somatic embryo development.

The final component of my seed development research has been a long-standing collaboration with Bob Goldberg to define the biological processes that occur in different spatial seed compartments and the gene networks that govern these processes. We profiled RNA populations in regions, tissues, and cell types of Arabidopsis and soybean seeds using laser capture microdissection. These data allowed us to generate an atlas of gene activity and biological processes that occur in previously unexplored compartments of the

seed. We also profiled RNAs in single nuclei of soybean seeds. Integration of the LCM and single nucleus sequencing datasets allowed us to define the transcriptomes of seed cell types and states and the biological processes and gene networks that operate in these cells.

A second, enduring passion that has characterized my entire academic career is the training future scientists and classroom teaching. I am fortunate to have trained in my lab many smart, talented, enthusiastic, and driven individuals as postdoctoral scholars, graduate students and undergraduate students. After leaving my lab, these individuals followed different career pathways according to their interests, and they moved into positions of prominence and leadership positions in academic research and/or teaching, university leadership, government laboratories, and industry. Each individual has made their own impact in their positions, and they have trained or taught others, thus amplifying my small contribution to their education. A broader amplification comes from the students whom I taught in the classroom. I was fortunate to have been in environments in which teaching was valued. My undergraduate, graduate, and postdoctoral advisors were all dedicated and talented teachers. As a Professor, I was a member of a Department that placed a strong emphasis on teaching and had a strong tradition of teaching excellence. This background provided me with the inspiration to become an effective teacher. In my classes, I seek to enhance student engagement by encouraging classroom discussion. I also stress critical thinking by discussing the experimental approaches that led to key scientific discoveries and emphasizing problem solving on homework assignments and examinations over memorization. I was excited by the advent of active learning approaches, because they provided additional tools to promote student engagement and learning. Perhaps my most cherished honor was receiving a teaching award from UC Davis.

Another of my passions has been efforts to increase the diversity of participants in science. My reasoning is that numerous studies have shown that diverse groups of individuals generate more creative and innovative solutions to problems than homogenous groups. Additionally, as a Garfield High School graduate, I am acutely aware of the challenges faced by individuals in underrepresented communities. Therefore, I have been particularly interested in increasing the participation of students from underrepresented groups in science.

I was fortunate to have the opportunity to participate in many activities to promote inclusion in several capacities at UC Davis and as a member and later chair of the ASPB Minority Affairs Committee, now known as the Equity, Diversity, and Inclusion Committee. I was also able to expose students to diversity at a global level. The College of Biological Sciences at UC Davis has a long-standing collaboration in graduate education with the Nara Institute of Science and Technology in Japan and the Institute of Genetics and Developmental Biology of the Chinese Academy of Sciences in Beijing. I had the pleasure of co-directing UC Davis' involvement in this collaboration in which graduate students from each institution participated in a week-long workshop in which they shared their research and worked together on group projects. I also co-led a distance learning journal club between graduate students at UC Davis and NAIST annually with Professor Keiji Nakajima, and I helped to make arrangements for NAIST students to spend a month doing research in UC Davis labs. These experiences exposed students to how science is conducted in different countries and introduced them to colleagues from other cultures that they may work with for the remainder of their careers.

What advice would you offer a young person considering a career in plant biology?

My advice is not limited to those considering a career in plant biology but, rather, is broadly applicable to those interested in a career in science.

First, obtain the best possible training in science, as this will serve as the foundation for your career. In addition to gaining expertise in the concept and tools of your scientific discipline, learn to communicate effectively, both in written and oral forms. I received tremendous training in these competencies from my mentors, and these skills proved to be instrumental throughout my career. I include learning to teach to be among these communication skills. Regardless of your chosen profession, you will be teaching others.

Second, identify your passion in science, and make a plan that will allow you make a career out of pursuing this passion, whether as a professor, government or industrial scientist, teacher, clinician, scientific writer, communicator, patent agent,

or consultant. There is no greater success in life than having a job that you truly love. But, be prepared to adapt your specific approaches and goals to stay current and accommodate advances in your discipline.

Third, create a mentoring network, and consult with your mentors regularly. Develop relationships with different individuals who can mentor you about distinct aspects of your life, such as your scientific field, professional development, and work-life balance. Reciprocate by taking advantage of opportunities to mentor others. I have had many, many mentors throughout my career, and, collectively, they account in large part for my career accomplishments. And I have never failed to learn from my mentees.

Fourth, strive to create an inclusive environment in your workplace that promotes diversity and helps to increase the participation of individuals from underrepresented groups. Because diversity promotes creativity, having a diverse group is likely to increase its robustness and productivity.

Finally, when things aren't going well and you are out-of-your-mind busy, just remember the five-year rule. This rule states that it will always seem that your life was so much easier five years earlier no matter where you are in your career. The take-home message is to be resilient - because your life now is not as busy or complicated as it will become.

In closing, I would like to acknowledge and express my deepest appreciation to three groups of individuals who helped me greatly during the course of my career.

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