ASPB Pioneer Member

Z. Renee Sung

How did you spend your career and what do you consider your important contributions to plant science?

I was born in Shanghai and grew up in Taiwan, where I was educated through my college years. In the summer of 1967, I received a Bachelor of Science (BS) degree from the National Taiwan University (Taida). Newly graduated, I flew for the first time in my life, halfway around the world, to join my family who had moved to West Berlin while I was finishing my education.

In Germany, I found the educational system didn't recognize my BS degree. So in the Fall of 1967, I enrolled at Frei University in West Berlin in order to accumulate enough units for graduate study in Germany. At the same time, I volunteered to do research in the Max Planck Institute of Cell Physiology directed by Dr. Otto Warburg. Upon learning that I'd received graduate admission in plant physiology and a research assistantship in Dr. Arthur McLaren's lab, for which I had applied in my senior year at Taida, I immediately left my family and the severe West Berlin winter to attend the University of California at Berkeley.

Dr. McLaren's lab was in the Soils and Plant Nutrition Department in Hoagland Hall at UC Berkeley. Hoagland Hall is where the formula for Hoagland solution was developed, which became the basis for formulation of the MS medium used for plant tissue culture. I started my work there by studying the nutritional value of macromolecules, such as the protein lysozyme. Being a basic protein, lysozyme reacts with the negative charges on root cell surfaces, where it disrupts new cell wall formation. In the presence of lysozyme, the fast- growing cells in the root elongation zone can't form new cell walls, leaving them practically naked. Looking down the microscope one day, I saw strange bubbles exuding from the root epidermis. After frantically searching through the literature in the library, I learned these bubbles of cytoplasm are called "protoplasts."

At the dawn of molecular biology in the early seventies, I learned of DNA and RNA, and I wondered what would be the effect of DNA on plant cells. Indeed, several researchers, including Professor Lucein Ledoux in Belgium, were already studying DNA uptake by germinating seeds, hoping to achieve genetic transformation in plants. At the same time, Dr. Peter Carlson at Yale University was launching the field of plant somatic genetics. These events marked the beginning of my interest in genetic research.

My serendipitous encounters with protoplasts, tissue culture, and DNA uptake led me to join Dr. Ethan Signer's lab at MIT as a postdoc in 1973. Dr. Signer, along with Dr. Arthur Galston, were the first Western scientists to visit China in 1970, after two decades of a closed-door policy. Inspired by his experience in China, upon his return to MIT Dr. Signer, a phage geneticist, decided to perform agricultural genetic research in the laboratory. He hired me to carry out a plant somatic genetics project.

In the middle of the 1970's, academic positions were scarce. Fortunately, my switch to the new field of somatic genetics landed me a job at UC Berkeley. So, in 1976 I moved back to Berkeley with a joint assistant professorship between the Departments of Genetics and Plant Pathology. While continuing to build a somatic genetics system using carrot tissue culture, I became interested in embryo development. I was mesmerized by seeing a flask of carrot somatic embryos floating freely in liquid medium. In fact, I was so moved by my work with carrot embryos that it was heart-breaking to wipe spilled embryos off the bench of the laminar flow hood.

To investigate the genetic basis of embryogenesis, my postdoc,

continued on next page

Z. Renee Sung *continued*

Annick Breton, successfully isolated temperature-sensitive embryogenesis mutants. To continue this line of investigation, we formed a collaboration with Mario Terzi and Fiorella Lo Schiavo in Pisa, Italy. However, the technical difficulties surrounding plant somatic genetics remained and hampered our ability to elucidate the mechanism of somatic embryogenesis.

After I received tenure, we began to use molecular biology tools to study embryo development in the hope of finding the genes that control embryogenesis. We identified many embryo-specific genes. However, most of them specified late embryo abundant proteins (LEA). LEAs were thought to be involved in protecting the embryo during dormancy and desiccation and providing metabolites for the germinating seedling. Consequently, these genes could not help us understand how embryos are formed. Nevertheless, my interest in developmental biology grew and I began to offer courses on plant development, in part just to educate myself.

In the 1980's, there were intense discussions on the choice of model organisms for plant biology research. At the Arabidopsis meetings I attended, exciting research findings were presented by mammalian and bacterial geneticists who had recently switched to studying Arabidopsis. Surely, I thought, a plant biologist like me ought to be able to succeed in the crowded field of Arabidopsis research. One day, I received a bag of Arabidopsis seeds from Dr. Chris Somerville, who was mailing them to scientists to promote Arabidopsis research, and that is how I started my research program on Arabidopsis.

Most plant developmental processes take place after germination. So my team and I began by isolating mutants impaired in seedling development, instead of embryo-lethal mutants, which I reasoned were mostly impaired in house-keeping genes. We identified many developmental mutants that provided new insights into the principles of plant development, e.g., rootmeristemless (rml) and embryonic flower (emf). Since the rml mutants have a root but no root meristem, we argued that the root gives rise to the meristem, not vice versa. Since emf mutants flowered upon germination, we proposed that "flower" is the default state and is repressed to allow leaf formation. These concepts were at odds with the conventional wisdom around "cell theory" of the past few decades, but in fact they were compatible with the understanding of many plant morphologists.

To prove our hypotheses, we launched into the arduous task of cloning genes. Since this was prior to the elucidation of the Arabidopsis genome, the goal of cloning genes would cost my students and postdocs many years of their youth. Fortunately, they all moved on to independent positions and have had successful careers. After gene sequences were deciphered, to understand the function of EMF genes my postdocs and I launched into the challenging field of epigenetics until my retirement in 2016.

Technology advancements strongly influenced my research directions. I had the good fortune to be able to switch research programs based on my interests and to employ cutting edge technologies. We were often greeted by failures rather than successes, in terms of our original objectives; however, unexpected results led to breakthroughs that truly moved the field forward. It was these eureka moments that made the long hours and hard work worthwhile. Upon publication of our findings, we always broke open a bottle of Champagne to celebrate!

I am grateful to all the dedicated and talented students and postdocs who worked with me, including numerous undergraduate students. I owe my career to them – Ian Furner, Chumpol Borkird, Susan Sell, David Ow, Anette Chan, Annick Breton, Tod Jones, Fiorella Lo Schiavo, Gerald Franz, Polys Hatzopolos, Ron Okimoto, Jane Smith, Jung Choi, and Pascale Goupil for our carrot somatic genetic and embryogenesis work; Shunong Bai, Linda Castle, Chang-Hsien Yang, Kvin Lertpiriyapong, Regina McClinton, Orna Kretchmer, Jim Matsson, Kevin Seeley, Rob Wilson, Lingjing Chen, Yong-Hwan Moon, and Dominique Aubert for Arabidopsis

continued on next page

Z. Renee Sung *continued*

molecular genetic studies; and Myriam Calonje, Rosario Sanchez, S.Y. Kim, Maosen Liu, and Li Pu for our epigenetics studies. Finally, Janet Cheng was responsible for all the anatomic work and the beautiful pictures in our publications. As we always said, without anatomy, there is no development!

What advice would you offer to someone considering a career in plant science research?

You can learn the basic principles of biology by studying plants, because plants are made of the same kind of genetic and biochemical molecules as animals. You can also learn the mechanisms of how an organism operates on the individual as well as the community level by studying plants, because, unlike an animal, a plant functions like a community in which individuals interact with each other and with the outside environment. With all these options available, you can't go wrong by pursuing a career in plant biology.