Finding My Path, Trusting My Voice

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Abstract I was a budding pianist immersed in music in Leningrad, in the Soviet Union (now Saint Petersburg, Russia), when I started over, giving up sheet music for the study of ciliates. In a second starting-over story, I became a refugee after emigrated to the United States, where I switched to studying carbohydrate-binding plant lectin proteins, dissecting plant vesicular trafficking, and isolating novel glycosyltransferases responsible for making cell wall polysaccharides. I track my journey as a plant biologist from student to principal investigator to founding director of the Center for Plant Cell Biology and then director of the Institute for Integrative Genome Biology at the University of California, Riverside and then being elected to the US National Academy of Sciences. I discuss implementing a new vision as the first and (so far) only female editor in chief of Plant Physiology, as well as how my laboratory helped develop chemical genomics tools to study the functions of essential plant proteins. Always wanting to give back what I received, I talk about my efforts to develop female scientist leadership in different countries and a constant theme throughout my life: a love of art and travel.

1 Motivations: How I Developed an Interest in Science

I was born in Germany. My father, Vladimir, a surgeon, and my mother, Alexandra, an X-ray technician, had met at a hospital in Germany, where both of them had been sent to work by the Soviet Union during World War II. In 1948, when I was a year and a half old, we came back to the Soviet Union. I was lucky to have very good parents. They loved me and my younger sister dearly, and we had a psychologically secure, happy, and loving home.

My childhood was not like that of many scientists, who fondly remember an interest in animals and plants and many hours spent exploring the outdoors. Studying piano since age six, I spent much of my childhood inside. I was a quiet child, and the long hours at the piano suited me. Constantly at the music school, I grew up exposed

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to symphonies and opera. Combined with the books that filled our apartment—our father read to us constantly—this created an enriching environment for me and my sister. I learned to be extremely disciplined, practicing for many hours a day. I attended a specialized music school that included a regular grade school in Leningrad (now Saint Petersburg). Even early on, I was certain that music and playing concert piano would be my life.

When I was in my last year of specialized music high school and planning to continue my music education, a teacher for my conducting class had a chat with me that turned my life upside down. It was the first time somebody questioned whether I could successfully compete as a concert pianist the rest of my life. I knew the career was fiercely competitive and required more than just incredible skills, but had grown up playing to receptive and appreciative audiences and thought I could make it. I started to question my abilities and aspirations and came to realize that although I was a very capable student, I would probably never be one of the select few at the top. After this realization, I was devasted and thought my life was over; however, I made a decision to start all over again. I dropped my last year of music school, went to evening high school, and worked as a music teacher to pay private tutors to learn chemistry, math, physics and biology. My life at this time was spent almost entirely working and studying, but the hard work paid off and I was able to pass exams and enroll in the Biology Department at Leningrad State University. There I continued studying hard to catch up with fellow students, many of whom came to the University from specialized physics, chemistry, math, and biology schools.

In retrospect, I am glad that I had a serious musical education, thanks to the dedication and support of my wonderful late parents. Studying for many years in a dedicated music school taught me to value and know high culture, be disciplined and organized. These traits have helped me in the past and continue to help and sustain me today. Later I have greatly appreciated the fact that my conductor teacher was very honest with me and I always tried to be very honest with my students and postdocs.

At the University, I was trained as a classical cell biologist and at that time it mostly meant working as an electron microscopist. I was working with unicellular organisms and was not a plant biologist. I married my fellow university classmate Alex Raikhel and we had our first son, Eugene in 1975. In 1978, I flew to Baku, Azerbaijan, to collect samples from the Caspian Sea, one of many such trips I had taken since becoming an assistant professor. After a few days, Alex and Eugene (almost three-year-old) joined me for a week of vacation time. On the return flight, on May 18, our plane crashed in a potato field between Moscow and Leningrad, killing some of the passengers on board. It was a large plane with many travelers, and the crash was a horrific experience. Our small family survived, but my perspective on life changed completely. Because my equipment and samples did not survive the crash, I had to get a statement for my institute from Aeroflot—the only available airline in the Soviet Union at the time—detailing how the equipment and collected samples had gone missing. This led to one of my most direct experiences with the Soviet system: The airline told me that I needed to go back to Baku, because as far as they were concerned, there had been no airplane crash! After some insistent prodding, I received an official paper statement that the crash was an “unexpected

landing". For me, it was the last straw: It became clear that we could not live in the Soviet Union anymore.

My husband and I disliked the Soviet system wholeheartedly and read samizdat, but we were always very careful with whom we shared our views; I would say we were silent dissidents. However, we knew that, being Jews, we could officially emigrate from the country. The saying at the time was that Jews were exchanged for grain from the United States. Later, I learned that this was due to an effort spearheaded in the United States by Senator Henry "Scoop" Jackson.

When I decided to leave USSR I already defended my Ph.D. and was an Assistant Professor at the Institute of the Academy of Science. I remember my laboratory supervisor at the Institute—a Member of the USSR National Academy of Science who had a chance to travel abroad—telling me I must have lost my mind to leave such a desirable position. He also said it was unlikely that I would get a job as a scientist in the U.S.; most likely, I would be sweeping the streets of New York and never have close friends. How wrong he was!!! In fact, we met later at an international cell biology meeting and he apologized for his prognosis.

I immigrated from USSR with my husband, Alex, also an Assistant Professor at the Institute of Zoology, Eugene and my mom, to Athens, Georgia in 1979 with a personal fortune of 25 dollars. Both of us had to start all over again as postdocs. My memory is that I felt completely lost and wondered how I could and would ever make the language, scientific and social transitions required to survive and succeed in this country. The late seventies were also not an easy time in the States: there was the Iranian crisis, the energy crisis, very high inflation and tremendous concerns about a recession and high unemployment. Our second son, Vincent, was born in Athens, Georgia in 1984 and after seven years on soft money we both were able to obtain our first permanent jobs in the U.S.

During the first year, at the University of Georgia I continue to study free-living ciliates. And even published a paper but honestly, I was bored. So, when I was offered it, I accepted a postdoctoral position in the cell biology laboratory in the Department of Botany. There was much excitement coming from the department at that time, and it was infectious. The department was active and fast paced, with many interesting lectures and a lot of buzz about isolating genes and doing gene transformation in plants—a stark contrast to the slow and swampy Department of Zoology, where I was before.

I later realized that the high-energy activity and enthusiasm were thanks to Professor Joe Key's vision for making the Department of Botany a leader among modern plant molecular biology departments. Key is also credited with helping to advance plant molecular biology in the United States. I experienced his knowledge first hand making first cDNA library and cloning wheat germ agglutinin in his laboratory. In the Botany Department I worked with graduate student Michael Mishkind, joining his project on lectins—proteins abundant in grains and legumes that bind carbohydrates and play an important role in plant immunity and responses to stress. We focused on wheat germ agglutinin. Michael taught me immunocytochemistry, and together we discovered that this protein is expressed in specific cell layers—the coleoptile and the embryonic root—of different grains, such as barley, wheat, and rye.

This lectin had different and interesting patterns of expression in these different agricultural plants. In wheat, it was expressed in the outer layer of the coleoptile; in rye, it was expressed in both the outer and inner layers; and in barley, it was completely absent from the coleoptile. We published the results of this work in Science which was one of the reasons, a few years later, that I was offered a position at the Plant Research Laboratory (PRL) at Michigan State University.

I did not know at the time that the PRL was the premier place in the country for plant biology. When I was invited for an interview, I proposed to extend our study of wheat germ agglutinin to understand the cell type–specific expression of these proteins and related lectins, both in monocots (such as rice and barley) and in dicots. The project was almost impossible to do then, and even today it is still very difficult in monocots, which have complicated polyploid genomes and long-life cycles and are difficult to transform. This type of study is easier in dicots, such as Arabidopsis and tobacco plants, but wheat germ agglutinin and other lectins we were studying are not present in these plants. The PRL was a very international institute at that time and I absolutely fell in love with it and was incredibly happy that I was offered a job there; my husband was offered a job at the Entomology Department. We moved from Georgia to Michigan in the summer on 1986. We packed our car, loaded with the boys, our cat, and the possessions we had accumulated by then, along with a little trailer full of monoclonal antibodies and frozen material in a nitrogen tank attached to the back (would have never allowed these days!)—not as dramatic as the move from the Soviet Union to Georgia, but still a major change for our family.

I became an Assistant Professor at the DOE Plant Research Lab when I was 39 years old. My colleagues and mentors at the PRL provided a local environment that was both stimulating and challenging, encouraging me to be the best possible scientist I could be. What I achieved was also due to the chance of time. I am a product of the age of molecular biology and now genomics with its rapidly expanding knowledge base and incredible information systems made possible by technological growth. This lucky moment in history has allowed all of us here today the privilege to be pioneers of new and fascinating frontiers.

In my lab, we studied cell biology of WGA and other chitin binding proteins and by the early 1990s, my laboratory was engrossed in trying to understand the mechanisms of trafficking of these proteins thorough the endomembrane system. Suddenly, I had found my research niche: intracellular organelle and membrane trafficking. We began to explore what the propeptides recognize and bind to and how vesicles move from one place to another, continuing to use a variety of standard biochemical, molecular biology, and genetic approaches.

I can give a simple analogy to explain protein trafficking. If we think about airspace and flight plans, we know that there are specific routes/pathways for flights and specific rules regarding air traffic. There are hubs where planes could be changed if malfunctions develop or detained if serious natural or man-made events occur. Protein trafficking in the cells is similar. After protein is synthesized, it has to be delivered to the proper part of the cell to perform its function. Sometimes protein arrives at the wrong place and the cell compensates for this mistake with built-in system redundancies. However, if the hub is extremely important, the mistake cannot be corrected

and the cell dies. This analogy, while simplistic, explains why we study the "rules and regulations" of protein trafficking in the cell. Many basic "rules" in eukaryotic cells are similar but as multicellular organisms, plants possess many specialized cell types, each surrounded by a cell wall and organized into tissues and organs. In addition, many proteins in plants are encoded by many similar genes (we call them multigene families). There are more multigene families in plants than in other organisms, probably because plants are sessile organisms and need more different ways/opportunities to deal with stress and environmental changes. Also, proteins function in various complexes with other proteins and this complexity brings specificity for a particular function. Therefore, we study the intricate network of "rules and regulations" for protein trafficking because it is key to the proper functioning of organelles in the live cell. I owe a great deal to my PRL colleagues, especially Professor Chris Somerville, who was an Arabidopsis expert and was particularly instrumental in advising me.

Another important project our laboratory began while at the PRL was the study of cell wall biosynthesis in collaboration with Prof. Kenneth Keegstra, a fellow plant biologist at the institute. In 1999, we were one of the two laboratories to isolate the first glycosyltransferase, an enzyme that decorates xyloglucan in the Golgi apparatus. Xyloglucan is a polysaccharide that is involved in plant cell wall biosynthesis. Subsequently, we found other enzymes that add other types of sugars to xyloglucan. Working on this project, I learned more about carbohydrates, chemistry, and gas chromatography than I had ever known before.

Working with energetic students and postdocs has always been the fun part of running a laboratory. What was hard in my transition to the PRL was the pressure of writing and waiting on grants over and over again. I was relatively lucky, I realize, in that I was always awarded national grants and in addition had support from the US Department of Energy thanks to the PRL's unique relationship with this department (the PRL was the only place in the country receiving millions of dollars of grant money for plant research). But with the Department of Energy's support came incredible pressure to perform and to publish in high-impact journals. In the beginning, it was quite overwhelming for me to balance writing grants, teaching, and running a laboratory.

Alex and I inevitably brought our work home with us. By the time we moved to Michigan, our sons knew all about their parents' proteins of interest. A few years into our time at Michigan State University, neither of them wanted to hear about genes, proteins, or their parents' model organisms. "No more wheat germ agglutinin or vitellogenin [Alex's mosquito's protein]," they would declare. I remember our younger son playing "family" with his animal toys: After the animal family had finished their dinner, he had the mom lion say to the dad lion, "It is my turn to go to the lab." The dad lion disagreed, thinking it was his turn. This was amusing but also an accurate depiction of our family life: Either Alex or I always tried to go back to the laboratory after dinner, while the other stayed home with the boys. On weekends, we spent Sunday together as a family (unless there was a looming grant deadline) but also divided Saturday into laboratory and family time. We talked about our research at home a lot, which might have deterred both boys from studying biology, but at least

they both saw how much we cared about and loved our work. Perhaps that is why Eugene chose an academic career and is now a cultural and medical anthropologist and professor at the University of Chicago.

There were many positive aspects to the structure that our careers gave our family life. We traveled a lot, both within the United States and abroad, and always took the kids with us. Both of our sons grew up aware of the world and its cultures and comfortable in new and unfamiliar situations. We constantly took them to concerts and museums, which is why, I would like to think, Vincent became interested in and studied music and became a professional composer. Vincent was very successful as a composer, but at some point, he realized that the competition in the music world is unbelievable. While I was visiting him in New York now quite a few years ago, he told me that he had decided to go back to school to become a medical doctor. He spent two years at Columbia in New York taking general science requirement courses and working as a tutor, entered to a medical school at Cornell University in New York and is now a physician at VA hospital in Seattle, WA. In a way, it seems to me that he has followed my path from music to biology via medicine.

2 Work Done: My Personal Scientific Approach

At the PRL, I had initially felt that I could only handle running my own laboratory—managing students and postdocs, writing grants, and teaching. But then, little by little, I realized that I could do more outside the scope of the laboratory, to give back. I had come to the United States with so little—no professional network to speak of, a language barrier, and no knowledge of the academic system—yet I had received mentorship, support, and career advice.

In 2000, as I was recovering from breast cancer treatment, I was asked if I would consider becoming the editor in chief of Plant Physiology, an international monthly journal that covers a wide range of plant science and is also one of the oldest plant science journals. By then, I had been on the editorial boards of several plant-focused and general science journals and was familiar with the work involved. Yet I had never been at the helm, and I saw the position as a new challenge and an opportunity to make a positive impact on the journal. The previous editor in chief, Maarten Chrispeels, who had held the position for eight years, did an incredible job, turning the journal into a future-facing, modern journal with high review standards. When I started, I felt the journal was poised to make a leap forward that would highlight the latest technology-driven insights in plant biology and widen its readership. I knew it would be a lot of work, but I also felt that it would be a fun challenge that would make a difference in the plant science community.

I set out to increase the visibility and influence of the journal and to not only move the content into the postgenomic era, but also energize the presentation of the content. I was able to invigorate the editorial board, bringing on associate editors who were leaders in their specialties to create an international and diverse team. To my amazement, every single one of the 71 scientists whom I asked to join agreed to

do so. We had scientists from 13 countries other than the United States, including Mexico, Italy, Argentina, and Israel. I am also proud to say that I was the first and (so far) only female editor in chief in the journal's 90-year history.

In the five years that I led the journal, Plant Physiology became the first plant-focused journal to publish genomic and systems biology research. We moved the journal online and managed to increase its impact. It was a very active and stimulating five years, and I could not have done it without incredible Plant Physiology staff and my personal assistant.

The editorship term was five years, and when I was asked to stay on longer, I realized how hard it is to stay creative and innovative on the same project. Perhaps this is different for others, but I have limits. The journal was a huge part of my life for five years, but in imagining an even brighter future for plant biology research, I stepped down in 2005. I was ready for the next step in my life!

So, after years at the PRL and the experience of being an editor in chief of Plant Physiology, I began to see that I could take on a leadership role. The PRL had offered me a director position, but I knew that I could never have a major leadership role there because that is where I had grown up as a scientist, so to speak. I had learned much from the PRL's director, Prof. Hans Kende, who had become a good friend because of our mutual love of science, music, and art: how to be a proactive leader, how not to let a situation escalates, and how an institute thrives when there are significant resources thanks to a well-supported infrastructure. Researchers can flourish only when they are well supported. Hans, who was instrumental in the success of the PRL, had shown me firsthand that this strategy works like a charm. He was an excellent scientist and a very smart human being, and I have tremendous respect for him. After observing him in action, I soon had my own opportunity to be a leader.

In 2001, was recruited by the University of California, Riverside (UCR). I moved my laboratory to the UCR where I became the founding director of the Center for Plant Cell Biology (CEPCEB). I loved the PRL and initially did not want to move. At the time, the UCR Department of Entomology was recruiting my husband. He had wanted to move away from Michigan's harsh weather for some time, but I had not been ready. But in 2001, the idea, for me, was becoming increasingly conceivable. Our younger son, was finishing high school, and our older son was already in graduate school at Princeton University. (By this time, our younger son had changed his name from Andrew to Vincent. He made the decision and changed his middle name to his first name at age 12 when I was on sabbatical in Australia, citing as his reason that there are too many Andrews.)

Both Alex and I were invited to visit UCR that February. I saw the ubiquitous citrus trees in bloom everywhere, and thought about how Shauna and Chris Somerville had already left the PRL for California and that, after ten years, it was perhaps time to find a new challenge. Both Alex and I received offers from UCR. I was hired by the chancellor, Raymond (Ray) L. Orbach; the dean of the College of Natural and Agricultural Sciences, Mike Clegg; and the department chair, Elizabeth (Betty) Lord, as a university distinguished professor and was given the Ernst and Helen Leibacher Endowed Chair and the chance to build a center for cell biology. But with formidable institutions like the University of California, Los Angeles, and the

University of California, San Diego, close by, I told Orbach that a center specifically for plant cell biology would be more realistic. I had a vision that the center, with an infrastructure of core facilities, would be open to all UCR researchers, regardless of whether they studied plant biology. Many scientists in the United States like to have their own equipment, but coming from Russia, I had learned that infrastructure that can be used by everyone helps everyone. I asked for new staff positions to run the core facilities—a bioinformatician, a microscopy facility coordinator, and eventually genomics instrumentation and proteomics experts, who would enable and empower the work of faculty and students—and the chancellor agreed.

At the time, in the late 1990s and early 2000s, the advent of genomics and proteomics technologies had increased the gene-to-researcher ratio exponentially. Researchers were now able to create snapshots of thousands of molecules inside the cell simultaneously. With this new systems biology approach in mind, the vision of the CEPCEB was to create a place where these technological tools would be accessible to all UCR researchers and where interdisciplinary work among biologists, engineers, computer scientists, chemists, and other researchers would increase our understanding of the complexities and dynamics of cells and tissues. I officially started in June 2001 as the founding director of the CEPCEB. Because Vincent was still in school in Michigan, for half a year we commuted so that he could finish school; we then finally moved to California in January 2002. I am proud to say that after just a few years three-quarters of the new center's faculty and staff were women, and that this is still the case today. By then, Orbach had been replaced as chancellor by France A. Cordova who later became the director of the National Science Foundation and she and I worked closely to bring the center together. It officially opened in October 2002. I was able to draw on my experience at the PRL and what I saw as improvements that could be made for the new center. Later, Cordova asked me to take over the directorship of the Institute for Integrative Genome Biology (IIGB), of which the CEPCEB is one of the centers.

When we celebrated the CEPCEB's tenth anniversary I transferred its directorship to my colleague and good friend Professor Julia Bailey-Serres and continued as director of the IIGB until my retirement in July 2016. Of course, the process of building the CEPCEB was not without challenges. Together with my colleagues, I worked like a horse to coordinate the center's facilities, hire the best creative new faculty possible and hire staff, create a new facility for chemical libraries, apply for several training grants, and organize workshops, which, in the end, changed the culture at UCR. At first, there were some who were not supportive of the way the center was coming together. But I just concentrated on my task to create a democratic, all-inclusive place for great plant research and research in general and tried to tune out any negativity. Eventually, I think many people saw that the CEPCEB was inclusive and that it made UCR a well-known biology research institution, but this took more than five years to achieve. I was elected to the National Academy of Sciences (NAS) in 2012. In May 2016, when Julia Bailey-Serres was elected to the National Academy of Sciences, we hosted a fantastic event. As far as I know, this makes the CEPCEB, IIGB and the UCR Department of Botany and Plant Sciences the only institute and/or department in the United States with four women who are members of the National

Academy of Sciences (Susan Wessler, Natasha Raikhel, Xuemei Chen and Julia Bailey-Serres). I also don't want to forget our CEPCEB colleague and friend the NAS member Sean Cutler.

When my laboratory moved to UCR, we continued vacuolar and protein trafficking projects. However, while still at the PRL, I had begun to think about the limitations of genetics for studying the essential processes of plants' endomembrane trafficking systems, including vacuole trafficking, endocytosis, and exocytosis. Endomembrane movement is complicated and dynamic, and we still know little about how plants regulate endocytic and secretory pathways. I saw the merits of using chemicals to perturb these essential processes in plants, as had already been demonstrated with mammalian cells. The small molecules would allow us to bypass the problems of redundancy and lethality, which are common features in plant genomes. We could increase or decrease the concentration of the chemicals, making the phenotype conditional in a way, with the added ability to wash out the chemical and reverse the phenotype. That is the power of chemicals.

I am most grateful to the Botany and Plant Science Department for giving me the Ernst and Helen Leibacher Chair. When I came to UCR in 2001 I wanted to set up a chemical biology platform for my own program and also the CEPCEB. I applied funds allocated by the administration for CEPCEB's inception to establishing microscopy, bioinformatics and later proteomics cores and to updating our Genomics capabilities. However, chemical biology/genomics was a new kid on the block, so-to speak, and I had to first see for myself whether or not the approach would be useful. This is where the Ernst and Helen Leibacher Chair funds became essential since I did not have outside funding for this project. Using this fund, I purchased the first chemical library of two thousand compounds and my lab performed the first chemical screen. Little by little, starting from scratch and making tons of mistakes, we began to learn how to design and conduct chemical screens. From the beginning, I understood that when screening several thousand compounds, it was important to design screens with very simple phenotype readouts. Eventually, we learned how to do this type of work and after we validated these chemical biology screens in our laboratory in collaboration, with the laboratories of Professors Jirı Friml and Eugenia Russinova at Ghent University in Belgium. Several CEPCEB's laboratories started to use the chemical libraries and perform screens, and incredible collaborations developed between biologists, chemists and bioinformaticians and computational people. We were successful in obtaining an IGERT grant based on this chemical genomics platform, insightful and groundbreaking papers were published, and CEPCEB /IIGB and UCR became known in the States and abroad for using and contributing to science with this technology. It does not mean that chemical genomics is CEPCEB's only contribution to the field of plant cell biology: there are many other fields for which CEPCEB is known.

I have been fortunate to be surrounded by strong and caring female scientists both at the PRL and at UCR. I have developed incredible relationships with these women, some of whom remain my closest friends, like my colleagues Professors Gloria Coruzzi (New York University), Joanne Chory (Salk Institute), Susan Wessler (now at UCR), Vicki Chandler (now at Minerva), and June Nasrallah (Cornell University)

and many more. Among my favorite memories is the 1994 Plant Molecular Biology Gordon Conference, where several of us, including the organizer, Vicki Chandler, found that we were, perhaps inadvertently, at the helm. As a comparison, only Gloria and Vicki had been speakers at the previous Plant Molecular Biology meeting. So now the momentum had changed, and colleagues dubbed us "the Power Women" that year. It was a pivotal time and a turning point: amid the laughter, we suddenly realized that it was women who were in charge of most of the sessions and giving the major talks. We recognized that we had a strong voice, and from that time on, we were really a team. We knew that we had had an impact when colleagues would later ask, "Who is going to be the next Power Women group?".

The support of fellow female plant biologists has been invaluable experience and growth as a scientist. Actually, this is now common in our field: We are supportive and thoughtful about our female colleagues and especially support and help develop young scientists in general. When I moved to UCR, I met Professor Betty Lord, who was the chair of the department and was instrumental in my hiring. Later, Betty became my close friend. After she and her husband moved from Riverside to Pasadena, I followed them. I have now gone full circle: from downtown Leningrad when I was young to downtown Old Pasadena now!

3 Science Today and Tomorrow

I have always been a cheerleader and supporter of female scientists and young people in general. But it was when I began to travel to Japan and then China that I found that I could make a true impact, particularly on the science careers of women, providing them with mentorship to reach their potential and being a voice of authority regarding their skill and intellect. As part of the Japan Society for the Promotion of Science's Fellowship for Research that I held in 1996 while on sabbatical in Japan, I encountered many brilliant female scientists who were resigned to work under the auspices of male researchers even though they were just as talented and capable of running their own laboratories. For two of these women, I am proud to say that I helped them to secure laboratories of their own. This prompted me to be bolder as I realized that I could encourage a cultural shift to bring women into the spotlight—not only as scientists in their own right, but also as leaders in the scientific community. After I completed the sabbatical, I began to travel frequently to China to give scientific talks on my laboratory's research. I saw that women made up the majority of the audience at my talks, and yet the scheduled meetings with scientists from the institutions, I visited took place only with men. When I did meet female researchers, it was mostly because they came up to me after talks to ask career questions in addition to scientific ones. Many of them were timid and conveyed the familiar "I am not good enough" sentiment about themselves.

These experiences inspired me to take action. I have worked directly with several universities in China as well as two institutes in Beijing and Shanghai, providing an example and mentoring the female scientists to be more self-confident and to

learn that their opinions and voices matter. I was head of an advisory board of a new joint institute between the John Innes Centre in the United Kingdom and two Chinese Academy of Sciences plant biology institutes located in Beijing and Shanghai, where we are trying to change the culture and incorporate better standards, especially for young researchers. There are many fantastic scientists in China, but the culture within the scientific community there has been slow to evolve and needs to embrace international scientific values: encouraging women and men in science to be bold researchers and to become prominent scientific leaders, and providing mentorship to young researchers to become more open to sharing their information and more independent scientists, rather than using their gifted hands to do only laboratory work. Although there have been many improvements, there is also still much to be done. However, I have encountered only encouragement and support in my efforts, and I have hopes that the culture is slowly changing for the better.

Another, perhaps lofty, project of mine is to foster a bigger and hopefully lifelong appreciation of visual art and music among younger scientists. Music did not turn out to be my profession, but it has been a running theme throughout my life. Music and art have enriched my life and sustained me through divorce, cancer, career stresses, and many other problems. I go to concerts and the opera in Los Angeles and the Metropolitan Opera in New York and Europe frequently and have a baby grand piano at home. At the PRL, I had a requirement for graduate students and postdocs leaving my laboratory. They had to have visited the Art Institute of Chicago at least once before leaving!

I have always felt a need to give back whenever I have found something that works well for me in my career, and I am now trying to do that with music and the arts. One project is to incorporate music into the agendas of science conferences. I have convinced the organizers of a science conference in China to add two 20-min classical Chinese and Western music performances in between scientific sessions. We call these exercises “creative disruptions.” There are many nearby universities with music departments, and we plan to have a chamber orchestra perform for the researchers in attendance. But my grand plan was to bring together scientists and artists from different disciplines—architects, musicians, animators, painters, cell biologists, mathematicians—and have them mingle their ideas. My gut feeling is that these two groups have a lot to learn from each other and will find ways to inspire each other. For example, one of Jonas Salk’s visions for his institute was to have the creation of art and science together. The science is going well, and it is time to focus on art as well!

My career has taken me all over the world, and I am thankful for that. I plan to continue to enjoy my wonderful children and grandchildren and would like to play an active part in their lives. I am traveling and often hiking a lot in the States and all over the world.

With a friend, I annually traveling to two national parks in the United States and one special place abroad. I also visit Italy, annually a country I love deeply and where I have several close friends. I find that scientists are particularly adventurous, seeking to go abroad to study and teach. My career has facilitated interaction with people from many different countries and cultures—scientists who have come through my

laboratory and the universities where I have worked and those I have met through conferences and sabbaticals—and some of them and their families became my friends for life. These friends all over the world have been a happy by-product of being a scientist. At the September 2016 European Network for Plant Endomembrane Research conference in Bordeaux, France, which I have attended every year since its inception, I was presented with a marvelous gift. The illustration, commissioned from a Belgium caricaturist (See Fig. 1), shows me seated at a baby grand piano on various textbooks in English and Russian, with the Golgi apparatus, endoplasmic reticulum, and other cellular components inside the piano; the chemicals my laboratory worked with coming out as music; and three women representing my support of women in science. The female sculpture placed as one of the piano's legs represents my general appreciation of art (I have quite a lot of art at home, and purchased this particular sculpture when visiting Luxembourg).

People wrote very nice things on the back; I was overwhelmed and completely surprised by this gift. At the retirement symposium organized by the IIGB, the scope of the international scientific family and community, I have helped to create was before me. I have mentored 47 postdoctoral fellows and 25 graduate students, some of whom were able to attend the retirement symposium. Seeing so many of them in the same room, along with many of my colleagues and friends from UCR and those who had flown in from different parts of the United States and around the world, was a humbling and gratifying experience.

Fig. 1 My caricature

4 Advice to the Next Generation of Scientists

I think that after reading my story above, you, future scientists, can clearly see my advice. Believe in yourself, find what you are interested in, do not afraid to ask many questions, work very hard and be open, kind and inclusive.

In biology research, when you ask a question, you always end up somewhere unexpected. Biology takes you on its own path and that it why it is so exciting and extremely interesting. My motto has always been: listen to nature. My laboratory never stayed on a true course of trafficking. We have contributed to protein machinery, cell wall biosynthesis, and plant physiology. I like to think that we tried to always be attentive to what nature was showing and teaching us. When my laboratory was at the PRL, we had already made observations that the function of trafficking is not only to deliver molecules from one place to another, but also to act in signal transduction crosstalk, development, and many other important events in the life of a plant. Every time we did a trafficking experiment, we saw interactions with hormones, with flowering, and with other components. We did as much as we could to make sense of the observations but then would always steer back to our main focus of plant cellular trafficking. We used all possible new technologies to answer our questions: we always learned something new! The postdocs would then take these interesting observations, start their own laboratories, and continue the path of unexpected biology findings.

I also would like to encourage young people to seriously consider research in plant sciences. Why plant science and plant cell biology are vital for everybody. People love and enjoy plants but not often remember how essential plants are for the well-being and health of humans and for a sustainable global environment on our planet. All animals including humans use plants in their diets. Most of the world farmland is already in use and currently feeding 7 billion people. However, by the year 2050 our planet will be populated by approximately 9 billion people and it will be necessary to use all available technologies and knowledge about plant growth and development in order to feed such a huge population. Animals, including humans, breathe because marine plants produce around 70–80% of the oxygen on our planet, allowing us to be here! We are clothed and make furniture largely from plants. Plants do not need us for all the above but we definitely need plants! We know a lot about the way plants develop (seeds germinate, seedlings grow and develop, plants flower) and respond and adapt to environmental conditions on a genetic level. We need to know much more, however, about what is happening on a cellular level to proteins in live cells during development or in response to different environmental conditions. If we know how a live cell works, we can think of clever ways to strengthen its "durability" and usefulness. This information is critical to addressing the challenges we face with the increasing worldwide demand for food, global warming, and clean energy production. We need young vibrant people to join our efforts to learn more and more deeply about plant science!

And finally, I would like to encourage young people to learn more about arts and music: this will make your life fuller and much richer.

I hear very often now about what an exceptionally difficult time it is for young people, and I agree that it is not easy. But it has never ever been easy! I hope that reading a part of my story young people see that one must believe in reaching for the stars. I never dreamt of being where I am today, but I always worked hard and loved doing science, working with people and love music and arts- all these events have made my life meaningful and exciting.

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For those who interested in more information about my life can refer to Natasha Raikhel article "Firmly Planted, Always Moving" published by Annual Review of Plant Biologists, in 2017, vol.68: 1–27

Natasha Raikhel studied the endosomal and vesicular trafficking to vacuoles in the model plant Arabidopsis thaliana. This important understanding of the basic biology of the plant cell endomembrane system can be translated to agriculture, to produce better crop fitness and increased production. She served as editor in chief of Plant Physiology, a major journal in plant sciences, and continue to be very active in several journals. She was the founding director of University of California, Riverside (UCR) Center for Plant Cell Biology and director of UCR's Institute for Integrative Genome Biology. Now retired, she has organized art exhibits and concerts at various European and Chinese scientific conferences and is working with universities and institutions in China, Europe and the USA to mentor and promote young scientists.