Upward Bound to a Ph.D. in Chemistry and Beyond

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"Mom! I am the only kid in high school who knows what an NMR is!" My career path to a Ph.D. in chemistry included raising a son. . .as a single parent. Once I made the decision to go back to college and to earn a degree, I realized that a career and a family life were hard to balance, but it could be done. I wanted a better life for my family and realized that this included getting a college education. This path to a Ph.D. in chemistry started in a small way in high school though I must admit that I did not like high school chemistry. I can say that I embraced a career in chemistry after working with some amazing mentors who helped me navigate undergraduate and graduate school as a student and as a single mom.

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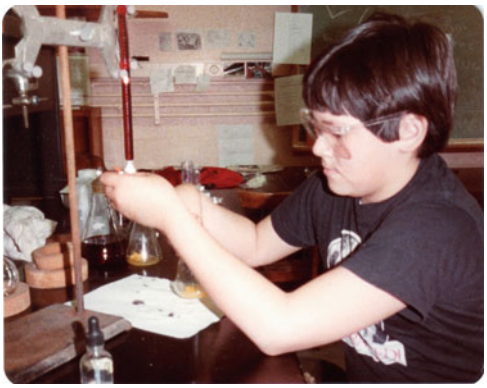

Daniel practicing titration for his sixth grade science fair project

I grew up in Prince Georges County Maryland, a suburb of S.E. Washington D.C. I am the oldest of seven children and one of two girls. My mother was always a stay-at-home mom and did not attend college. She did not know how to drive a car and still does not drive. My father divorced my mother when I was 13. Imagine seven kids, no transportation, very little child support, and no job. After looking back at this time in my life, I can honestly say that the Daughters of Charity at the Catholic schools that I attended, from kindergarten to grade 12, were my first mentors. They made sure that we received food baskets, toys, and clothes at holidays. I was given a scholarship to attend the girls' Catholic high school and bus money to make sure that I got to school. One year I was asked to work in the high school chemistry lab washing glassware and cleaning up the benches. Little did I know that my first introduction to chemistry would start me on a path to a Ph. D. in chemistry. In fact, at that time, I did not appreciate the beauty of chemistry but did appreciate the beauty of clean glassware! I did not realize that my high school chemistry teacher, Sister Mary Ellen, saw that I was an apprentice chemist. Today I tell my students that mentors have X-ray vision and can see things about you that you cannot see yourself.

During high school, I worked as a paper "boy" for a Washington daily newspaper. Keep in mind that during the late sixties, there were strictly defined job titles for males and females. I also babysat children in the neighborhood, a traditional job for a teenage girl. As a junior and senior in high school, I worked at Ford's Theater and National Theater in the evenings and on weekends as an usher. It was nice to have some spending money! I was a good student in high school but was not thinking about college. I did not know what I wanted to be when I "grew up." I knew that I did enjoy science. If I had any thoughts about college, I did not have a clue about how to start the college application process or where I would find the money to pay for college tuition. No one in my family had ever attended college or knew how to apply and I was told that there was no money for college. One day, however, the Sisters spoke to my mother about a new program for low-income students who had the potential to go to college. This program even paid the students a stipend for transportation, $10.00 per week! This program was called Upward Bound and was

held at Trinity College in Washington D.C. Once again, my mentors provided me with a door to a better future, an opportunity for a college education. I tell my students today that one should always listen to a mentor because his or her advice can take you farther than a car!

I attended Upward Bound at Trinity College for three years. I was delighted to be able to live on the campus during the summer and to not have to watch over my younger siblings. I looked forward to the Saturdays during the school year, where I could take the bus to Trinity College for classes, tutoring, lunch, and $10.00. Upward Bound showed me the possibilities that a college education could provide to a first-generation student who was eager to learn. Upward Bound showed me that I could succeed in college by providing me with supplemental instruction, tutors, and opportunities to explore majors. During the summers, I lived on campus, ate in the cafeteria, and attended classes. One year, I asked for a science and math tutor and was able to work one-on one with a Trinity student who was hired just for me! In addition to academic classes, we learned how to read college catalogs and to complete applications for admission and for financial aid. We took practice SAT exams and learned how to improve our study skills. Each summer, Upward Bound took us on trips to visit colleges and universities. We also took cultural trips to concerts and shows. I remember seeing the Alvin Alley Dance Theater and hearing Ray Charles at a concert. We also attended a Washington Senators baseball game. Life was more than watching my brothers and sister and I began to imagine the possibility of attending college as a science major.

At home, I was still expected to watch my brothers and sister and this turned out to be a major roadblock to college. So in a way, my family: brothers, sister, and mother did influence my career. I had decided that I wanted to major in a science and had applied to several colleges on the east coast, hoping for scholarships and grants. I found out later that I had received acceptance letters, but my mother did not understand that financial aid offers were sent in separate letters. She turned down offers of admission without telling me because there was no mention of funding. I learned about this several years later. I was accepted to the University of Maryland, a bus ride with two transfers, away. I could still live at home and attend college. I could still live at home and babysit. This was not my plan. I desperately wanted to get out of the house so I married the man I was dating, two months after I graduated from high school. I could attend college and live in an apartment and not have to babysit! At the time, this was heaven. But soon afterwards, I discovered that this was a mistake. I was pregnant by the end of the fall semester. I dropped out of Maryland, had my son, Daniel, and started a job as a clerical worker at an insurance company in Washington D.C. My college career was over, so it seemed.

Reviewing insurance applications and ordering new id cards for clients was not the life that I imagined, but we did get health insurance, the office was on a bus route, and my salary helped to pay the bills. After two years of marriage, I realized that my marriage was a huge mistake and moved out with my infant son. One year later, my ex-husband was killed drunk driving. My job at the insurance company paid the bills and provided health insurance; however, I wanted more for myself and my son. I

learned to drive for the first time and bought a car. I returned to Prince Georges Community College as a part-time student with hopes of becoming a pre-med major.

My first class was held in the evening at Andrews Air Force Base. It was a college algebra class with no more than two or three women in the section. Keep in mind that I was a clerical worker for five years. Clerical workers do not use algebra. I knew that I could ask questions so when the teacher started discussing "slope," I raised my hand and asked him to define a slope. He drew a "slope" on the board and laughed along with the class. I was not happy, but I was very determined. I told the teacher after class that I asked a legitimate question and that I would earn an "A" in his class and I did. I tell my students this story and remind them that no question is a silly question and that my job as a professor and mentor is to facilitate their learning.

This class and the few other classes that I took as a part-time student gave me the courage and the time to do the unthinkable: resign my job and go back to college as a full-time student. I needed to know that I could succeed in college. I also needed to know that I could afford college as a single mom. I was terrified of quitting a secure job, but I had to quit in order to move forward in my life and to find a satisfying career. It helped that my son was now in kindergarten and in a Head Start program which reduced my babysitting costs. My Upward Bound training kicked in and I was accepted as a full-time student at Prince Georges Community College, Maryland. I knew how to apply for financial aid and to search for private scholarships and grants. From the federal government, I received a Basic Education Opportunity Grant, BEOG, better known as the Pell Grant of today. I also wrote to my state senator, Steny Hoyer, for assistance with finding financial aid for college. Remember that there is no such thing as a silly question! As a result of my question to then state Senator Hoyer, I received a two-year full scholarship from the state of Maryland. Today, Congressman Hoyer represents the fifth District of Maryland and is the second-ranking member of the House Democratic Leadership. Though I have never met him in person, I am truly grateful that he took the time to provide a constituent with the help necessary to raise a child and earn a college degree. I consider him a mentor who supported my decision to return to college full-time at a time in my life when I had many doubts.

Now that my son and I were both full-time students, we settled into a routine, Wake up, pack lunch, eat breakfast, and head to school. After school, relax a little, prepare dinner, do homework, and get ready for bed. During the weekend, we cleaned house, washed clothes, studied, and visited the Smithsonian. I was a college student, pre-med major, and a mom. Life was hard, but finally, life was meaningful.

I enrolled in my first general chemistry course in the 1978 fall semester. I relearned the language of chemistry and fell in love with dimensional analysis. Where was dimensional analysis when I needed it in my math classes? In the spring 1979 semester, I truly enjoyed thermodynamics, balancing oxidation–reduction reactions, and solving chemical equilibrium problems in gen chem II. I still have my gen chem textbook, Nebergall fifth edition, though minus its front cover. My professor, Dr. Pat Cunniff, encouraged me to major in chemistry and suggested that I attend a summer program for women and minority students at the University of

Maryland professional school in Baltimore. I attend that program and she was right. I was not a pre-med student but a chemistry major. I listened to my mentor!

I flew through classes at Prince Georges Community College and transferred to the University of Maryland as a chemistry major. My son was growing up fast and was in elementary school full-time. A major obstacle for any parent is to find an amazing and trustworthy babysitter. I was fortunate that there was such a woman in the next apartment building who took care of neighborhood children like they were her own. How do I know this? Late one night, my son and I were outside watching something in the sky. It was too long ago and I don't recall the astronomical event that had us up late. It was dark and cold outside and our babysitter saw us standing in the parking lot. She hurried down thinking that her "baby" was hurt and we were waiting for an ambulance. Great babysitters are precious like gold and make a significant obstacle to work and family balance, childcare, turn into a small issue that is easily solved.

I mentioned earlier that there is no such thing as a silly question. I asked my way through my undergraduate program. Who is the best calculus teacher? I asked the chair of the math department and found an amazing calculus professor. How can I survive calculus-based physics? Visit the physics tutoring lab and practice problem solving. Should I take physical chemistry during the summer? Yes! I took both physical chem I and II during the summer session. I regret that Dr. Sandra Greer, 2004 Garvan-Olin Medal Recipient and winner of the 2014 ACS Award for Encouraging Women Into Careers in the Chemical Sciences, was not my physical chemistry professor. She is an outstanding advocate for women in chemistry and in STEM. Today, I consider her a mentor. What would undergraduate research do to help my career? Undergraduate research will introduce you to opportunities beyond that in a traditional laboratory course. I did find an undergraduate research mentor, Dr. Mike Bellama, who introduced me to basic research methods. My son was in sixth grade and I graduated with my B.S. in chemistry in 1981.

I am very happy to be the first in my family to graduate from college. I earned my B.S. in chemistry and shared my first graduation photo with Daniel

Life was good and I knew that I wanted more so I applied for and was accepted in the M.S. program at Maryland. Life was good but not good enough to go to another university out of state which would mean finding a new babysitter, new school for my son, and new housing. At Maryland, I was eligible for graduate student housing. My son was now ten years old and convinced me to give him a house key. The chemistry department was a 5 minute drive or 15 minute walk away from our apartment on the College Park campus. I was first nervous about leaving him early in the morning, 30 minutes before the school bus arrived, but several kids in graduate housing caught the bus and he did not want to be late in front of the other kids. He also checked in when he got back home with a quick phone call to my lab. Life continued to be good.

I conducted my M.S. research at the National Bureau of Standards, now called the National Institute of Standards and Technology. I synthesized barium and titanium sol-gel coatings and learned how to use an inert atmosphere glove box and how to tune an NMR. However, driving to Gaithersburg every day caused some stress, due to my son being at home in College Park. I mentioned earlier that babysitters are gold though we do not call a caregiver for a 10 year old, a babysitter! I found other moms in graduate housing who were happy to keep an eye on my son while I was off campus. Though I must say that 95% of these moms were not graduate students but were married to graduate students. As an undergraduate at Maryland, I had one class with one woman visiting professor and I did not have any classes with women faculty in the M.S. program. I was fortunate to find mentors at Maryland who understood that I was a grad student and a mom. However, I did start wondering about the absence of women faculty in chemistry and the sciences. I earned my M.S. in inorganic chemistry in 1984, and with a 12-year-old son, I was ready to start a Ph.D. program out of state.

Today I tell my undergraduates to ask many questions as they explore graduate program opportunities. What is your policy on comprehensive exams? Do you have to choose a research group by the end of your first semester? Can one interview both grad students and research directors before choosing a group? Is health insurance provided? How many seminars do you expect a grad student to give? Are there travel funds to present at professional meetings? What other training (proposal writing, IRB, safety) is provided to grad students? Will you pay my travel to visit your program and campus? Ask questions before you make that critical decision about a graduate program. I must admit that I did not ask all of the questions that I should have asked when considering Ph.D. programs. Ask questions that are important to you. I did mention that I was a single parent with a son. One professor told me about the preschool program on his campus. I quickly learned to mention that my son was in eighth grade and that I was not the typical grad student with younger children. After many questions and three campus visits, I decided to attend the University of South Carolina where I could afford to live on my graduate student stipend and raise a growing boy.

Our move to Columbia was not without problems. I discovered that I had to have knee surgery and postponed my Ph.D. program to January 1985. Once we arrived in town, my son was very nervous about starting a new school in a new state in the middle of the school year. He broke out in a rash and I had to find a local doctor

during the first week that we were in town. He spent the first 12 years of his life in the Washington D.C. area and was scared to leave all of the family behind. He also thought that he would be called a "Yankee." He was worried about a class that he (and all students) was required to take in seventh grade in Maryland: a quarter semester of sewing, shop, cooking, and Spanish. He did not want to be teased by new friends in South Carolina for taking sewing and cooking! He could deal with shop and Spanish. He was worried about his math skills and if he had to read extra literature books to catch up. His worries were legitimate but turned out to be groundless. He quickly made friends and, to my knowledge, was never called a "Yankee" or even a "Damn Yankee." He was ahead in math and helped his new friends understand "The Hobbit" which according to my son was disliked by all. Remember that this was over twenty five years ago before the Hobbit films that we love today. We both agreed that the spring 1985 semester was a tough one without family and longtime friends in the neighborhood, but we survived. Thinking aback on this major change in our life, I would not have done anything differently. I took the time that I needed to be "Mom" apart from my being a graduate student. Make time for your child because he or she will grow up so quickly. Your research will still be there for you.

We settled into a routine once that spring semester was over. During the summer, my son hung out with his new friends and I hung out in the Odom research lab. I took my time to find an understanding research advisor who accepted that I was both a single mom and a graduate student. It was important that whomever I worked for would recognize that sometimes I had to be a mom, especially a mom to a teenage son. I decided to work for Jerry Odom for several reasons. I was intrigued by the vacuum line chemistry at NIST and thought that I would enjoy learning new techniques. I also wanted to move to p block of the periodic table. I wanted to learn new chemistry and found that Group 14 and Group 16 chemistry was the focus in the Odom research group. I could learn new synthetic methods using my personal vacuum line! The Odom group also used NMR extensively to characterize products and to follow reactions, but this was not the usual ^{1}H or ^{13}C NMR. We played with ^{29}Si and ^{73}Ge as well as ^{77}Se and ^{125}Te. What fun! My son and I were finally at home in South Carolina. Daniel was happy at Irmo High School, home of the world famous, so I was told, Okra Festival. I don't recall eating okra except if it was hidden in soup. I never ate the favorite southern breakfast food, grits, while living in South Carolina. This was our life in South Carolina!

My classes and comprehensive exams were over and my focus was on my research. I spent many long weekends running NMR experiments. My son would come with me and do his homework while I set up my experiments. He often commented that he was the only high school student in South Carolina who knew what an NMR experiment was! Afterwards we would go shopping, see a movie, or visit friends. This worked great until Daniel was 15, that age when children become very vocal about driving and wanting a car. However, I was a graduate student raising a growing boy on a graduate student's salary. "Mom, I need a car," was his favorite sentence though sometimes it changed to "Mom, I need a Mustang." He got his learner's permit, and during the weekends, I taught him how to drive on empty parking lots on campus. He learned to drive on interstates by driving me to campus,

again on the weekends, when I needed to set up experiments. One morning he was trying to merge onto the highway and saw a line of tractor trailers quickly approaching his in lane. I laugh at this now because he was not asking for a car at this moment; instead he said over and over again "Trucks are coming!" After we arrived at campus and he realized that he survived highway driving, he still wanted a car!

My new saying became "Get a job if you want a car." He did and started working at a veterinary clinic on weekends and sometimes after school. We moved to South Carolina with one cat, Garfield, and one car. During our time in Columbia, our cat family grew to include Doris (named after Daniel's grandmother who does not like cats), Oreo, and Patches and a second car. There was peace at last for a while.

Time passed quickly and I was soon writing. Daniel was happy that I had reached this stage of my program and that my bench work was done. Raising a teenager while in graduate school was challenging and at times very funny. He did have a car but he also wanted a mom who did not smell like rotten garlic, the smell of selenium compounds. Each evening, I had to change clothes after a day in the lab because of the "garlic" (selenium) smell. We were in the grocery store one day and the clerk remarked that she smelled something funny. Of course, my son assumed that it was me and was totally embarrassed. He did not want to be seen in public with me in my fragrant lab clothes. He took over the grocery shopping and often made dinner during the week. I taught him how to use the best kitchen appliance in the world: the Crock Pot! He learned to make chili, soups, and became quite good with Crock Pot chicken and potatoes. We were a team with a common goal: graduation for both of us!

Dreams do come true. Daniel graduated from high school and I earned my Ph.D. in Inorganic Chemistry from the University of South Carolina

I completed my dissertation and was preparing to defend when a hiring freeze was put into place on campus. Jerry asked me to put off defending my dissertation till the very last day since he would not be able to pay me with the hiring freeze in place. See what I mean about finding the best research mentor! The defense day finally came and Daniel was in the audience. The presentation went smoothly and the questions began. I could see Daniel squirming in the back of the room. He did not understand the "defense" process and was getting upset about the nonstop questions. I reached a point where I could not answer a question and the defense was over. A lesson learned is to explain to your older children about the process that you are going through to earn an advanced degree. It requires long hours in the lab, in library, and writing. Grad students must be able to communicate their chemistry as a teaching assistant in the undergraduate lab, giving a departmental seminar, or presenting at a professional conference. Tell your children that being a grad student or research scientist is not the same as a 9–5 job but depends on the chemistry.

My son graduated from high school three days after I passed my defense and received my Ph.D. in inorganic chemistry. I would have never thought that one day I would earn a Ph.D. in chemistry when I was growing up in Washington D.C. Even today, I still am amazed that I have a Ph.D., but this should not be a feeling of amazement but one of confidence. This is another lesson learned that I share with my students. You can do anything if you have the determination and drive to succeed. Find mentors who understand that work (both undergraduate and graduate school) and family need to be balanced in a way that is best for you. Keep your mentors informed even when chemistry has to be pushed to the back Bunsen burner. Don't be afraid to ask questions. If you can't feel comfortable talking with your mentor then that partnership will not succeed. Remember the goal and do what is best for your family and for your science.

I moved to Dallas, Texas as a postdoctoral research associate in the lab of Patty Wisian-Neilson at Southern Methodist University. Continuing my tradition, I joined her group to learn new skills and polyphosphazene chemistry. I moved to Texas with four cats! Cats were not welcome in residence halls! Daniel stayed in South Carolina for college. He studied finance and now lives in Maryland with Bonnie, his wife, and their three children, Elaina, Waverly, and Logan.

I was still trying to find my chemical career path after my postdoc. I worked at the FDA lab in Dallas where I was an analytical chemist. It was an interesting job with great benefits and never boring. After a day identifying pesticides in cantaloupe or measuring how much mercury is in a shark, I was teaching intro chemistry at a community college twice a week. I really enjoyed interacting with students more than interacting with a GC-MS. I was not an analytical chemist, so I found a job in Fort Worth as a synthetic sol-gel chemist and lab manager. I soon discovered that a job in industry was not for me. After a search for a tenure-track position, I joined the faculty of the Department of Chemistry at Middle Tennessee State University in 1996. I am delighted to say that my husband, Charles Gross, a native Texan, retired and followed me to Tennessee. His job is now to take care of me, our cats, and our home.

Today I am a full professor and Director of the Women In STEM Center on campus. I am an advocate for our women students who sometimes still question if

they can have a career in chemistry and a family. We share stories, discuss options, and offer possible solutions. I encourage my students to consider all opportunities such as undergraduate research, internships, and professional presentations which will enhance their resume. I ask women students to step outside of their comfort zone and take on leadership roles on campus. Women can juggle and balance both a career in chemistry and a family. I know because I have a wonderful career in academia and a son who does know an NMR!

Daniel did not receive a car for his high school graduation. He did receive this t-shirt!

Main Steps in Judith's Career

Judith Iriarte-Gross earned her B.S. and M.S. in Chemistry from the University of Maryland, College Park, and her Ph.D. in Inorganic Chemistry from the University of South Carolina. She completed a postdoctoral research project at Southern Methodist University. Before joining Middle Tennessee State University (MTSU) in 1996, she worked as a chemist for the FDA and as a chemist and lab manager in the plastics industry. Dr. Iriarte-Gross mentors an active undergraduate research group in the scholarship of science education and has been involved with SENCER, Science Education for New Civic Engagement and Responsibilities since 2005. Dr. Iriarte-Gross is nationally known for her advocacy for encouraging girls and women in the sciences. She was named an Association for Women in Science (AWIS) Fellow in 2009. In 2009, she was named the director of the Women in STEM Center at MTSU, the only center for women in STEM in Tennessee. She is currently co-President of the Tennessee Chapter of AWIS and represents AWIS on the National Champions Board of the National Girls Collaborative Project.